TUHH
Hamburg
University of
Technology

Module Manual

Master of Science (M.Sc.)

Theoretical Mechanical Engineering

Cohort: Winter Term 2019

Updated: 27th January 2023

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Program description

Content

The 4-semester research-oriented master's degree (MSc) "Theoretical Mechanical Engineering" builds on research-oriented Mechanical Engineering-oriented undergraduate degree programs (BSc). Required are in-depth knowledge in mathematics and science and engineering fundamentals. The graduates acquire basic research and methodological oriented content, including interdisciplinary orientation, mechanical engineering knowledge and associated mechanical engineering expertise to develop mathematical descriptions, analysis and synthesis of complex technical systems methods, products or processes. In this course, the program combines the two most important theoretical and methodological areas, namely the simulation technology and systems theory. For this purpose, mathematical foundations and in-depth knowledge in areas such as the Technical dynamics, control engineering, numerical and structural mechanics are learned.

Career prospects

The master's degree program in Theoretical Mechanical Engineering prepares its graduates for professional and managerial positions in research and development. Through the course’s focus on theory-method-oriented content and principles as well as intensive scientific thinking training, graduates are qualified for a wide field of work, especially in the area of mechanical and automotive engineering, biotechnology and medical technology, power engineering, aerospace engineering, shipbuilding, automation , materials science and related fields.

Learning target

The graduates can:

• analyze and solve scientific problems, even if they are defined uncommon or incomplete and competing specifications

• formulate abstract and complex problems from a new or evolving the field of their discipline

• apply innovative methods in basic research oriented problem solving and develop new scientific methods

• identify information needs and find information

- plan and perform theoretical and experimental investigations

• Evaluate data critically and draw conclusions

• analyze and evaluate the use of new and emerging technologies.

Graduates are able to:

• develop concepts and solutions to basic research, partly unusual problems, possibly involving other disciplines,

- create and develop new products, processes and methods

• apply their scientific engineering judgment to work with complex, possibly incomplete information, to identify contradictions and deal with them

• classify knowledge from different fields methodically and systematically, to combine and handle complexity;

• familiarize themselves systematically, and in a short time frame, with new tasks

- To reflect systematically the non-technical implications of engineering activity and to act responsibly

• to develop solutions and further methodological skills.

Program structure

The course is divided into basic research core courses and an application-specific specialization. In addition to the core subjects and mathematics, students develop in-depth knowledge in areas such as technical dynamics, control engineering, numerical and structural mechanics. To deepen the foundations of application specific specializations, modules are selected. Other technical and non-technical elective courses may be selected from the range of subjects TUHH and the University of Hamburg. During the last semester the Master thesis is carried out.

The curricular content is thus divided into six groups:

• Key skills, required courses (24 ECTS)

• Key skills, electives (24 ECTS)

• Project Work (12 ECTS)

• A specialization (18 ECTS)

• General non-technical content (12 ECTS)

• Master's thesis (30 ECTS).

The areas of specialization are:

• Biological and Medical Engineering

• Energy Technology

• Aircraft Systems

• Maritime Technology

• Numerical and computer science

• Product development and production

• Materials Engineering

The choice of specialization is required, its contents are closely related to the research topics of the Institute. The key skills already acquired in undergraduate study for mechanical engineering are developed within the Master's program.

Core Qualification

Important

Module M0523: Business & Management

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	• Students are able to find their way around selected special areas of management within the scope of business management. • Students are able to explain basic theories, categories, and models in selected special areas of business management. • Students are able to interrelate technical and management knowledge.
Skills	• Students are able to apply basic methods in selected areas of business management. • Students are able to explain and give reasons for decision proposals on practical issues in areas of business management.
Personal Competence	
Social Competence	• Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems
Autonomy	• Students are capable of acquiring necessary knowledge independently by means of research and preparation of material.
Workload in Hours	Depends on choice of courses
Credit points	6

Course L1486: Business Model Generation & Green Technologies

Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	0
Lecturer	Prof. Michael Prange
Language	EN
Cycle	WiSe
Content	• Overview about Green Technologies • Introduction to Business Model Generation • Business model patterns • Design techniques for business ideas • Strategy development • Value proposition architecture • Business plan and financing • Component-based foundations • Lean Entrepreneurship Based on examples and case studies primarily in the field of green technologies, students learn the basics of Business Model Generation and will be able to develop business models and to evaluate start-up projects.
Literature	Präsentationsfolien, Beispiele und Fallstudien aus der Vorlesung Presentation slides, examples and case studies from the lecture

Course L1487: Corporate Entrepreneurship & Green Innovation	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Michael Prange
Language	EN
Cycle	WiSe
Content	• Overview about Green Innovation • Introduction to Corporate Entrepreneurship • Entrepreneurial thinking in established companies • Entrepreneurs and managers • Strategic innovation processes • Corporate Venturing • Product Service Systems • Open Innovation • User Innovation Based on examples and case studies primarily in the field of green innovation, students learn the basics of corporate entrepreneurship and will be able to implement entrepreneurial thinking in established companies and to describe strategic innovation processes.
Literature	Präsentationsfolien, Beispiele und Fallstudien aus der Vorlesung Presentation slides, examples and case studies from the lecture

Course L1280: Creation of Business Opportunities	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Examination Form	Referat
Examination duration and scale	30 Minuten
Lecturer	Prof. Christoph Ihl
Language	EN
Cycle	SoSe
Content	Important note: This course is part of an 6 ECTS module consisting of two courses "Entrepreneurship" & "Creation of Business Opportunities", which have to be taken together in one semester. Startups are temporary, team-based organizations, which can form both within and outside of established companies, to pursue one central objective: taking a new venture idea to market by designing a business model that can be scaled to a full-grown company. In this course, students will form startup teams around self-selected ideas and run through the process just like real startups would do in the first three months of intensive work. Startup Engineering takes an incremental and iterative approach, in that it favors variety and alternatives over one detailed, linear five-year business plan to reach steady state operations. From a problem solving and systems thinking perspective, student teams create different possible versions of a new venture and alternative hypotheses about value creation for customers and value capture vis-à-vis competitors. We will draw on recent scientific findings about international success factors of new venture design. To test critical hypotheses early on, student teams engage in scientific, evidence-based, experimental trial-and-error learning process that measures real progress. Upon completion of this course, students will be able to: · Apply a modern innovation toolkit relevant in both the corporate & startup world · Analyze given business opportunities in terms of its constituent elements · Design new business models by gathering and combining relevant ideas, facts and information · Evaluate business opportunities and derive judgment about next steps & decisions Course language is English, but participants can decide to give their graded presentations in German. Students are invited to apply to this course module already with a startup idea and/ or team, but this is not a requirement! We will form teams and ideas in the beginning of the course. Class meetings have alternate intervals of lecture inputs, teamwork, mentoring, and peer feedback. Attendance is mandatory for at least 80% of class time due to large proportion of teamwork sessions. Student teams give three presentations and submit them with backup analyses. Grading scheme: · Startup discovery presentation after 5 weeks: 30% · Startup validation presentation after 10 weeks: 30% · Final startup pitches after 13 weeks: 40%
Literature	• Blank, S. & Dorf, B. (2012). The startup owner's manual. • Gans, J. & Stern, S. (2016). Entrepreneurial Strategy. • Osterwalder, A. & Yves, P. (2010). Business model generation. • Maurya, A. (2012). Running lean: Iterate from plan A to a plan that works. • Maurya, A. (2016). Scaling lean: Mastering the Key Metrics for Startup Growth. • Wilcox, J. (2016). FOCUS Framework: How to Find Product-Market Fit.

Course L2348: Drivers of success for projects	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	0
Lecturer	Lucia Pohl
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Course L1384: Intellectual Property	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Janna Thomsen, Cathérine Elkemann
Language	DE
Cycle	WiSe
Content	• Trademark law • Copyright • Patent law • Know-how, supplementary performance protection, et al. • Enforcement of intellectual property rights • Licensing of intellectual property rights • Hypothecation, security assignment and evaluation of intellectual property rights
Literature	Quellen und Materialen wird im Internet zur Verfügung gestellt

Course L2347: Human resource management for engineers	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	0
Lecturer	Helge Kochskämper
Language	DE
Cycle	WiSe
Content	
Literature	

Course L1711: Innovation Debates	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	3 Präsentationen der schriftlichen Ausarbeitung à 20 Minutes
Lecturer	Prof. Daniel Heiner Ehls
Language	EN
Cycle	WiSe
Content	Scientific knowledge grows continuously but also experiences certain alignments over time. For example, early cultures had the believe of a flat earth while latest research has a spherical earth model. Also in social science and business management, from time to time certain concepts that have even been the predominant paradigm are challenged by new observations and models. Consequently, certain controversies emerge and build the base for advancing theory and managerial practice. With this lecture, we put ourselves in the middle of heated debates for informed academics and practitioners of the day after tomorrow. The lecture targets several controversies in the domain of technology strategy and innovation management. By the classical academic method and the novel problem based learning format of a structured discussion, a given controversy is scrutinized. On selected topics, students will discuss a dispute and gain a thorough understanding. Specifically, based on a brief introduction of a motion, a affirmative constructive as well as a negative constructive is presented by two different student groups. Each presentation is followed by a response of the other group and questions from the class. Topics range from latest theories and concepts for value capture, to the importance of operating within a global marketplace, to cutting edge approaches for innovation stimulation and technology management. Consequently, this lecture deepens the knowledge in technology strategy and innovation management (TIM), enables a critical thinking and thought leadership.
Literature	1. Course notes and materials provided before the lecture 2. Leiblein/ Ziedonis (2011): Technology Strategy and innovation management. Edward Elgar Publishing Ltd (optional)

Course L0940: Innovation Management	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Cornelius Herstatt
Language	DE/EN
Cycle	SoSe
Content	Innovation is key to corporate growth and sustainibility. In this lecture Prof. Herstatt presents a systematic way from generating ideas to the successful implementation of innovations. **The lecture is presented in German language only**
Literature	• Goffin, K., Herstatt, C. and Mitchell, R. (2009): Innovationsmanagement: Strategie und effektive Umsetzung von Innovationsprozessen mit dem Pentathlon-Prinzip, München: Finanzbuch Verlag **Weiterführende Literatur** • Innovationsmanagement Juergen Hauschildt • F + E Management Specht, G. / Beckmann, Chr. • Management der frühen Innovationsphasen Cornelius Herstatt, Birgit Verworn (im TUHH-Intranet auch als E-Book verfügbar) • Bringing Technology and Innovation Into the Boardroom • weitere Literaturempfehlungen auf Anfrage

Course L0161: Internationalization Strategies	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	20-30 Minuten Referat einschl. Diskussionsleitung plus schriftliche Ausarbeitung (ca. 10 Seiten)
Lecturer	Prof. Thomas Wrona
Language	EN
Cycle	SoSe
Content	• Introduction • Internationalization of markets • Measuring internationalization of firms • Target market strategies • Market entry strategies • Timing strategies • Allocation strategies • Working in small teams on close-to-reality problems based on presented theories • Paper writing on developed solution to the given problem/project e.g. market attractiveness analysis; development of market entry strategy for a hypothetical product in a given region
Literature	• Bartlett/Ghoshal (2002): Managing Across Borders, The Transnational Solution, 2nd edition, Boston • Buckley, P.J./Ghauri, P.N. (1998), The Internationalization of the Firm, 2nd edition • Czinkota, Ronkainen, Moffett, Marinova, Marinov (2009), International Business, Hoboken • Dunning, J.H. (1993), The Globalization of Business: The Challenge of the 1990s, London • Ghoshal, S. (1987), Global Strategy: An Organizing Framework, Strategic Management Journal, p. 425-440 • Praveen Parboteeah, K.,Cullen, J.B. (2011) , Strategic International Management, International 5th Edition • Rugman, A.M./Collinson, S. (2012): International Business, 6th Edition, Essex 2012

Course L2350: Leadership	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 min
Lecturer	Dr. Thomas Kosin
Language	DE
Cycle	WiSe
Content	
Literature	

Course L1231: Management and Leadership	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 Minuten
Lecturer	Prof. Christian Ringle
Language	DE
Cycle	SoSe
Content	• definitions and foundations of strategic management • strategic planning • strategic analysis and forecast • development of strategic options • strategy evaluaton, implementation and strategic control
Literature	- Bea, F.X.; Haas, J.: Strategisches Management, 5. Auflage, Stuttgart 2009. - Dess, G. G.; Lumpkin, G. T.; Eisner, A. B.: Strategic management: Creating competitive advantages, Boston 2010 - Hahn, D.; Taylor, B.: Strategische Unternehmensplanung: Strategische Unternehmensführung, 9. Auflage, Heidelberg 2006. - Hinterhuber, H.H.: Strategische Unternehmensführung Bd. 1: Strategisches Denken, 7. Aufl., Berlin u. a. 2004 - Hinterhuber, H.H.: Strategische Unternehmensführung Bd. 2: Strategisches Handeln, 7. Aufl., Berlin u. a. 2004 - Hungenberg, H.: Strategisches Management in Unternehmen, 6. Auflage, Wiesbaden 2011 - Johnson, G.; Scholes, K.; Whittington, R.: Strategisches Management. Eine Einführung, 9. Auflage, München 2011 - Macharzina, K.: Unternehmensführung: Das internationale Managementwissen, 7. Auflage, Wiesbaden 2010. - Porter, M.E.: Competitive strategy, New York 1980 (deutsche Ausgabe: Wettbewerbsstrategie, 10. Aufl., Frankfurt am Main 1999) - Welge, M. K.; Al-Laham, A.: Strategisches Management, 5. Auflage, Wiesbaden 2008.

Course L1857: Entrepreneurial Management	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	20 Minuten inklusive 15 Seiten Ausarbeitung
Lecturer	Prof. Christoph Ihl
Language	EN
Cycle	WiSe
Content	Important note: This course is part of an 6 ECTS module consisting of the three courses "Startup Engineering", "Startup Engineering Project" and "Entrepreneurship Management", which have to be taken together in one semester. Startups are temporary, team-based organizations, which can form both within and outside of established companies, to pursue one central objective: taking a new venture idea to market by designing a business model that can be scaled to a full-grown company. In this course, students will form startup teams around self-selected ideas and run through the process just like real startups would do in the first three months of intensive work. Startup Engineering takes an incremental and iterative approach, in that it favors variety and alternatives over one detailed, linear five-year business plan to reach steady state operations. From a problem solving and systems thinking perspective, student teams create different possible versions of a new venture and alternative hypotheses about value creation for customers and value capture vis-à-vis competitors. To test critical hypotheses early on, student teams engage in an evidence-based, experimental trial-and-error learning process that measures real progress. Upon completion of this course, students will be able to: · Apply a modern innovation toolkit relevant in both the corporate & startup world · Analyze given business opportunities in terms of its constituent elements · Design new business models by gathering and combining relevant ideas, facts and information · Evaluate business opportunities and derive judgment about next steps & decisions Course language is English, but participants can decide to give their graded presentations in German. Students are invited to apply to this course module already with a startup idea and/ or team, but this is not a requirement! We will form teams and ideas in the beginning of the course. Class meetings have alternate intervals of lecture inputs, teamwork, mentoring, and peer feedback. Attendance is mandatory for at least 80% of class time due to large proportion of teamwork sessions. Student teams give three presentations and submit them with backup analyses. Grading scheme: · Startup discovery presentation after 5 weeks: 30% · Startup validation presentation after 10 weeks: 30% · Final startup pitches after 13 weeks: 40%
Literature	• Blank, S. & Dorf, B. (2012). The startup owner's manual. • Gans, J. & Stern, S. (2016). Entrepreneurial Strategy. • Osterwalder, A. & Yves, P. (2010). Business model generation. • Maurya, A. (2012). Running lean: Iterate from plan A to a plan that works. • Maurya, A. (2016). Scaling lean: Mastering the Key Metrics for Startup Growth. • Wilcox, J. (2016). FOCUS Framework: How to Find Product-Market Fit.

Course L0863: Marketing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	WiSe
Content	**Contents** Basics of Marketing The philosophy and fundamental aims of marketing. Contrasting different marketing fields (e.g. business-to-consumer versus business-to-business marketing). The process of marketing planning, implementation and controlling Strategic Marketing Planning How to find profit opportunities? How to develop cooperation, internationalization, timing, differentiation and cost leadership strategies? Market-oriented Design of products and services

	How can companies get valuable customer input on product design and development? What is a service? How can companies design innovative services supporting the products? Pricing What are the underlying determinants of pricing decision? Which pricing strategies should companies choose over the life cycle of products? What are special forms of pricing on business-to-business markets (e.g. competitive bidding, auctions)? Marketing Communication What is the role of communication and advertising in business-to-business markets? Why advertise? How can companies manage communication over advertisement, exhibitions and public relations? Sales and Distribution How to build customer relationship? What are the major requirements of industrial selling? What is a distribution channel? How to design and manage a channel strategy on business-to-business markets? **Knowledge** Students will gain an introduction and good overview of • Specific challenges in the marketing of innovative goods and services • Key strategic areas in strategic marketing planning (cooperation, internationalization, timing) • Tools for information gathering about future customer needs and requirements • Fundamental pricing theories and pricing methods • Main communication instruments • Marketing channels and main organizational issues in sales management • Basic approaches for managing customer relationship **Skills** Based on the acquired knowledge students will be able to: • Design market timing decisions • Make decisions for marketing-related cooperation and internationalization activities • Manage the challenges of market-oriented development of new products and services • Translate customer needs into concepts, prototypes and marketable offers • Determine the perceived quality of an existing product or service using advanced elicitation and measurement techniques that fit the given situation • Analyze the pricing alternatives for products and services • Make strategic sales decisions for products and services (i.e. selection of sales channels) • Analyze the value of customers and apply customer relationship management tools **Social Competence** The students will be able to • have fruitful discussions and exchange arguments • present results in a clear and concise way • carry out respectful team work **Self-reliance** The students will be able to • Acquire knowledge independently in the specific context and to map this knowledge on other new complex problem fields. • Consider proposed business actions in the field of marketing and reflect on them.
Literature	Homburg, C., Kuester, S., Krohmer, H. (2009). Marketing Management, McGraw-Hill Education, Berkshire, extracts p. 31-32, p. 38-53, 406-414, 427-431 Bingham, F. G., Gomes, R., Knowles, P. A. (2005). Business Marketing, McGraw-Hill Higher Education, 3rd edition, 2004, p. 106-110 Besanke, D., Dranove, D., Shanley, M., Schaefer, S. (2007), Economics of strategy, Wiley, 3rd edition, 2007, p. 149-155 Hutt, M. D., Speh, T.W. (2010), Business Marketing Management, 10th edition, South Western, Lengage Learning, p. 112-116

Course L2440: Mergers & Acquistions (M&A)	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 min
Lecturer	Prof. Philipp Haberstock
Language	DE
Cycle	SoSe
Content	
Literature	

Course L0709: Project Management	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Prof. Carlos Jahn
Language	EN
Cycle	WiSe
Content	The lecture “project management” aims at characterizing typical phases of projects. Important contents are: possible tasks, organization, techniques and tools for initiation, definition, planning, management and finalization of projects. This will also be deepened by exercises within the framework of the event. The following topics will be covered in the lecture: • SMART, Work Breakdown Structure, Operationalization, Goals relation matrix • Metra-Potential Method (MPM), Critical-Path Method (CPM), Program evaluation and review technique (PERT) • Milestone Analysis, Earned Value Analyis (EVA) • Progress reporting, Tracing of project goals, deadlines and costs, Project Management Control Loop, Maturity Level Assurance (MLA) • Risk Management, Failure Mode and Effects Analysis (FMEA), Risk Matrix
Literature	Project Management Institute (2017): A Guide to the Project Management Body of Knowledge (PMBOK® Guide) 6. Aufl. Newtown Square, PA, USA: Project Management Institute. DeMarco, Tom (1997). The Deadline: A Novel About Project Management. DIN Deutsches Institut für Normung e.V. (2009). Projektmanagement - Projektmanagementsysteme - Teil 5: Begriffe. (DIN 69901-5) Frigenti, Enzo and Comninos, Dennis (2002). The Practice of Project Management. Haberfellner, Reinhard (2015). Systems Engineering: Grundlagen und Anwendung Harrison, Frederick and Lock, Dennis (2004). Advanced Project Management: A Structured Approach. Heyworth, Frank (2002). A Guide to Project Management. ISO - International Organization for Standardization (2012). Guidance on Project Management. (21500:2012(E)) Kerzner, Harold (2013). Project Management: A Systems Approach to Planning, Scheduling, and Controlling. Lock, Dennis (2018). Project Management. Martinelli, Russ J. and Miloševic, Dragan (2016). Project Management Toolbox: Tools and Techniques for the Practicing Project Manager. Murch, Richard (2011). Project Management: Best Practices for IT Professionals. Patzak, Gerold and Rattay, Günter (2009). Projektmanagement: Leitfaden zum Management von Projekten, Projektportfolios, Programmen und projektorientierten Unternehmen.

Course L1385: Project Management in Industrial Practice	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Dipl.-Ing. Wilhelm Radomsky
Language	DE
Cycle	WiSe
Content	• Project management in a company • Project life cycle / Project environment • Project structuring / Project planning • Deployment of methods / Team development • Contract / Risk / Change management • Multi-project management / Quality management • Project controlling / Reporting • Project organization / Project conclusion
Literature	• Brown (1998): Erfolgreiches Projektmanagement in 7 Tagen • Burghardt (2002): Einführung in Projektmanagement • Cleland / King (1997): Project Management Handbook • Hemmrich, Harrant (2002): Projektmanagement, In 7 Schritten zum Erfolg • Kerzner (2003): Projektmanagement • Litke (2004): Projektmanagement • Madauss (2005): Handbuch Projektmanagement • Patzak / Rattay (2004): Projektmanagement • PMI (2004): A Guide to the Project Management Body of Knowledge • RKW / GPM: Projektmanagement Fachmann • Schelle / Ottmann / Pfeiffer (2005): ProjektManager

Course L1897: Project Management and Agile Methods	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	Ausarbeitung eines Projektplans in Kleingruppen (ca. 5-10 Seiten)
Lecturer	Christian Bussler
Language	DE
Cycle	SoSe
Content	The Seminar teaches the basics of project management, which constitutes the foundations for technical as well as for business projects. It also includes a sideline about process management. The participants will work on the following questions: • What is a project and what challenges does it imply? • What methods have been developed to meet those challenges? • How have this methods evolved over time? What is “state of the art” today? • What basic skills should project members have? • What is the difference between project and process? How can the latter be analyzed? The approaches are not just taught theoretically, but put to use in group work. Through this approach, participants are enabled to work successfully on actual projects - and manage projects later on. As project work is increasingly important in work life, project management is a key skill for job applicants. Main topics of the seminar include: • The “magic triangle” of project objectives • Typical project phases • Key instruments and methods (project structure plan, RACI, Gantt chart) • Project organization and steering • Team communication and collaboration • The agile approach of Scrum • Process levels and cascading • Process improvement With the knowledge and experience from the seminar, participants should be able to acquire a basic certificate in project management with relatively little additional effort. The certification is available through institutions like GPM. Participants already start working on their homework paper in the group work. It comprises 5 to 10 pages and a structure plan for the chosen project, which can be done in Excel for example. Ideally, the members of the work groups write their homework paper together. The expected scale of the paper would increase in this case, yet not proportionally with the number of group members (4 participants would be expected to hand in a paper of 15-20 pages).
Literature	Hans-D. Litke, Ilonka Kunow; Projektmanagement. 3. Auflage 2015 Georg Patzak, Günter Rattay; Projektmanagement: Projekte, Projektpotfolios, Programme und projektorientierte Unternehmen. 6. Auflage 2014 G P M Deutsche Gesellschaft für Projektmanagement; Kompetenzbasiertes Projektmanagement (PM3): Handbuch für die Projektarbeit, Qualifizierung und Zertifizierung auf Basis der IPMA Competence Baseline Version 3.0. 6. Auflage, 2014 Tom DeMarco; Der Termin: Ein Roman über Projektmanagement. 2007 Jeff Sutherland, Ken Schwaber; Der Scrum Guide. Der gültige Leitfaden für Scrum: Die Spielregeln. Ständig aktualisiert, kostenloser Download auf http://www.scrumguides.org/ Jurgen Appello; Management 3.0: Leading Agile Developers, Developing Agile Leaders. 2010

Course L2349: Accounting and Financial Statements	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 min
Lecturer	Prof. Matthias Meyer
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Course L1293: Risk Management	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 Minuten
Lecturer	Dr. Meike Schröder
Language	DE
Cycle	WiSe
Content	Risks are inherent in every aspect of business, and the ability of managing risks is one important aspect that differentiates successful business leaders from others. There exist various categories of risk, such as credit, country, market, liquidity, operational, supply chain and reputational. Companies are vulnerable to risks. What makes such risks even more complex and challenging to manage is that the risks are often not within the direct control of the business executive. They can exist outside of the company boundary, and yet the impact to the company can be huge. The awareness and knowledge of how to manage risks in companies, will become increasingly important. Some of the main topics covered in this lecture include: • Targets and legal aspects of risk management • Risks and their impact • Risk types (classification) • Risk management and human resource • Steps of the risk management process and their instruments • Methods of risk assessment • Implementation of risk management • Management of specific risks This lecture is presented in German language only.
Literature	Brühwiler, B., Romeike, F. (2010), Praxisleitfaden Risikomanagement. ISO 31000 und ONR 49000 sicher anwenden, Berlin: Erich Schmidt. Cottin, C., Döhler, S. (2013), Risikoanalyse. Modellierung, Beurteilung und Management von Risiken mit Praxisbeispielen, 2. überarbeitete und erweiterte Aufl., Wiesbaden: Springer. Eller, R., Heinrich, M., Perrot, R., Reif, M. (2010), Kompaktwissen Risikomanagement. Nachschlagen, verstehen und erfolgreich umsetzen, Wiesbaden: Gabler. Fiege, S. (2006), Risikomanagement- und Überwachungssystem nach KonTraG. Prozess, Instrumente, Träger, Wiesbaden: Deutscher Universitäts-Verlag. Frame, D. (2003), Managing Risk in organizations. A guide for managers, San Francisco: Wiley. Götze, U., Henselmann, K., Mikus, B. (2001), Risikomanagement, Heidelberg: Physica-Verlag. Müller, K. (2010), Handbuch Unternehmenssicherheit. Umfassendes Sicherheits-, Kontinuitäts- und Risikomanagement mit System, 2., neu bearbeitete Auflage, Wiesbaden: Springer. Rosenkranz, F., Missler-Behr, M. (2005), Unternehmensrisiken erkennen und managen. Einführung in die quantitative Planung, Berlin u.a.: Springer. Wengert, H., Schittenhelm F. A. (2013), Coporate Risk Mangement, Berlin: Springer.

Course L1389: Key Aspects of Patent Law	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	
Lecturer	Prof. Christian Rohnke
Language	DE
Cycle	SoSe
Content	Mayor Issues in Patent Law: The seminar covers five mayor issues in german patent law, namely patentatbility, prosecution, ownership and employee inventions, infringement and licensing and other commercila uses. The lecturer will give an introduction to each issue which will be followed by in-depth inquiry by the participants through group work, presentation of results and moderated discussion.
Literature	wird noch bekannt gegeben

Course L1491: Startup Engineering	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	Ausarbeitung einer Geschäftsidee auf 20-30 Seiten (Inhaltsfolien zur detailliierten Dokumentation des Herangehensweise). Bearbeitungsdauer über den ganzen Kurs hinweg 13 Wochen, Zwischen- und Abschlusspräsentation jeweils 15 min plus 15 Diskussion.
Lecturer	Prof. Christoph Ihl
Language	EN
Cycle	WiSe
Content	Important note: This course is part of an 6 ECTS module consisting of the three courses "Startup Engineering", "Startup Engineering Project" and "Entrepreneurship Management", which have to be taken together in one semester. Startups are temporary, team-based organizations, which can form both within and outside of established companies, to pursue one central objective: taking a new venture idea to market by designing a business model that can be scaled to a full-grown company. In this course, students will form startup teams around self-selected ideas and run through the process just like real startups would do in the first three months of intensive work. Startup Engineering takes an incremental and iterative approach, in that it favors variety and alternatives over one detailed, linear five-year business plan to reach steady state operations. From a problem solving and systems thinking perspective, student teams create different possible versions of a new venture and alternative hypotheses about value creation for customers and value capture vis-à-vis competitors. To test critical hypotheses early on, student teams engage in an evidence-based, experimental trial-and-error learning process that measures real progress. Upon completion of this course, students will be able to: · Apply a modern innovation toolkit relevant in both the corporate & startup world · Analyze given business opportunities in terms of its constituent elements · Design new business models by gathering and combining relevant ideas, facts and information · Evaluate business opportunities and derive judgment about next steps & decisions Course language is English, but participants can decide to give their graded presentations in German. Students are invited to apply to this course module already with a startup idea and/ or team, but this is not a requirement! We will form teams and ideas in the beginning of the course. Class meetings have alternate intervals of lecture inputs, teamwork, mentoring, and peer feedback. Attendance is mandatory for at least 80% of class time due to large proportion of teamwork sessions. Student teams give three presentations and submit them with backup analyses. Grading scheme: · Startup discovery presentation after 5 weeks: 30% · Startup validation presentation after 10 weeks: 30% · Final startup pitches after 13 weeks: 40%
Literature	• Blank, S. & Dorf, B. (2012). The startup owner's manual. • Gans, J. & Stern, S. (2016). Entrepreneurial Strategy. • Osterwalder, A. & Yves, P. (2010). Business model generation. • Maurya, A. (2012). Running lean: Iterate from plan A to a plan that works. • Maurya, A. (2016). Scaling lean: Mastering the Key Metrics for Startup Growth. • Wilcox, J. (2016). FOCUS Framework: How to Find Product-Market Fit.

Course L1492: Startup Engineering Project	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	20 min
Lecturer	Prof. Christoph Ihl
Language	EN
Cycle	WiSe
Content	Important note: This course is part of an 6 ECTS module consisting of the three courses "Startup Engineering", "Startup Engineering Project" and "Entrepreneurship Management", which have to be taken together in one semester. Startups are temporary, team-based organizations, which can form both within and outside of established companies, to pursue one central objective: taking a new venture idea to market by designing a business model that can be scaled to a full-grown company. In this course, students will form startup teams around self-selected ideas and run through the process just like real startups would do in the first three months of intensive work. Startup Engineering takes an incremental and iterative approach, in that it favors variety and alternatives over one detailed, linear five-year business plan to reach steady state operations. From a problem solving and systems thinking perspective, student teams create different possible versions of a new venture and alternative hypotheses about value creation for customers and value capture vis-à-vis competitors. To test critical hypotheses early on, student teams engage in an evidence-based, experimental trial-and-error learning process that measures real progress. Upon completion of this course, students will be able to: · Apply a modern innovation toolkit relevant in both the corporate & startup world · Analyze given business opportunities in terms of its constituent elements · Design new business models by gathering and combining relevant ideas, facts and information · Evaluate business opportunities and derive judgment about next steps & decisions Course language is English, but participants can decide to give their graded presentations in German. Students are invited to apply to this course module already with a startup idea and/ or team, but this is not a requirement! We will form teams and ideas in the beginning of the course. Class meetings have alternate intervals of lecture inputs, teamwork, mentoring, and peer feedback. Attendance is mandatory for at least 80% of class time due to large proportion of teamwork sessions. Student teams give three presentations and submit them with backup analyses. Grading scheme: · Startup discovery presentation after 5 weeks: 30% · Startup validation presentation after 10 weeks: 30% · Final startup pitches after 13 weeks: 40%
Literature	• Blank, S. & Dorf, B. (2012). The startup owner's manual. • Gans, J. & Stern, S. (2016). Entrepreneurial Strategy. • Osterwalder, A. & Yves, P. (2010). Business model generation. • Maurya, A. (2012). Running lean: Iterate from plan A to a plan that works. • Maurya, A. (2016). Scaling lean: Mastering the Key Metrics for Startup Growth. • Wilcox, J. (2016). FOCUS Framework: How to Find Product-Market Fit.

Course L2409: Strategic Shared-Value Management	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	30 Minuten
Lecturer	Dr. Jill Küberling-Jost
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2295: Strategische Planung mit Planspielen	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	
Lecturer	Dr. Jan Spitzner
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2410: Technology Entrepreneurship	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	30 Minuten
Lecturer	Prof. Christoph Ihl
Language	EN
Cycle	SoSe
Content	
Literature	

Course L1351: Management Consulting	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	
Lecturer	Gerald Schwetje
Language	DE
Cycle	SoSe
Content	The Management Consulting lecture teaches students knowledge that is complementary to their technical and business administration studies. They learn the basics of consulting and agent-principal theory and are given an overview of the consulting market. They are also shown how management consulting works and which methodical building blocks (processes) are needed to deal with a client's concerns and to undertake a consulting process. By means of practical examples students gain an insight into the extensive range of management consultancy services and of functional consulting.
Literature	Bamberger, Ingolf (Hrsg.): Strategische Unternehmensberatung: Konzeptionen - Prozesse - Methoden, Gabler Verlag, Wiesbaden 2008 Bansbach, Schübel, Brötzel & Partner (Hrsg.): Consulting: Analyse - Konzepte - Gestaltung, Stollfuß Verlag, Bonn 2008 Fink, Dietmar (Hrsg.): Strategische Unternehmensberatung, Vahlens Handbücher, München, Verlag Vahlen, 2009 Heuermann, R./Herrmann, F.: Unternehmensberatung: Anatomie und Perspektiven einer Dienstleistungselite, Fakten und Meinungen für Kunden, Berater und Beobachter der Branche, Verlag Vahlen, München 2003 Kubr, Milan: Management consulting: A guide to the profession, 3. Auflage, Geneva, International Labour Office, 1992 Küting, Karlheinz (Hrsg.): Saarbrücker Handbuch der Betriebswirtschaftlichen Beratung; 4. Aufl., NWB Verlag, Herne 2008 Nagel, Kurt: 200 Strategien, Prinzipien und Systeme für den persönlichen und unternehmerischen Erfolg, 4. Aufl., Landsberg/Lech, mi-Verlag, 1991 Niedereichholz, Christel: Unternehmensberatung: Beratungsmarketing und Auftragsakquisition, Band 1, 2. Aufl., Oldenburg Verlag, 1996 Niedereichholz; Christel: Unternehmensberatung: Auftragsdurchführung und Qualitätssicherung, Band 2, Oldenburg Verlag, 1997 Quiring, Andreas: Rechtshandbuch für Unternehmensberater: Eine praxisorientierte Darstellung der typischen Risiken und der zweckmäßigen Strategien zum Risikomanagement mit Checklisten und Musterverträgen, Vahlen Verlag, München 2005 Schwetje, Gerald: Ihr Weg zur effizienten Unternehmensberatung: Beratungserfolg durch eine qualifizierte Beratungsmethode, NWB Verlag, Herne 2013 Schwetje, Gerald: Wer seine Nachfolge nicht regelt, vermindert seinen Unternehmenswert, in: NWB, Betriebswirtschaftliche Beratung, 03/2011 und: Sparkassen Firmenberatung aktuell, 05/2011 Schwetje, Gerald: Strategie-Assessment mit Hilfe von Arbeitshilfen der NWB-Datenbank - Pragmatischer Beratungsansatz speziell für KMU: NWB, Betriebswirtschaftliche Beratung, 10/2011 Schwetje, Gerald: Strategie-Werkzeugkasten für kleine Unternehmen, Fachbeiträge, Excel-Berechnungsprogramme, Checklisten/Muster und Mandanten-Merkblatt: NWB, Downloadprodukte, 11/2011 Schwetje, Gerald: Die Unternehmensberatung als komplementäres Leistungsangebot der Steuerberatung - Zusätzliches Honorar bei bestehenden Klienten: NWB, Betriebswirtschaftliche Beratung, 02/2012 Schwetje, Gerald: Die Mandanten-Berater-Beziehung: Erfolgsfaktor Beziehungsmanagement, in: NWB Betriebswirtschaftliche Beratung, 08/2012 Schwetje, Gerald: Die Mandanten-Berater-Beziehung: Erfolgsfaktor Vertrauen, in: NWB Betriebswirtschaftliche Beratung, 09/2012 Wohlgemuth, Andre C.: Unternehmensberatung (Management Consulting): Dokumentation zur Vorlesung „Unternehmensberatung", vdf Hochschulverlag, Zürich 2010

Course L0536: Management of Trust and Reputation	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	20-30 Minuten und Thesenpapier
Lecturer	Dr. Michael Florian
Language	DE
Cycle	SoSe
Content	The seminar offers a comparison and analysis of relevant theoretical concepts and practical issues in the corporate management of trust and reputation. Selected case studies will be used to discuss opportunities, problems, and limitations using trust and reputation to coordinate and control economic behavior.
Literature	Allgäuer, Jörg E. (2009): Vertrauensmanagement: Kontrolle ist gut, Vertrauen ist besser. Ein Plädoyer für Vertrauensmanagement als zentrale Aufgabe integrierter Unternehmenskommunikation von Dienstleistungsunternehmen. München: brain script Behr. Beckert, Jens; Metzner, André; Roehl, Heiko (1998): Vertrauenserosion als organisatorische Gefahr und wie ihr zu begegnen ist. In: Organisationsentwicklung 17 (4), S. 57-66. Eberl, Peter (2003): Vertrauen und Management. Studien zu einer theoretischen Fundierung des Vertrauenskonstruktes in der Managementlehre. Stuttgart: Schäffer-Poeschel. Eberl, Peter (2012): Vertrauen und Kontrolle in Organisationen. Das problematische Verhältnis der Betriebswirtschaftslehre zum Vertrauen. In: Möller, Heidi (Hg.): Vertrauen in Organisationen. Riskante Vorleistung oder hoffnungsvolle Erwartung? Wiesbaden: Springer VS, S. 93-110. Eisenegger, Mark (2005): Reputation in der Mediengesellschaft. Konstitution Issues Monitoring Issues Management. Wiesbaden: VS Verlag für Sozialwissenschaften. Florian, Michael (2013): Paradoxien des Vertrauensmanagements. Risiken und Chancen einer widerspenstigen immateriellen Ressource. In: Personalführung 46, Heft 2/2013, S. 40-47. Grüninger, Stephan (2001): Vertrauensmanagement - Kooperation, Moral und Governance. Marburg: Metropolis. Grüninger, Stephan; John, Dieter (2004): Corporate Governance und Vertrauensmanagement. In: Josef Wieland (Hg.): Handbuch Wertemanagement. Erfolgsstrategien einer modernen Corporate Governance. Hamburg: Murmann, S. 149-177. Meifert, Matthias (2008): Ist Vertrauenskultur machbar? Vorbedingungen und Überforderungen betrieblicher Personalpolitik. In: Rainer Benthin und Ulrich Brinkmann (Hg.): Unternehmenskultur und Mitbestimmung. Betriebliche Integration zwischen Konsens und Konflikt. Frankfurt/Main, New York: Campus, S. 309-327. Neujahr, Elke; Merten, Klaus (2012): Reputationsmanagement. Zur Kommunikation von Wertschätzung. In: PR-Magazin 06/2012, S. 60-67. Osterloh, Margit; Weibel, Antoinette (2006): Investition Vertrauen. Prozesse der Vertrauensentwicklung in Organisationen. Wiesbaden: Gabler. Osterloh, Margit; Weibel, Antoinette (2006): Vertrauen und Kontrolle. In: Robert J. Zaugg und Norbert Thom (Hg.): Handbuch Kompetenzmanagement. Durch Kompetenz nachhaltig Werte schaffen. Festschrift für Prof. Dr. Dr. h.c. mult. Norbert Thom zum 60. Geburtstag. Bern [u.a.]: Haupt, S. 53-63. Osterloh, Margit; Weibel, Antoinette (2007): Vertrauensmanagement in Unternehmen: Grundlagen und Fallbeispiele. In: Manfred Piwinger und Ansgar Zerfaß (Hg.): Handbuch Unternehmenskommunikation. Wiesbaden: Gabler, S. 189-203. Schmidt, Matthias; Beschorner, Thomas (2005): Werte- und Reputationsmanagement. München und Mering: Hampp. Seifert, Matthias (2003): Vertrauensmanagement in Unternehmen. Eine empirische Studie über Vertrauen zwischen Angestellten und ihren Führungskräften. 2. Aufl. München und Mering: Hampp. Sprenger, Reinhard K. (2002): Vertrauen führt. Worauf es im Unternehmen wirklich ankommt, Frankfurt/Main, New York. Thiessen, Ansgar (2011): Organisationskommunikation in Krisen. Reputationsmanagement durch strategische, integrierte und situative Krisenkommunikation. Wiesbaden: VS Verlag für Sozialwissenschaften. Walgenbach, Peter (2000): Das Konzept der Vertrauensorganisation. Eine theoriegeleitete Betrachtung. In: Die Betriebswirtschaft 60 (6), S. 707-720. Walgenbach, Peter (2006): Wieso ist Vertrauen in ökonomischen Transaktionsbeziehungen so wichtig, und wie lässt es sich generieren? In: Hans H. Bauer, Marcus M. Neumann und Anja Schüle (Hg.): Konsumentenvertrauen. Konzepte und Anwendungen für ein nachhaltiges Kundenbindungsmanagement. München: Vahlen, S. 17-26. Weibel, Antoinette (2004): Kooperation in strategischen Wissensnetzwerken. Vertrauen und Kontrolle zur Lösung des sozialen Dilemmas. Wiesbaden: Dt. Univ.-Verl. Weinreich. Uwe (2003): Vertrauensmanagement. In: Deutscher Manager-Verband e.V. (Hg.): Die Zukunft des Managements. Perspektiven für die Unternehmensführung. Zürich: Vdf, Hochsch.-Verl. an der ETH, S. 193-201.

Course L1381: Public and Constitutional Law	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	2 Stunden
Lecturer	Klaus-Ulrich Tempke
Language	DE
Cycle	WiSe/SoSe
Content	Different areas of public law; proceedings, jurisdiction of administrative courts with stages of appeal, members of the courts; Court levels, organization and legal capacity; Introduction to and structure of fundamental rights; Human dignity: the guiding principle of the constitution; General right of privacy and freedom of action.
Literature	

Module M0524: Non-technical Courses for Master

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 Nontechnical Academic Programms (NTA)** imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its **teaching architecture**, in its **teaching and learning arrangements**, in **teaching areas** and by means of teaching offerings in which students can qualify by opting for **specific competences** and a **competence level** at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses. **The Learning Architecture** consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechnical academic programms follow the specific profiling of TUHH degree courses. The learning architecture demands and trains independent educational planning as regards the individual development of competences. It also provides orientation knowledge in the form of "profiles". The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in one to two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making the transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation to study these subjects in one or two specific semesters during the course of studies. **Teaching and Learning Arrangements** provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dealing with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are deliberately encouraged in specific courses. **Fields of Teaching** are based on research findings from the academic disciplines cultural studies, social studies, arts, historical studies, communication studies, migration studies and sustainability research, and from engineering didactics. In addition, from the winter semester 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start-ups in a goal-oriented way. The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging goal-oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations. **The Competence Level** of the courses offered in this area is different as regards the basic training objective in the Bachelor's and Master's fields. These differences are reflected in the practical examples used, in content topics that refer to different professional application contexts, and in the higher scientific and theoretical level of abstraction in the B.Sc. This is also reflected in the different quality of soft skills, which relate to the different team positions and different group leadership functions of Bachelor's and Master's graduates in their future working life. **Specialized Competence (Knowledge)** Students can • explain specialized areas in context of the relevant non-technical disciplines, • outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area, • different specialist disciplines relate to their own discipline and differentiate it as well as make connections, • sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representation in the specialized sciences are subject to individual and socio-cultural interpretation and historicity, • Can communicate in a foreign language in a manner appropriate to the subject.
Skills	**Professional Competence (Skills)** In selected sub-areas students can • apply basic and specific methods of the said scientific disciplines, • aquestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline, • to handle simple and advanced questions in aforementioned scientific disciplines in a sucsessful manner, • justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.

Personal Competence	
Social Competence	**Personal Competences (Social Skills)** Students will be able • to learn to collaborate in different manner, • to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees, • to express themselves competently, in a culturally appropriate and gender-sensitive manner in the language of the country (as far as this study-focus would be chosen), • to explain nontechnical items to auditorium with technical background knowledge.
Autonomy	**Personal Competences (Self-reliance)** Students are able in selected areas • to reflect on their own profession and professionalism in the context of real-life fields of application • to organize themselves and their own learning processes • to reflect and decide questions in front of a broad education background • to communicate a nontechnical item in a competent way in writen form or verbaly • 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

Course L1775: “What’s up, Doc?” Science and Stereotypes in Literature and Film	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dr. Jennifer Henke
Language	EN
Cycle	WiSe/SoSe
Content	Popular novels and films significantly contribute to the public understanding of science and its representatives. How to define “good” or “bad” science is negotiated in a variety of artistic works. Stereotypes such as the “mad scientist”, which originated in early nineteenth century England, continue to persist. Mary Shelley created the prototype of the obsessive and reckless scientist in Frankenstein - The Modern Prometheus (1818) who conducts his forbidden experiments in a secret lab and crosses ethical boundaries. This masculine stereotype has been followed by further ones such as the noble, adventurous or clumsy scientist, whereas scholars have only recently begun to consider the representation of female science. First, this seminar is devoted to selected formations of knowledge in relation to literature from classical antiquity to the present. Second, the focus shall rest on the production of persistent stereotypes in various media formats such as novels or films while paying particular attention to the aspect of gender. The overall goal of the seminar is an understanding of science as a cultural practice. Requirements for participation: Shelley, Mary: Frankenstein. New York: Norton, 2012. Please pay attention to the exact publication dates.
Literature	Teilnahmevoraussetzungen: Shelley, Mary: Frankenstein. New York: Norton, 2012. Bitte ausschließlich diese Edition anschaffen.

Course L2064: 120 years of film history	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Prof. Margarete Jarchow
Language	DE
Cycle	SoSe
Content	The lecture deals with the relationship between the develpoment of film technology, film aesthetics, and society. Based on the nineteenth-century film's precursors such as the laterna magica, photography and kinetoscope, crucial stages of more than 120 years of film history are studied chronologically in terms of: How does the development of new media techniques reflect certain social changes and needs? What new forms of aesthetic expression are possible through such technical innovations as the introduction of sound film, color film or handheld camera? And to what extent do these new forms of aesthetic expression in turn reflect certain social sensitivities, ultimately the respective zeitgeist? Main topics of the lecture are: the technical euphoria of the 19th century, the early film, the German Expressionist film, the classic Hollywood cinema, the European postwar cinema, exploitation and underground cinema, New Hollywood, the blockbuster cinema, independent cinema up to current phenomena like the „cinema of dissolution“. On the one hand, the participants learn in-depth, detailed knowledge of the history, meaning and analysis of the medium film and thereby acquire media literacy. On the other hand, the participants should gain a deeper understanding of the real interdependencies of technologies in culture and society and their historical transformation processes through an interdisciplinary perspective on film (history of technology, media studies and social science).
Literature	

Course L1774: Applied Arts: Form and Function	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Prof. Margarete Jarchow, Dr. Christian Lechelt
Language	DE
Cycle	WiSe/SoSe
Content	From Arts & Crafts to modern Design - applied arts focus on the design of all kinds of products. Therefore applied arts allow to come to more thorough conclusions about social, historical, cultural issues. In the course the impact of social developments on these particular genres are discussed.
Literature	Wird noch angegeben Will be announced in lecture

Course L2338: Bauhaus architecture - a search for traces	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dr. Jörg Schilling
Language	DE
Cycle	WiSe/SoSe
Content	The „100 years of bauhaus“ centenery also involved examining the references, differences and similarities to Hamburg architecture from 1919-1933. The seminar intends to find these traces in social (i.e. Jarrestadt) and private (i.e. Landhaus Michaelsen / Puppenmuseum) housing as well as in numerous other building projects. During the excursions to buildings by Hamburg architects like Fritz Schumacher, Gustav Oelsner, Karl Schneider and others we will discuss aspects related to architectural modernism.
Literature	wird im Seminar bekanntgegeben

Course L1882: Facilitating groups in problem-oriented courses	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	Schriftliche Ausarbeitung (in mehreren Teilen) sowie eine Präsentation, Teilnahme an Gruppendiskussionen
Lecturer	Siska Simon
Language	DE
Cycle	WiSe/SoSe
Content	Content: - Changing the role of the teacher in problem-oriented courses - Structure and benefits of problem-oriented courses - Attitude and beliefs concerning teaching and learning - Question and discussion techniques - Group dynamic processes - Situation-related interventions - dealing with heterogeneous groups - Moderation and presentation - Interference levels and conflict management - Feedback processes and methods Methods: - impulse lectures and group work - Planning, execution and reflection of an exemplary course unit - Micro teaching and feedback - peer observation and feedback
Literature	Auszüge aus Fachliteratur zu oben genannten Themen werden in der Veranstaltung ausgegeben

Course L1990: Clash of Cultures. Film and TV series as images of the own and the other	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Jacobus Bracker
Language	DE
Cycle	WiSe/SoSe
Content	Images are negotiating concepts of the own, other and alien. Especially tv series like “Game of Thrones”, “Vikings”, or “The Walking Dead” and films like “Alien” or “Lord of the Rings” show clashes of cultures. Irrespective of their genre - fantasy, science fiction, or history - the moving images use always similar patterns to show and tell the own and the other. During the seminar we will deal with such concepts and concepts of culture and the specifics of film and series to watch and analyse selected examples from these perspectives.
Literature	Literaturhinweise, Texte etc. werden zu gegebener Zeit online zur Verfügung gestellt.

Course L1176: The end is near - Survival in the post-apocalypse	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dr. Marlis Bussacker
Language	DE
Cycle	WiSe/SoSe
Content	According to the FAZ in December 2015, the end of the world is booming. At all times, people have dealt with the imminent future scenario of ultimate horror - the collapse of their own world. Where does the idea of a final disaster come from? What's so fascinating about our own demise? During the seminar we will take a look at European cultural history, which is closely linked to mythological and religious prophecies about the end of the world. However, this question, or rather the question of survival in a post-apocalyptic world, has fortunately remained speculative to this day despite regular predictions. Since the end of the world has not yet happened in reality, we are therefore dependent on the imagination of writers, screenwriters and directors who have anticipated the event in an infinite number of texts, films and series. Based on selected films and texts, the seminar will focus on the questions of which apocalyptic scenarios are developed, with which problems the survivors are confronted and how they deal with the situation and with each other. The focus is on the reactions of people in a state of extreme threat. Which survival strategies are presented to us, how do we assess the behaviour of the actors, can we create alternatives? Furthermore, the effect of the genre on the recipient will be discussed. Do we dismiss films like Armaggedon and The Day After Tomorrow as entertaining thrills? Do we just enjoy the special effects? Do we feel threatened? Do we take them in the end as real instructions for action? Do they make us reflect? Or are even current social discourses reflected in the garment of the apocalypse?
Literature	

Course L1441: German as a Foreign Language for International Master Programs	
Typ	Seminar
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Examination Form	Klausur
Examination duration and scale	
Lecturer	Dagmar Richter
Language	DE
Cycle	WiSe/SoSe
Content	Master’s German course in cooperation with IBH e.V. - Master’s German courses at different levels In the international studies program these are obligatory for non-native speakers of German and for students without a DSH certificate or equivalent TEST-DAF result. Grading after an aptitude test. All other students must sign up for a total of 4 ECTS from the catalog of non-technical supplementary courses.
Literature	- Will be announced in lectures -

Course L1884: The Hamburger Speicherstadt - from achievements of engineering to world cultural heritage	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	20 minütiges Referat mit anschließender Diskussion
Lecturer	Dr. Jörg Schilling
Language	DE
Cycle	WiSe/SoSe
Content	The seminar wants to show the problems and challenges for the engineers, who built the Hamburger Speicherstadt and their sustainable architectural solutions, which are still of vital importance and the basis for becoming a world cultural heritage.
Literature	u.a.: Hamburg und seine Bauten unter Berücksichtigung seiner Nachbarstädte Altona und Wandsbek, hg. vom Architekten- und Ingenieur-Verein zu Hamburg, Hamburg 1890; Karin Maak: Die Speicherstadt im Hamburger Hafen, Hamburg 1895; Hermann Hipp: Freie und Hansestadt Hamburg, Köln 1989; Matthias von Popowski: Franz Andreas Meyer (1837-1901). Oberingenieur und Leiter des Ingenieurwesens von 1872-1901, in: Wie das Kunstwerk Hamburg entstand, hg. v. Dieter Schädel, Hamburg 2006, S. 64-79; Ralf Lange: HafenCity + Speicherstadt : das maritime Quartier in Hamburg, Hamburg 2010.

Course L1996: Digital culture(s): from subculture to media mainstream	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dr. Oliver Schmidt
Language	DE
Cycle	WiSe/SoSe
Content	The course gives an introduction to the development of digitization in a media cultural perspective. In addition to technical aspects, we will focus on the cultural impact of digitization for current media users and the ermergence und development of media subcultures from the late 1970s to the 21st century. On the one hand, we will deal with questions such as: What is digitization? What is culture? What are digital (sub)cultures? In this context, the concept of ‚digital natives' and ‚digital immigrants', coined by Marc Prensky, will also be discussed. On the other hand, there will be a historical perspective on topics and developments such as the mediatization oft he children's room in the early 1980s, the hacker scene, video game culture, the demo scene, digital culture in cinema, 8-bit culture, digital aesthetics , net art, post-digitality and ultimately the question of how digital subcultures have become part of the media mainstream at the beginning of the 21st century.
Literature	

Course L2367: Digital art	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	Referat ca. 20 min. plus anschließende Diskussion
Lecturer	Dr. Imke Hofmeister
Language	DE
Cycle	WiSe/SoSe
Content	Digitalization is having a major impact on many areas of our lives and the use of digital technologies in art and design has increased rapidly. After all, art is not only subject to constant change, but also constantly adapts to technical conditions. After the photographic art of the mid-19th century and the video art of the 1960s, which already brought about major changes in artistic creation, digital art is becoming increasingly important in the field of media art. The first attempts to use the computer with corresponding graphic software as an artistic medium took place in the 80/90s of the 20th century. Since then, there has been a broad development in the field of digital art, which now encompasses the most diverse digital pictorial phenomena and art genres and is thus intertwined in its objects, theories and practices with digital media in a variety of ways. The seminar gives an overview of the history of digital art and its different genres. These include, for example, photopaintings, where digital manipulation, filtering processes and painting can process the image and transform it over many stages into a completely new form. Also 3-D images, vector graphics, mathematical art and computer art in general. At the same time, the digital development in art is to be illuminated, from the first beginnings on the computer with comparatively simple "digital aids", e.g. in the form of simple image processing programs, to the present sophisticated graphic tools. In addition, the presentation, dissemination and conservation possibilities of digital art will also be discussed, which can be disseminated very well on the Internet primarily because it can be displayed on a computer screen. The great fascination with digital creative work and the almost inexhaustible possibilities offered by the medium of computers to artists, who will continue to ensure that digital art finds a permanent place alongside traditional media, will also be discussed. Finally, in contrast to the traditional production methods in the field of fine arts and design, there are always new manifestations of digital art, which ultimately give not only the "trained" artist but also the layman far-reaching possibilities for artistic expression. And all this in the spirit of the performance artist Joseph Beuys , who postulated, every human being is capable of creativity, indeed "every human being is an artist". The seminar will also discuss the question of how digital art can be described as "the" contemporary art, i.e. contemporary art in the age of digital technology. Furthermore, it is of great interest to what extent the perception of art per se has already changed and will continue to change in a digitalized society.
Literature	folgt

Course L1725: Introduction to the Science & Technoloy Studies (STS)	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	Gruppenreferat (30 bis 45 Minuten, Eigenanteil je Person 10 bis 15 Minuten) inkl. schriftlicher Ausarbeitung, Ggf. alternativ eine längere, schriftliche Ausarbeitung.
Lecturer	Dr. Simon Egbert
Language	EN
Cycle	WiSe/SoSe
Content	Since the end of the 1980's or the beginning of the 1990's, in the Sociology of Technology a line of research has emerged which initially called for a socialization of the sociology of technology (especially through the Social Construction of Technology Approach [SCOT]) and right away called for its re-materialisation (especially through Bruno Latour and the Actor-Network Theory). Technologies, thus their basic idea, are always intertwined with society and shaped by their socio-cultural context. In reverse, society is also inherently formed by the existing technologies and an adequate sociology of technology has to deal especially with the interaction of both. In the seminar at hand first of all an overview shall be given about the classical sociology of technology which routinely used argumentations inspired by technological determinism, which shall be followed by the presentation of the SCOT-approach. The later in turn was criticised by the Actor-Network Theory (which will be presented in a separate section as well) as being social deterministic which has led to a rather heated debate about the agency of technological artefacts, which shall be presented and discussed in a further part of the seminar. In the last section of the class it shall be determined what kind of relevance the sociological analysis of technological artefacts and their societal embedding can or could implicate for the own lifeworld of the students - especially of course with special focus on their engineer studies.
Literature	Bammé, Arno (2009): Science and Technology Studies: ein Überblick. Marburg: Metropolis. Degele, Nina (2002): Einführung in die Techniksoziologie. München: Fink. Hackett, Edward et al. (Hrsg.) (2008): The Handbook of Science and Technology Studies. 3rd Edition. Cambridge: MIT Press. Häußling, Roger (2014): Techniksoziologie. Baden-Baden: Nomos. MacKenzie, Donald/Judy, Wajcman (2003): The social shaping of technology. 2nd Edition. Maidenhead et al.: Open University Press. Sismondo, Sergio (2010): An Introduction to Science and Technology Studies, 2nd Edition. Chichester: Wiley-Blackwell.

Course L2336: Introduction to Marxian Theory of Economy	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Dr. Martin Schütz
Language	DE
Cycle	WiSe/SoSe
Content	Capitalism - what's the definition in Marxian economical theorie? Which are the functions of gold, money, interest? Focusing on the Marxian basis categories Ware - Gebrauchswert - Tauschwert - Wert - Arbeit - Austauschprozess - Geld - Zirkulation - Arbeitskraft, the subjects of the lecture are the first four chapters of 'Das Kapital' vol. 1, accompanied by discussion of neo-classical theory, monetarism etc.
Literature	Karl Marx, Das Kapital, Band 1, Berlin 1962ff (=Marx-Engels-Werke [MEW] Bd. 23), S. 1-390 Dieser Text steht text- und seitengenau im Internet zur Verfügung: http://www.mlwerke.de/me/me23/me23_000.htm oder http://www.zeno.org/Philosophie/M/Marx,+Karl/Das+Kapital David Harvey, Marx' Kapital lesen, Hamburg 2017, Seiten 1-214 Begleitend: Harvey selbst hat seine ‚Kapital'-Seminare (auf Englisch) als Stream veröffentlicht: http://davidharvey.org/reading-capital/ Ergänzende Literatur: Altvater, Elmar (Hg.) (1999): Kapital.doc. Das Kapital (Bd. 1) von Marx in Schaubildern mit Kommentaren. Mit CD-ROM. Münster Artus, Ingrid u.a. (Hg.) (2014): Marx für SozialwissenschaftlerInnen. Eine Einführung. Wiesbaden Fülberth, Georg (2008): G Strich. Kleine Geschichte des Kapitalismus. 4., verb. und erw. Aufl. Köln Krause, Alexandra (2014): Kritik der Politischen Ökonomie - Wachstum als Imperativ kapitalistischen Wirtschaftens. In: Artus (2014) S. 135-160. Münch, Richard (2008): Soziologische Theorie. Grundlegung durch die Klassiker. Korr. Nachdr. 2008. Frankfurt/Main (Soziologische Theorie, 1). Nachtwey, Oliver (2014): Arbeit, Lohnarbeit und Industriearbeit. In: Artus (2014) S. 109-134 Söllner, Fritz (2015): Die Geschichte des ökonomischen Denkens. 4. Aufl. Berlin

Course L1994: Facts, Facts, Facts - Understanding and Applying Techniques of Journalism - in German	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Prof. Margarete Jarchow, Matthias Kowalski
Language	DE
Cycle	WiSe/SoSe
Content	Regardless of whether it is via classic channels such as newspapers and magazines or radio and TV as well as via internet, social media or via communication in specialist circles: Today we encounter journalism in almost all forms of public and private communication. But what makes a story really important in this flood of content? How do we recognize relevance? How do we expose fake news? In this block seminar the principles of journalistic techniques are imparted by means of practical examples and editorial exercises. The participants also develop tools to detect and deactivate manipulation and fake news. Regular attendance and attendance at all block dates is required.
Literature	

Course L2370: Facts, Facts, Facts - Understanding and Applying Techniques of Journalism - in English	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Prof. Margarete Jarchow
Language	EN
Cycle	WiSe/SoSe
Content	Regardless of whether it is via classic channels such as newspapers and magazines or radio and TV as well as via internet, social media or via communication in specialist circles: Today we encounter journalism in almost all forms of public and private communication. But what makes a story really important in this flood of content? How do we recognize relevance? How do we expose fake news? In this block seminar the principles of journalistic techniques are imparted by means of practical examples and editorial exercises. The participants also develop tools to detect and deactivate manipulation and fake news. Regular attendance and attendance at all block dates is required.
Literature	folgt

Course L0970: Foreign Language Course	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 min
Lecturer	Dagmar Richter
Language	
Cycle	WiSe/SoSe
Content	In the Field of the Nontechnical Complementary Courses students are able to chose foreign language courses. Therefore the Hamburger Volkshochschule offers a special language programm on TUHH campus for TUHH Students. It includes courses in english, chinese, french, japanese, portuguese, russia, swedish, spanisch and german as a foreign language. All lectures impart common language knowledge, english courses although english for technical purposes.
Literature	Kursspezifische Literatur / selected bibliography depending on special lecture programm.

Course L0983: Management and Communication	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	90-minütige interaktive Präsentation im Team inkl. Handout.
Lecturer	Wibke Derboven
Language	DE
Cycle	SoSe
Content	The seminar will present basic elements of personality-promoting work organisation, motivation theories, different management concepts, communication theories and approaches to conflict and knowledge management. These subjects are applied to specific practical examples. Participants are given the opportunity to reflect on their own communicative and social behaviour.
Literature	Große Boes, Stefanie; Kaseric, Tanja (2010): Trainer-Kit. Die wichtigsten Trainings-Theorien, ihre Anwendung im Seminar und Übungen für den Praxistransfer. 4. Aufl. Bonn: managerSeminare Verlags GmbH Klutmann, Beate (2004): Führung: Theorie und Praxis. Hamburg: Windmühle Laufer, Hartmut (2011): Grundlagen erfolgreicher Mitarbeiterführung. Führungspersönlichkeit, Führungsmethoden, Führungsinstrumente. 11. Auflage. Offenbach: GABAL Neuberger, Oswald (2002): Führen und führen lassen. 6. überarb. und erw. Aufl. Stuttgart: Lucius und Lucius Schulz von Thun, Friedemann; Ruppel, Johannes; Stratmann, Roswitha (2002): Miteinander reden: Kommunikationspsychologie für Führungskräfte. 4. Aufl. Reinbek bei Hamburg

Course L1883: Guest, barbarian or subject with equal rights? ‘The refugee’ in the history of ‘Western’ political ideas.	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	5-10 Minuten Vortrag im Rahmen eines Gruppenreferats; anschließend Diskussion
Lecturer	Dr. Simone Beate Borgstede
Language	DE/EN
Cycle	WiSe/SoSe
Content	The seminar discusses concepts of ‘the refugee’ in the history of ‘Western’ political ideas over a period of about 2,750 years. We will try to understand these concepts as historically distinct. We will also analyze the powerful effect of related stereotypes and images. We will read and contextualize philosophical, sociological, juridical, literary and political texts. In the second part of the seminar we will use the patterns we found to understand actual discourses on flight and migration. One aim is also to recognize alternative representations in the articulations and practices of the refugees themselves.
Literature	Agamben, Giorgio, ‚Homo Sacer: Die souveräne Macht und das nackte Leben.’ Arendt, Hannah, ‚Wir Flüchtlinge’ und ‚Das Recht, Rechte zu haben’. Aristoteles, Politik und Platon, Politeia (Auszüge). Derrida, Jacques, ‚Weltbürger aller Länder, noch eine Anstrengung!’ Erpenbeck, Jenny: Gehen, ging, gegangen. Roman. Genfer Konvention und Menschenrechtserklärung. Homer, Die Odyssee. Simmel, Georg, ‚Exkurs über den Fremden’. Dazu kommen Textstellen aus Bibel und Koran, aktuelle Interviews mit Migrationsforscher_innen wie Manuela Bojadzijev und Vassilis Tsianos, aber auch Erklärungen von Geflüchteten-Gruppen, Musiktexte, Fotographien und Filmspots.

Course L1844: Stay cool in conflict. Nonviolent Communication by Marshall Rosenberg	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	2-3 Seiten bzw. 10-20 Minuten plus anschließende Besprechung
Lecturer	Dr. Claudia Wunram
Language	EN
Cycle	WiSe/SoSe
Content	„Words can build bridges or create rafts“ - this is also true for the scientific and business world. For example, how do I react if I get attacked in a professional debate by an opponent or by a colleague in my team, or if a fight arises during the planning of a project? In a challenging situation, what will help me to communicate respectfully and with appreciation? How can I express criticism or irritation honestly, directly and without reproach? Nonviolent Communication is a concept developped by Marshall B. Rosenberg, Ph.D., intended to help create an appreciative attitude towards oneself and others, and to live by it. Nonviolent Communication opens paths to express oneself in a mindful and responsible way, so that a bridge can be built even in challenging situations of conflict. Effective and satisfactory cooperation is only possible with well functioning communication between all parties involved, otherwise things will become difficult and inefficient. By working with their own examples and anticipating questions that might arise in their future professional lives, the students of Engineering Sciences will be able to reflect their own communicative behavior and learn ways of cooperation and conjoint solution finding. This course will impart the essential competencies of communication necesary for that.
Literature	German: • Rosenberg, Marshall. (2001) Gewaltfreie Kommunikation. Eine Sprache des Lebens. Junfermann • Rosenberg, Marshall B. und Seils, Gabriele. (15. Auflage 2012) Konflikte lösen durch Gewaltfreie Kommunikation. Ein Gespräch mit Gabriele Seils. Herder Taschenbuch • Larsson, Liv. (2013) 42 Schlüsselunterscheidungen in der GFK. Für ein tieferes Verständnis der Gewaltfreien Kommunikation. Junfermann • De Haen, Nayoma V. und Torsten Hardieß. (2015) 30 Minuten Gewaltfreie Kommunikation. Gabal • Connor, Jane M. und Killian, Dian, Drs. (2014) Verbindung herstellen - Trennendes überbrücken. Mit jedermann, jederzeit und überall eine gemeinsame Ebene finden. Praktische GFK für den Alltag. Junfermann • Dietz, Angela. (2015) Macht ohne Machtwort. Verantwortung übernehmen, Potenziale entfalten. Business Village • Miyashiro, Marie R. (2013) Der Faktor Empathie. Ein Wettbewerbsvorteil für Teams und Organisationen. Junfermann • Brüggemeier, Beate. (2010) Wertschätzende Kommunikation im Business. Wer sich öffnet, kommt weiter. Wie Sie die GFK im Berufsalltag nutzen. Junfermann • Heim, Vera und Lindemann, Gabriele. (2016) Beziehungskompetenz im Beruf. Brücken bauen mit Empathie und Gewaltfreier Kommunikation. Haufe Taschen Guide English: • Rosenberg, Marshall B., Ph.D. (3rd Edition 2015) Nonviolent Communication: A Language of Life. Create your Life, your Relationships, and your World in Harmony with your Values. Puddledancer Press • Connor, Jane, Ph.D. and Killian, Dian, Ph.D. (2nd edition 2012) Connecting Across Differences: Finding Common Ground with Anyone, Anywhere, Anytime. Puddledancer Press • Miyashiro, Marie R. (2011) The Empathy Factor. Your Competitive Advantage for Personal, Team and Business Success. Puddledancer Press • Roele, Hugo and Rich-Tolsma, Matthew, Drs. (2015) The Book of Needs. A Structural Model for Listening. Kommunikasie.nl • Kashtan, Miki. (2014) Reweaving our Human Fabric. Working Together to Create a Nonviolent Future. Fearless Heart Publications

Course L2345: Theory, Research and Practice of University Teaching	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	Schriftliche Ausarbeitung (in mehreren Teilen) sowie eine Präsentation
Lecturer	Prof. Christian Kautz, Jenny Alice Rohde
Language	DE
Cycle	WiSe/SoSe
Content	This course covers theory and practice of being a student teaching assistant in small-group instructional settings at TUHH. As part of the seminar, the participants have the opportunity to reflect on their work, e. g. through mutual observation and discussion.

	For prior knowledge / the event requirements: This event requires basic first work / collaboration experiences in the academic work structures of a higher education institution, which Master's students have acquired as part of the qualification for the Bachelor's degree at a university. These presumed work experiences include specific self-study experiences at a college. These are picked up, reflected, expanded and further developed both theoretically and practically with regard to learning from and in groups and later guiding this learning process. Furthermore, experiences with different types of learning / group types of higher education, which are part of a degree program acquired during the bachelor's program, are assumed, taken up, reflected on, expanded and further developed here in the master's program. The course also requires basic knowledge of presenting scholarly work results obtained by Master's students with a Bachelor's degree. In the course, this experience with and in representation in a group situation will be expanded and further developed in the direction of students' involvement with their own role as well as their design in face-to-face interaction as well as in group processes, learning and leadership situations, as masters graduates Graduate unlike bachelor graduates professionally stronger in a moderating role and with the guidance of humans because with the guidance in subject matters are demanded. According to the later professional role, the work of the seminar promotes and enables graduate students significantly more than graduates' qualifications for independent work and learning, transferring what they have learned to new areas, contributing, involving discussion and contributing their own examples and interests.
Literature	**Auszüge aus Fachliteratur zu oben genannten Themen werden in der Veranstaltung ausgegeben.** Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman. Bosse, E. (2016). Herausforderungen und Unterstützung für gelingendes Studieren: Studienanforderungen und Angebote für den Studieneinstieg. In I. van den Berk, K. Petersen, K. Schultes, & K. Stolz (Hrsg.). Studierfähigkeit - theoretische Erkenntnisse, empirische Befunde und praktische Perspektiven (Bd. 15). (S.129-169). Hamburg: Universität Hamburg. Collins, D. & Holton, E. (2004). The effectiveness of managerial leadership development programs: A meta-analysis of studies from 1982 to 2001. Human resource development quarterly, 15(2), 217 - 248. Danielsiek, H., Hubwieser, P., Krugel, J., Magenheim, J., Ohrndorf, L., Ossenschmidt, D., Schaper, N. & Vahrenhold, J. (2017). Verbundprojekt KETTI: Kompetenzerwerb von Tutorinnen und Tutoren in der Informatik. In A. Hanft, F. Bischoff, B. Prang (Hrsg.), Working Paper Lehr-/Lernformen. Perspektiven aus der Begleitforschung zum Qualitätspakt Lehre. Abgerufen von KoBF: Freeman, S., Eddy, SL., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H. & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematic. Proceedings of the National Academy of Sciences 11(23), 8410-8415. Glathe, A. (2017). Effekte von Tutorentraining und die Kompetenzentwicklung von MINTFachtutor* innen in Lernunterstützungsfunktion. (Nicht veröffentlichte Dissertation). Technische Universität Darmstadt, Deutschland. Kirkpatrick, D. L. (1959). Techniques for Evaluation Training Program. Journal of the American Society of Training Directors, 13, 21-26. Hänze, M. Fischer, E. Schreiber, Biehler, R. & Hochmuth, R- (2013). Innovationen in der Hochschullehre: empirische Überprüfung eines Studienprogramms zur Verbesserung von vorlesungsbegleitenden Übungsgruppen in der Mathematik. Zeitschrift für Hochschulentwicklung, 8(4), 89- 103. Kröpke, H. (2014). Who is who? Tutoring und Mentoring - der Versuch einer begrifflichen Schärfung. In D. Lenzen & H. Fischer (Hrsg.), Tutoring und Mentoring unter besonderer Berücksichtigung der Orientierungseinheit (Bd. 5). (21-29). Hamburg: Universitätskolleg-Schriften. Kühlmann, T. (2007). Fragebögen. In J. Straub, A. Weidemann & D. Weidemann (Hrsg.), Handbuch interkulturelle Kommunikation und Kompetenz (346-352). Stuttgart: Metzler. Mayring, P. (2010). Qualitative Inhaltsanalyse. Grundlagen und Techniken (11. aktualisierte und überarbeitete Auflage). Weinheim/Basel: Beltz.

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Desirability). Zeitschrift für Differentielle und Diagnostische Psychologie, 2, 199-218.

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Tutor/innen der Ingenieurwissenschaften? Eine explorative Analyse von Reflexionsberichten. Vortrag

auf der 47. Tagung der Deutschen Gesellschaft für Hochschuldidaktik, Karlsruhe.

Heterogenität der Studierenden und Lösungsansätze von Tutor/-innen

Jenny Alice Rohde. Posterpräsentation auf der Tagung “Tutorielle Lehre und Heterogenität”. Technische Universität Darmstadt, 16.05.2019.Hochschuldidaktische Tutorenqualifizierung - Eine Basisqualifizierung des akademischen Nachwuchses und Chance für den Wandel der Lehr-/Lernkultur?

Jenny Alice Rohde & Caroline Thon-Gairola. Posterpräsentation auf der DGHD am 07.03.2019.Welches Lehrverhalten zeigen geschulte Tutor/innen? Eine explorative Analyse selbst- und fremdwahrnehmungsbasierter Reflexionsberichte

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d ie hochs chul l ehre 2019 www.hochschullehre.org

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5(1), 25-49.

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and Other Unintended Consequences of Student Evaluation. Perspectives on Psychological Science,

11(6), 800-816.

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Lehren und Lernen im Fach Mathematik. Weinheim: Beltz.

Course L1509: Intercultural Communication	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Prof. Margarete Jarchow, Anna Katharina Bartel
Language	EN
Cycle	WiSe/SoSe
Content	As young professionals with technical background you may often tend to focus on communicating numbers and statistics in your presentations. However, facts are only one aspect of convincing others. Often, your personality, personal experience, cultural background and emotions are more important. You have to convince as a person in order to get your content across. In this workshop you will learn how to increase and express your cultural competence. You will apply cultural knowledge and images in order to positively influence communicative situations. You will learn how to add character and interest to your talks, papers and publications by referring to your own and European Cultural background. You will find out the basics of communicating professionally and convincingly by showing personality and by referring to your own cultural knowledge. You will get hands-on experience both in preparing and in conducting such communicative situations. This course is not focussing on delivering new knowledge about European culture but helps you using existing knowledge or such that you can gain e.g. in other Humanities courses. Content • How to enrich the personal character of your presentations **by referring to European and your own culture** • How to properly arrange **content and structure.** • How to use **PowerPoint for visualization** (you will use computers in an NIT room). • How to be well-prepared and convincing **when delivering** your thoughts to your audience**.**
Literature	Literaturhinweise werden zu Beginn des Seminars bekanntgegeben. Literature will be announced at the beginning of the seminar.

Course L2015: Intercultural Management - Theory and Awareness Training	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	15 Minuten Vortrag und dessen schriftliche Ausarbeitung (10 Seiten)
Lecturer	Prof Jürgen Rothlauf
Language	EN
Cycle	WiSe/SoSe
Content	The subject of the course is the deepening of the intercultural dimension of international management in relation to fundamental challenges, the importance of culture in team work and leadership of large multinational companies. In addition, culture-awareness trainings are discussed and carried out.
Literature	Rothlauf, J (2014): A Global View on Intercultural Management - Challenges in a Globalized World, De Gruyter Oldenbourg Verlag, 360 p

Course L2346: Young, educated, (non)political - are our young engineers well prepared for the future?	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Vincent-Immanuel Herr
Language	DE
Cycle	WiSe/SoSe
Content	Digitalization, climate change, democracy - society is facing fundamental upheavals. The next generation of young engineers in particular must no longer remain out of debate and can provide answers to the big questions of our time. Why is social commitment important? Is studying preparing us well for the future? What needs to improve? In the interactive workshop, the participants will be accompanied in analyzing their own generation and their own actions and in developing thesis on how to improve technical studies and training. The result of the seminar will be a joint thesis paper.
Literature	Wird im Seminar bekannt gegeben.

Course L2176: Culture of Communication - Theories and Methods of Successful Communication	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Anna Katharina Bartel
Language	DE
Cycle	WiSe/SoSe
Content	This course is for master students. In this seminar, we will explore different theories, models and methods from the fields of communication, psychology and cultural theory. The participants will work on theoretical content and do group presentations. They will also use examples from their own experiences to apply models and methods in practical exercises. The way we communicate shapes the way we experience our relationships, in the business world as well as in our private lives. We spend an overwhelming amount of time in group situations. This makes it worthwhile to explore how communication works within the group context and how, within these different groups, different cultures of communication develop. This particularly applies in highly specialized fields, such as engineering. Our ability to flexibly and successfully move from one context to another helps us along in building successful careers and allows us to feel positive about our private lives. However, this is not always simple. For example: • If we are part of a context in which many conflicts arise • If we have to switch between different contexts frequently • Or if, on the one hand, complicated facts and data are our main focus but on the other hand, we have to communicate them to people who are not familiar with the subject. Maybe we even have to win their attention in order to help along our causes. Oftentimes, this leads to misunderstandings. There also might be a lack of openness or willingness to embrace conflict. This might make it difficult for us to reach our goals. To be able to reflect on the way we communicate, to identify patterns of communication and the ability to actively build positive relationships through communication are useful skills to help overcome those obstacles..
Literature	• Knoblauch, H. (1995). Kommunikationskultur: Die kommunikative Konstruktion kultureller Kontexte (Materiale Soziologie, Band 5). de Gruyter. • Geert Hofstede, Geert Jan Hofstede, Michael Minkov. (2010). Cultures and Organizations - Software Of The Mind:Intercultural Cooperation and Its Importance for Survival. McGraw-Hill Education. • Bay, Rolf H. (2006) Erfolgreiche Gespräche durch aktives Zuhören. Ehningen. Expert-Verlag. • Cohn, Ruth (1975). Von der Psychoanalyse zur Themenzentrierten Interaktion. Stuttgart. Klett - Cotta • Fengler, Jörg (1998) Feedback geben. Weinheim. Beltz. • Lumma, Klaus (2006). Die Teamfibel oder das Einmaleins der Team- & Gruppenqualifizierung im sozialen und betrieblichen Bereich. Windmühle. • Spies, Stefan. (2010). Der Gedanke lenkt den Körper: Körpersprache - Erfolgsstrathegien eines Regisseurs. Hoffmann und Campe.

Course L0535: Theory of Communication	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	20-30 Minuten Referat und Thesenpapier
Lecturer	Dr. Michael Florian
Language	DE
Cycle	SoSe
Content	The seminar focuses on sociological theories of communication and selected problems of practical application in the area of crisis communication. The issue of crisis communication will be analyzed on the basis of case studies.
Literature	Habermas, Jürgen (1981): Theorie des kommunikativen Handelns. 2 Bände. Frankfurt/Main: Suhrkamp. Luhmann, Niklas (1984): Soziale Systeme. Grundriß einer allgemeinen Theorie. Frankfurt/Main: Suhrkamp. Malsch, Thomas (2005): Kommunikationsanschlüsse. Zur soziologischen Differenz von realer und künstlicher Sozialität. Wiesbaden: VS Verlag für Sozialwissenschaften. Malsch, Thomas; Schmitt, Marco (Hg.) (2014): Neue Impulse für die soziologische Kommunikationstheorie. Empirische Widerstände und theoretische Verknüpfungen. Springer Fachmedien: Wiesbaden. Meckel, Miriam; Schmid, Beat F. (Hg.) (2008): Unternehmenskommunikation. Kommunikationsmanagement aus Sicht der Unternehmensführung. 2., überarbeitete und erweiterte Auflage. Gabler GWV Fachverlage: Wiesbaden. Merten, Klaus (1999): Einführung in die Kommunikationswissenschaft. Bd 1/1: Grundlagen der Kommunikationswissenschaft. Münster: Lit Verlag. Nolting, Tobias; Thießen, Ansgar (Hg.) (2008): Krisenmanagement in der Mediengesellschaft. Potenziale und Perspektiven der Krisenkommunikation. Wiesbaden: VS Verlag für Sozialwissenschaften. Schützeichel, Rainer (2004): Soziologische Kommunikationstheorien. Konstanz: UVK Verlagsgesellschaft. Thießen, Ansgar (2011): Organisationskommunikation in Krisen. Reputationsmanagement durch situative, integrierte und strategische Krisenkommunikation. VS Verlag für Sozialwissenschaften/Springer Fachmedien: Wiesbaden. Thießen, Ansgar (Hg.) (2013): Handbuch Krisenmanagement. Springer Fachmedien: Wiesbaden.

Course L1732: criminology and society - in German	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	Gruppenreferat (30 bis 45 Minuten, Eigenanteil je Person 10 bis 15 Minuten) inkl. schriftlicher Ausarbeitung, Ggf. alternativ eine längere, schriftliche Ausarbeitung.
Lecturer	Sarah Schirmer
Language	DE
Cycle	WiSe/SoSe
Content	The seminar will provide an overview of Criminology and introduce different theories of criminality. It is necessary to consider the discipline of Criminology within its historical context in order to understand how some theories have evolved. The students will use this knowledge of Criminology theory to discuss and consider the advantages and disadvantages of each theory. Discussions will include how society constructs crime as well as a more philosophical debate about a determined view.
Literature	Wird zeitnah bekannt gegeben. Will be announced in lecture.

Course L2369: Literature and Culture for international students of Master's degree programs in English (non-native speakers of German)	
Typ	Seminar
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Examination Form	Referat
Examination duration and scale	45 min. Präsentation und anschließende Diskussion
Lecturer	Bertrand Schütz
Language	DE
Cycle	WiSe/SoSe
Content	The seminar LITERATURE AND CULTURE investigates what culture is, especially what characterises epistemic cultures. Culture is to be understood as the creative response to a given situation and the capacity to integrate inputs and influences, therefore as an ongoing process of permanent readjustment and learning, and by no means as a fixed identity in terms of an “essence”. There is a growing awareness that Europe cannot lay claim to possess the ultimate standards of knowledge. A topography of our contemporary world is to be sketched by highlighting its historical and cultural premises. For more information please refer to the German description and the StudIP.
Literature	Je nach Thematik des Semesters wird eine spezifische Literatur-Liste erstellt. cf. StudIP

Course L1837: People in Business Organizations	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	Schriftliche Hausarbeit 7-10 Textseiten; verpflichtend: Präsentation der Zwischenergebnisse mit Diskussion (geht nicht in die Bewertung mit ein)
Lecturer	Dr. Martin Schütz
Language	DE
Cycle	WiSe/SoSe
Content	The influence of technological change and social change on business organizations - how to manage the organizational change.
Literature	Becker, Karen Louise (2007): Unlearning in the workplace. A mixed methods study. PhD. Queensland University of Technology, Brisbane. Faculty of Education. Online verfügbar unter http://eprints.qut.edu.au/16574/. Frey, Dieter; Gerkhardt, Marit; Peus, Claudia; Traut-Mattausch, Eva; Fischer, Peter (2014): Veränderungen managen. Widerstände und Erfolgsfaktoren der Umsetzung. In: Lutz von Rosenstiel, Erika Regnet und Michel E. Domsch (Hg.): Führung von Mitarbeitern. Handbuch für erfolgreiches Personalmanagement. 7. Aufl. Stuttgart: Schäffer-Poeschel, S. 547-559. Hauser, Berndhard (2014): Konflikte in und zwischen Gruppen. In: Lutz von Rosenstiel, Erika Regnet und Michel E. Domsch (Hg.): Führung von Mitarbeitern. Handbuch für erfolgreiches Personalmanagement. 7. Aufl. Stuttgart: Schäffer-Poeschel, S. 354-367. Kieser, Alfred; Walgenbach, Peter (2007): Organisation. 5. Aufl. Stuttgart: Schäffer-Poeschel. Miebach, Bernhard (2012): Organisationstheorie. Problemstellung - Modelle - Entwicklung. 2. Aufl. Wiesbaden: Springer Fachmedien Wiesbaden; Imprint: Springer VS. Müller, Ursula (Hg.) (2013): Geschlecht und Organisation. Wiesbaden: Springer VS (Geschlecht und Gesellschaft, 45). Olfert, Klaus (2012): Organisation. 16. Aufl. Herne: NWB Verlag. Pohlmann, Markus; Markova, Hristina (2011): Soziologie der Organisation. Eine Einführung. Konstanz, München: UVK-Verl.-Ges. (3573). Preisendörfer, Peter (2011): Organisationssoziologie. Grundlagen, Theorien und Problemstellungen. 3. Aufl. Wiesbaden: VS Verlag für Sozialwissenschaften. Robbins, Stephen P.; Judge, Timothy A. (2013): Organizational Behavior. 15. Aufl. Boston, Mass: Pearson. Rosenstiel, Lutz von; Nerdinger, Friedemann W. (2011): Grundlagen der Organisationspsychologie. Basiswissen und Anwendungshinweise. 7. Aufl. Stuttgart: Schäffer-Poeschel. Sanders, Karin; Kianty, Andrea (2006): Organisationstheorien. Eine Einführung. 1. Aufl. Wiesbaden: VS Verlag für Sozialwissenschaften. Schreyögg, Georg (2008): Organisation. Grundlagen moderner Organisationsgestaltung, mit Fallstudien. 5. Aufl. Wiesbaden: Gabler (Lehrbuch). Vahs, Dietmar (2012): Organisation. Ein Lehr- und Managementbuch. 8. Aufl. Stuttgart: Schäffer-Poeschel. Weinert, Ansfried B. (2004): Organisations- und Personalpsychologie. 5. Aufl. Weinheim: BeltzPVU.

Course L1846: Classical Journalism and New Media	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	Ca. 20 min. plus anschließende Diskussion
Lecturer	Dieter Bednarz
Language	DE
Cycle	WiSe/SoSe
Content	The world wide walkover of the internet dramatically changed the perception of classical media like newspapers, magazines and even TV. In this seminar the reasons of and the consequences for the dramatic changes regarding our information habits will be analyzed and discussed. Has the media expert Neil Postman been right, when he one said, that we all one day will be „overnewsed but underinformed“? Keeping a close eye on the real challenges of journalism, the seminar will discuss the standards of ethics in politics and media.
Literature	Wird im Seminar genannt

Course L1023: Politics	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dr. Stephan Albrecht
Language	EN
Cycle	WiSe/SoSe
Content	Scientists and engineers neither just strive for truths and scientific laws, nor are they working in a space far from politics. Science and engineering have contributed to what we now call the Anthropocene, the first time in the history of mankind when essential cycles of the earth system, e.g. carbon cycle, climate system, are heavily influenced or even shattered. Furthermore, Peak oil is indicating the end of cheap fossil energy thus triggering the search for alternatives such as biomass. Systems of knowledge, science and technology in the OECD countries have since roughly 30 years increasingly become divided. On the one hand new technologies such as modern biotechnology, IT or nanotechnology are developing rapidly, bringing about many innovations for industry, agriculture, and consumers. On the other hand scientific studies from earth, environmental, climate change, agricultural and social sciences deliver increasingly robust evidence on more or less severe impacts on society, environment, global equity, and economy resulting from innovations during the last 50 years. Technological innovation thus is no longer an uncontested concept. And many protest movements demonstrate that the introduction of new or the enlargement of existing technologies (e.g. airports, railway stations, highways, high-voltage power lines surveillance) isn't at all a matter of course. It is important to bear in mind the fact that all processes of technological innovation are made by humans, individually and collectively. Industrial, social, and political organizations as actors from the local to global level of communication, deliberation, and decision making interact in diverse arenas, struggling to promote their respective corporate and/or political agenda. So innovations are as well a problem of technology as a problem of politics. Innovation and technology policies aren't the same in all countries. We can observe conceptual and practical variations. Since the 1992 Earth Summit in Rio de Janeiro Agenda 21 constitutes a normative umbrella, indicating Sustainable Development (SD) as core cluster of earth politics on all levels from local to global. Meanwhile other documents such as the Millennium Development Goals (MDG) have complemented the SD agenda. SD can be interpreted as operationalization of the Universal Declaration of Human Rights, adopted in 1948 by the General Assembly of the United Nations and since amended many times. Engineers and scientists as professionals can't avoid to become confronted with many non-technical and non-disciplinary items, challenges, and dilemmas. So they have to choose between alternative options for action, as individuals and as members of organizations or employees. Therefore the seminar will address core elements of the complex interrelations between science, society and politics. Reflections on experiences of participants - e.g. from other countries as Germany - during the seminar are very welcome. The goals of the seminar include: • Raising awareness and increasing knowledge about the political implications of scientific work and institutions; • Improving the understanding of different concepts and designs of innovation and technology policies; • Increasing knowledge about the status and perspectives of sustainable development as framework concept for technological and scientific progress; • Understanding core elements of recent arguments, conflicts, and crises on technological innovations, e.g. geo-engineering or bio-economy; • Improving the understanding of scientists' responsibility for impacts of their professional activities; • Embedding individual professional responsibility in social and political contexts. The seminar will deal with current problems from areas such as innovation policy, energy, food systems, and raw materials. Issues will include the future of energy, food security and electronics. Historical issues will also be addressed. The seminar will start with a profound overarching introduction. Issues will be introduced by a short presentation and a Q & A session, followed by group work on selected problems. All participants will have to prepare a presentation during the weekend seminar. The seminar will use inter alia interactive tools of teaching such as focus groups, simulations and presentations by students. Regular and active participation is required at all stages.
Literature	Literatur wird zu Beginn des Seminars abgesprochen.

Course L1856: Politics and Science - in German	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	Referat ca. 20 min. plus anschließende Diskussion
Lecturer	Dr. Mirko Himmel, Dr. Ines Krohn-Molt
Language	DE
Cycle	WiSe/SoSe
Content	Scientists often like to believe that their work is non-political. Within this seminar we want to demonstrate how deeply both are interconnected and converged. Not only, scientific guidance is often needed to take a political decision but also scientific outcomes are a sub-ject to political interpretation. Also, politics are significantly influencing scientific progress by framing research agendas and by funding decisions.
Literature	Wird im Seminar genannt

Course L1779: Politics and Science - in English	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dr. Frederik Postelt, Dr. Gunnar Jeremias
Language	EN
Cycle	WiSe/SoSe
Content	Scientists often like to believe that their work is non-political. Within this seminar we want to demonstrate how deeply both are interconnected and converged. Not only, scientific guidance is often needed to take a political decision but also scientific outcomes are a sub-ject to political interpretation. Also, politics are significantly influencing scientific progress by framing research agendas and by funding decisions. During this seminar we would like to show the different range of influences - scientific, economic, social, environmental, ethical/normative, security-related - affecting decision-making on science and politics. Using case studies on current debates on food security, public health, nuclear energy and terrorism to discuss the interrelation between science and politics illuminating the role of various actors in this process, such as: • Governments, • International organizations, • Scientific associations, • Industry, • Civil society, and • Individual scientists. The guiding questions will be: • How does and should science influence politics? • How does and should politics influence science? In order to take responsibility for the consequences of scientific work, engineers and scientists increasingly need to acknowledge the political dimension of their work and their role in the political process. We will address this political dimension of scientific work by discussing: • Biographies and motivations of famous scientists, • Individual responsibility of scientists for the implications of their work, and • The role of codes of conduct as guidelines for responsible behaviour. The goals of the seminar include: • Raising awareness and increasing knowledge about the political dimensions of scientific work, • Providing guidelines for evaluating political implications of scientific research, • Improving the understanding of scientists' and engineers' responsibility for the results of their professional activities, • Taking decisions at the institutional, national and international level about rules and regulations concerning scientific conduct, and • Choosing arguments and defending positions in situations of conflicting interests. The seminar will use current issues, such as dilemmas in the life sciences or bio fuels to demonstrate the problematic relationship between science and politics. The seminar, however, does not focus on providing in-depth knowledge of these current issues. We strongly discourage students that have participated in an "Ethics for Engineers" seminar to take this course, because the contents of the two seminars overlap. Issues will be introduced by short presentations and a Q&A session, followed by group work on selected problems. All participants will have to prepare a presentation. Those requiring a graded certificate ("Schein") additionally have to write a 3-4 page paper on selected issues. The seminar will use interactive tools of teaching such as role playing and simulations. Group work and active participation is expected at all stages of the seminar.
Literature	will be announced in lecture wird im Seminar bekannt gegeben

Course L1734: Projectrealisation: TUHH goes circular - Sustainability in Research, Education and campus management	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe/SoSe
Content	
Literature	Wird im Seminar bekanntgegeben Will be announced in lecture.

Course L1872: Social Learning: Social Commitment in Refugee Issues / Master	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	10 Seiten
Lecturer	Muthana Al-Temimi
Language	DE
Cycle	WiSe/SoSe
Content	folgt
Literature	Wird im Seminar bekannt gegeben. Will be announced in lecture.

Course L1647: Soft skill seminar for dual study programme (dual@TUHH) / Master	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	Referat mit 2-3 Videoübungen à 20 Minuten + anschließende Diskussion
Lecturer	Silke Wolckenhaar-Wagner, Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Course L1771: The Arabic Spring an its Consequences	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dieter Bednarz
Language	DE
Cycle	WiSe/SoSe
Content	The world wide walkover of the internet dramatically changed the perception of classical media like newspapers, magazines and even TV. In this seminar the reasons of and the consequences for the dramatic changes regarding our information habits will be analyzed and discussed: Taking a close look at the Middle East the political impact of the new media´s triumphal procession will be assessed and evaluated. How come that Twitter and Facebook on one hand facilitated the so called Arabic Spring and caused hope for the rise of democracy in the region, while on the other hand the revolutionaries failed so dramatically - at least for now. Keeping a close eye on both fields, the Media and the Middle East, the seminar will discuss the standards of ethics in politics and journalism.
Literature	Wird im Seminar angegeben und besprochen. Will be announced in the lecture.

Course L1916: Responsible Conduct in Technology & Science	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dr. Mirko Himmel, Dr. Ines Krohn-Molt
Language	DE
Cycle	WiSe/SoSe
Content	Aim of the seminar is raising awareness for the responsibility of engineers and researchers for a proper and ethical conduct in technology and science. The Participants will present and discuss practical examples for good as well as bad conduct in science.
Literature	folgt im Seminar

Course L1991: What can philosophy do?	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dr. Ursula Töller
Language	DE
Cycle	WiSe/SoSe
Content	Over the centuries, the philosophy is lined up as a discipline that provides complex and universal answers to contemporary history and circumstances. Often, she could design utopias that have led the way for political upheaval. While all scientific disciplines are subject to an increasing differentiation, the philosophy in the second half of the 20th century has lost its claim to universality. But what then are the topics of the philosophy of the 20th and 21st century and what impact have philosophical theories for processes of change? We will provide an overview of Western philosophies of the 20th and 21st century. and take a critical look at the self-understanding of philosophy.
Literature	Gerhardt Schweppenhäuser: Kritische Theorie, Stuttgart 2010 Postmoderne und Dekonstruktion, Texte französischer Philosophen der Gegenwart, hrsg. von Peter Engelmann, Reclam UB 8668 Thomas Rentsch: Philosophie des 20. Jhdts. Von Husserl bis Derrida, München 2014 Geschichte der Philosophie in Text und Darstellung, Bd. 8=20 Jhdt. Reclam UB 9918 Geschichte der Philosophie in Text und Darstellung, Bd. 9= Gegenwart Reclam UB 18267

Course L2343: Academic Writing and Presentation for Master-Students	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
Lecturer	Dr. Ursula Töller
Language	DE
Cycle	WiSe/SoSe
Content	The course is aimed at Master students who are planning to write their thesis, want to pursue their PhD or intend to present their research results at conferences and in journals. The course is structured on three levels: 1. writing, 2. presenting and 3. interacting in organizational structures. The latter refers to the work environment at university as well as in research groups and enterprises. In the course of the seminar, the participants become acquainted with various methods and theories on the subject. Furthermore, the methods and theories will be put into practice, reflected upon and discussed as part of the seminar.
Literature	• Umberto Eco, Wie man eine wiss. Abschlussarbeit schreibt (2010) • Helga Esselborn-Krumbiegel, Von der Idee zum Text. Eine Anleitung zum wissenschaftlichen Schreiben (2008) • Tony Buzan: Das Mind-Map-Buch. (2001) • John W. Chinneck: How to organize your Thesis (1999) • Lothar Seiwert: Das neue 1x1 des Zeitmanagements (2003) • Steven R. Covey: Die sieben Wege der Effektivität (2000) • Harold Kerzner: Twenty Common Mistakes Made by New or Inexperienced Project Manager (2010) • Friedemann Schulz von Thun: Miteinander Reden. (1996) Tim McClintock: Dealing with Specific Types of Difficult People. (2008)

Course L2029: “Lying press”? Functions and current challenges of journalism	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	20 min
Lecturer	Prof. Horst Pöttker
Language	DE
Cycle	WiSe/SoSe
Content	Lying press - there is a revival of the disparaging invective. Journalists use to shoot it down by leading it back to its supposed roots in the NS-propaganda. This is less convincing as several parties and ideologies have used it since the middle of the 19th century to discredit the media of other parties and ideologies. And it is missing the core of the problem. Critics are reasonably afraid that the choice of “lying press” to the “non-word of the year” 2014 has blocked the question, if there is a justified criticism of information media and journalism - or more precisely of the relationship between journalism and its audience. If this is the case both - journalism and audience - are involved from the perspective of inter actionism. Against this background interactive instructions will be given by scholarly literature and practical examples from the German and international media business. Questions like the following will be discussed: • Is journalism really a profession? If so - since when? • What is journalism for? (task and duties, functions, self-images) • Do the audience and journalists themselves have a reasonable understanding of tasks, functions, practices, problems of journalism? • What is the current concept of journalistic professionalism? Has it ever been the same? • From an international perspective: Does journalism in Germany have special shortcomings - if so, how can they be removed? • What are the economic challenges for journalism from the digital media upheaval? • In which direction do journalistic professionalism and self-understanding change in the digital media world? Objective is solid learning about professional tasks, ethics, techniques, endagerments, history and current problems of journalism including science journalism.
Literature	Zur Einführung: Lilienthal, Volker/Neverla, Irene (Hrsg.) (2017): „Lügenpresse“. Anatomie eines politischen Kampfbegriffs. Köln: Kiepenheuer & Witsch. https://www.kiwi-verlag.de/buch/luegenpresse/978-3-462-31782-4/ Pöttker, Horst (2010): Der Beruf zur Öffentlichkeit. Über Aufgabe, Grundsätze und Perspektiven des Journalismus in der Mediengesellschaft aus der Sicht praktischer Vernunft. In: Publizistik, 55. Jg., H. 2, S. 107-128. https://www.springerprofessional.de/en/der-beruf-zur-oeffentlichkeit/5889108 Weischenberg, S. (2007): Das *Jahrhundert des Journalismus* ist vorbei. Rekonstruktionen und Prognosen zur Formation gesellschaftlicher Selbstbeobachtung. In: *Bartelt-Kircher*, G. et al.: Krise der Printmedien - eine Krise des Journalismus? Berlin und New York, de Gruyter Saur, S. 32-60. https://medien21.wordpress.com/2011/10/17/weischenberg-das-jahrhundert-des-journalismus-ist-vorbei/ Eine ausführliche Literaturliste wird am Anfang des Seminars verteilt.

Module M1259: Technical Complementary Course Core Studies for TMBMS (according to Subject Specific Regulations)

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	see FSPO
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	see FSPO
Skills	see FSPO
Personal Competence	
Social Competence	see FSPO
Autonomy	see FSPO
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0
Credit points	6
Course achievement	None
Examination	according to Subject Specific Regulations
Examination duration and scale	see FSPO
Assignment for the Following Curricula	Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Module M0751: Vibration Theory

Courses

Title	Typ	Hrs/wk	CP
Vibration Theory (L0701)	Integrated Lecture	4	6

Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	• Calculus • Linear Algebra • Engineering Mechanics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to denote terms and concepts of Vibration Theory and develop them further.
Skills	Students are able to denote methods of Vibration Theory and develop them further.
Personal Competence	
Social Competence	Students can reach working results also in groups.
Autonomy	Students are able to approach individually research tasks in Vibration Theory.
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	2 Hours
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0701: Vibration Theory

Typ	Integrated Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	WiSe
Content	Linear and Nonlinear Single and Multiple Degree of Freedom Oscillations and Waves.
Literature	K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen. Springer Verlag, 2013.

Module M0808: Finite Elements Methods

Courses

Title	Typ	Hrs/wk	CP
Finite Element Methods (L0291)	Lecture	2	3
Finite Element Methods (L0804)	Recitation Section (large)	2	3

Module Responsible	Prof. Otto von Estorff
Admission Requirements	None
Recommended Previous Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students possess an in-depth knowledge regarding the derivation of the finite element method and are able to give an overview of the theoretical and methodical basis of the method.
Skills	The students are capable to handle engineering problems by formulating suitable finite elements, assembling the corresponding system matrices, and solving the resulting system of equations.
Personal Competence	
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.
Autonomy	The students are able to independently solve challenging computational problems and develop own finite element routines. Problems can be identified and the results are critically scrutinized.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	**Compulsory** **Bonus** **Form** **Description** No 20 % Midterm
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Civil Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Product Development, Materials and Production: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory

Course L0291: Finite Element Methods	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	WiSe
Content	- General overview on modern engineering - Displacement method - Hybrid formulation - Isoparametric elements - Numerical integration - Solving systems of equations (statics, dynamics) - Eigenvalue problems - Non-linear systems - Applications - Programming of elements (Matlab, hands-on sessions) - Applications
Literature	Bathe, K.-J. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

Course L0804: Finite Element Methods	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0846: Control Systems Theory and Design

Courses

Title	Typ	Hrs/wk	CP
Control Systems Theory and Design (L0656)	Lecture	2	4
Control Systems Theory and Design (L0657)	Recitation Section (small)	2	2

Module Responsible	Prof. Herbert Werner
Admission Requirements	None
Recommended Previous Knowledge	Introduction to Control Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can explain how linear dynamic systems are represented as state space models; they can interpret the system response to initial states or external excitation as trajectories in state space • They can explain the system properties controllability and observability, and their relationship to state feedback and state estimation, respectively • They can explain the significance of a minimal realisation • They can explain observer-based state feedback and how it can be used to achieve tracking and disturbance rejection • They can extend all of the above to multi-input multi-output systems • They can explain the z-transform and its relationship with the Laplace Transform • They can explain state space models and transfer function models of discrete-time systems • They can explain the experimental identification of ARX models of dynamic systems, and how the identification problem can be solved by solving a normal equation • They can explain how a state space model can be constructed from a discrete-time impulse response
Skills	• Students can transform transfer function models into state space models and vice versa • They can assess controllability and observability and construct minimal realisations • They can design LQG controllers for multivariable plants • They can carry out a controller design both in continuous-time and discrete-time domain, and decide which is appropriate for a given sampling rate • They can identify transfer function models and state space models of dynamic systems from experimental data • They can carry out all these tasks using standard software tools (Matlab Control Toolbox, System Identification Toolbox, Simulink)
Personal Competence	
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.
Autonomy	Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it when solving given problems. They can assess their knowledge in weekly on-line tests and thereby control their learning progress.
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	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Compulsory Aircraft Systems Engineering: Specialisation Avionic and Embedded Systems: Elective Compulsory Computational Science and Engineering: Specialisation II. Engineering Science: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory

Course L0656: Control Systems Theory and Design	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	State space methods (single-input single-output) • State space models and transfer functions, state feedback • Coordinate basis, similarity transformations • Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem • Controllability and pole placement • State estimation, observability, Kalman decomposition • Observer-based state feedback control, reference tracking • Transmission zeros • Optimal pole placement, symmetric root locus Multi-input multi-output systems • Transfer function matrices, state space models of multivariable systems, Gilbert realization • Poles and zeros of multivariable systems, minimal realization • Closed-loop stability • Pole placement for multivariable systems, LQR design, Kalman filter Digital Control • Discrete-time systems: difference equations and z-transform • Discrete-time state space models, sampled data systems, poles and zeros • Frequency response of sampled data systems, choice of sampling rate System identification and model order reduction • Least squares estimation, ARX models, persistent excitation • Identification of state space models, subspace identification • Balanced realization and model order reduction Case study • Modelling and multivariable control of a process evaporator using Matlab and Simulink Software tools • Matlab/Simulink
Literature	• Werner, H., Lecture Notes „Control Systems Theory and Design“ • T. Kailath "Linear Systems", Prentice Hall, 1980 • K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997 • L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999

Course L0657: Control Systems Theory and Design	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1204: Modelling and Optimization in Dynamics

Courses

Title	Typ	Hrs/wk	CP
Flexible Multibody Systems (L1632)	Lecture	2	3
Optimization of dynamical systems (L1633)	Lecture	2	3

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	• Mathematics I, II, III • Mechanics I, II, III, IV • Simulation of dynamical Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students demonstrate basic knowledge and understanding of modeling, simulation and analysis of complex rigid and flexible multibody systems and methods for optimizing dynamic systems after successful completion of the module.
Skills	Students are able + to think holistically + to independently, securly and critically analyze and optimize basic problems of the dynamics of rigid and flexible multibody systems + to describe dynamics problems mathematically + to optimize dynamics problems
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups and to document the corresponding results.
Autonomy	Students are able to + assess their knowledge by means of exercises. + acquaint themselves with the necessary knowledge to solve research oriented tasks.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1632: Flexible Multibody Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried, Dr. Alexander Held
Language	DE
Cycle	WiSe
Content	1. Basics of Multibody Systems 2. Basics of Continuum Mechanics 3. Linear finite element modelles and modell reduction 4. Nonlinear finite element Modelles: absolute nodal coordinate formulation 5. Kinematics of an elastic body 6. Kinetics of an elastic body 7. System assembly
Literature	Schwertassek, R. und Wallrapp, O.: Dynamik flexibler Mehrkörpersysteme. Braunschweig, Vieweg, 1999. Seifried, R.: Dynamics of Underactuated Multibody Systems, Springer, 2014. Shabana, A.A.: Dynamics of Multibody Systems. Cambridge Univ. Press, Cambridge, 2004, 3. Auflage.

Course L1633: Optimization of dynamical systems	
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	1. Formulation and classification of optimization problems 2. Scalar Optimization 3. Sensitivity Analysis 4. Unconstrained Parameter Optimization 5. Constrained Parameter Optimization 6. Stochastic optimization 7. Multicriteria Optimization 8. Topology Optimization
Literature	Bestle, D.: Analyse und Optimierung von Mehrkörpersystemen. Springer, Berlin, 1994. Nocedal, J. , Wright , S.J. : Numerical Optimization. New York: Springer, 2006.

Module M0939: Control Lab A

Courses

Title	Typ	Hrs/wk	CP
Control Lab I (L1093)	Practical Course	1	1
Control Lab II (L1291)	Practical Course	1	1
Control Lab III (L1665)	Practical Course	1	1
Control Lab IV (L1666)	Practical Course	1	1

Module Responsible	Prof. Herbert Werner
Admission Requirements	None
Recommended Previous Knowledge	• State space methods • LQG control • H2 and H-infinity optimal control • uncertain plant models and robust control • LPV control
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can explain the difference between validation of a control lop in simulation and experimental validation
Skills	• Students are capable of applying basic system identification tools (Matlab System Identification Toolbox) to identify a dynamic model that can be used for controller synthesis • They are capable of using standard software tools (Matlab Control Toolbox) for the design and implementation of LQG controllers • They are capable of using standard software tools (Matlab Robust Control Toolbox) for the mixed-sensitivity design and the implementation of H-infinity optimal controllers • They are capable of representing model uncertainty, and of designing and implementing a robust controller • They are capable of using standard software tools (Matlab Robust Control Toolbox) for the design and the implementation of LPV gain-scheduled controllers
Personal Competence	
Social Competence	• Students can work in teams to conduct experiments and document the results
Autonomy	• Students can independently carry out simulation studies to design and validate control loops
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Credit points	4
Course achievement	None
Examination	Written elaboration
Examination duration and scale	1
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L1093: Control Lab I

Typ	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Herbert Werner, Patrick Göttsch, Adwait Datar
Language	EN
Cycle	WiSe/SoSe
Content	One of the offered experiments in control theory.
Literature	Experiment Guides

Course L1291: Control Lab II	
Typ	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Herbert Werner, Patrick Göttsch, Adwait Datar
Language	EN
Cycle	WiSe/SoSe
Content	One of the offered experiments in control theory.
Literature	Experiment Guides

Course L1665: Control Lab III	
Typ	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Herbert Werner, Patrick Göttsch, Adwait Datar
Language	EN
Cycle	WiSe/SoSe
Content	One of the offered experiments in control theory.
Literature	Experiment Guides

Course L1666: Control Lab IV	
Typ	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Herbert Werner, Patrick Göttsch, Adwait Datar
Language	EN
Cycle	WiSe/SoSe
Content	One of the offered experiments in control theory.
Literature	Experiment Guides

Module M1306: Control Lab C

Courses

Title	Typ	Hrs/wk	CP
Control Lab IX (L1836)	Practical Course	1	1
Control Lab VII (L1834)	Practical Course	1	1
Control Lab VIII (L1835)	Practical Course	1	1

Module Responsible	Prof. Herbert Werner
Admission Requirements	None
Recommended Previous Knowledge	• State space methods • LQG control • H2 and H-infinity optimal control • uncertain plant models and robust control • LPV control
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can explain the difference between validation of a control lop in simulation and experimental validation
Skills	• Students are capable of applying basic system identification tools (Matlab System Identification Toolbox) to identify a dynamic model that can be used for controller synthesis • They are capable of using standard software tools (Matlab Control Toolbox) for the design and implementation of LQG controllers • They are capable of using standard software tools (Matlab Robust Control Toolbox) for the mixed-sensitivity design and the implementation of H-infinity optimal controllers • They are capable of representing model uncertainty, and of designing and implementing a robust controller • They are capable of using standard software tools (Matlab Robust Control Toolbox) for the design and the implementation of LPV gain-scheduled controllers
Personal Competence	
Social Competence	• Students can work in teams to conduct experiments and document the results
Autonomy	• Students can independently carry out simulation studies to design and validate control loops
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Credit points	3
Course achievement	None
Examination	Written elaboration
Examination duration and scale	1
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1836: Control Lab IX

Typ	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Herbert Werner, Patrick Göttsch, Adwait Datar
Language	EN
Cycle	WiSe/SoSe
Content	One of the offered experiments in control theory.
Literature	Experiment Guides

Course L1834: Control Lab VII	
Typ	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Herbert Werner, Patrick Göttsch
Language	EN
Cycle	WiSe/SoSe
Content	One of the offered experiments in control theory.
Literature	Experiment Guides

Course L1835: Control Lab VIII	
Typ	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Herbert Werner, Patrick Göttsch, Adwait Datar
Language	EN
Cycle	WiSe/SoSe
Content	One of the offered experiments in control theory.
Literature	Experiment Guides

Module M1150: Continuum Mechanics

Courses

Title	Typ	Hrs/wk	CP
Continuum Mechanics (L1533)	Lecture	2	3
Continuum Mechanics Exercise (L1534)	Recitation Section (small)	2	3

Module Responsible	Prof. Christian Cyron
Admission Requirements	None
Recommended Previous Knowledge	Basics of linear continuum mechanics as taught, e.g., in the module Mechanics II (forces and moments, stress, linear strain, free-body principle, linear-elastic constitutive laws, strain energy).
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can explain the fundamental concepts to calculate the mechanical behavior of materials.
Skills	The students can set up balance laws and apply basics of deformation theory to specific aspects, both in applied contexts as in research contexts.
Personal Competence	
Social Competence	The students are able to develop solutions, to present them to specialists in written form and to develop ideas further.
Autonomy	The students are able to assess their own strengths and weaknesses. They can independently and on their own identify and solve problems in the area of continuum mechanics and acquire the knowledge required to this end.
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	45 min
Assignment for the Following Curricula	Materials Science: Specialisation Modeling: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L1533: Continuum Mechanics

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	• kinematics of undeformed and deformed bodies • balance equations (balance of mass, balance of energy, ...) • stress states • material modelling
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Course L1534: Continuum Mechanics Exercise	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	• kinematics of undeformed and deformed bodies • balance equations (balance of mass, balance of energy, ...) • stress states • material modelling
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Module M0714: Numerical Treatment of Ordinary Differential Equations

Courses

Title	Typ	Hrs/wk	CP
Numerical Treatment of Ordinary Differential Equations (L0576)	Lecture	2	3
Numerical Treatment of Ordinary Differential Equations (L0582)	Recitation Section (small)	2	3

Module Responsible	Prof. Sabine Le Borne
Admission Requirements	None
Recommended Previous Knowledge	• Mathematik I, II, III für Ingenieurstudierende (deutsch oder englisch) oder Analysis & Lineare Algebra I + II sowie Analysis III für Technomathematiker • Basic MATLAB knowledge
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to • list numerical methods for the solution of ordinary differential equations and explain their core ideas, • repeat convergence statements for the treated numerical methods (including the prerequisites tied to the underlying problem), • explain aspects regarding the practical execution of a method. • select the appropriate numerical method for concrete problems, implement the numerical algorithms efficiently and interpret the numerical results
Skills	Students are able to • implement (MATLAB), apply and compare numerical methods for the solution of ordinary differential equations, • to justify the convergence behaviour of numerical methods with respect to the posed problem and selected algorithm, • for a given problem, develop a suitable solution approach, if necessary by the composition of several algorithms, to execute this approach and to critically evaluate the results.
Personal Competence	
Social Competence	Students are able to • work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge), explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.
Autonomy	Students are capable • to assess whether the supporting theoretical and practical excercises are better solved individually or in a team, • to assess their individual progress and, if necessary, to ask questions and seek help.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Mathematical Modelling in Engineering: Theory, Numerics, Applications: Specialisation I. Numerics (TUHH): Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Technomathematics: Specialisation I. Mathematics: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0576: Numerical Treatment of Ordinary Differential Equations	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne, Dr. Christian Seifert
Language	DE/EN
Cycle	SoSe
Content	Numerical methods for Initial Value Problems • single step methods • multistep methods • stiff problems • differential algebraic equations (DAE) of index 1 Numerical methods for Boundary Value Problems • multiple shooting method • difference methods • variational methods
Literature	• E. Hairer, S. Noersett, G. Wanner: Solving Ordinary Differential Equations I: Nonstiff Problems • E. Hairer, G. Wanner: Solving Ordinary Differential Equations II: Stiff and Differential-Algebraic Problems

Course L0582: Numerical Treatment of Ordinary Differential Equations	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne, Dr. Christian Seifert
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0807: Boundary Element Methods

Courses

Title	Typ	Hrs/wk	CP
Boundary Element Methods (L0523)	Lecture	2	3
Boundary Element Methods (L0524)	Recitation Section (large)	2	3

Module Responsible	Prof. Otto von Estorff
Admission Requirements	None
Recommended Previous Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students possess an in-depth knowledge regarding the derivation of the boundary element method and are able to give an overview of the theoretical and methodical basis of the method.
Skills	The students are capable to handle engineering problems by formulating suitable boundary elements, assembling the corresponding system matrices, and solving the resulting system of equations.
Personal Competence	
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.
Autonomy	The students are able to independently solve challenging computational problems and develop own boundary element routines. Problems can be identified and the results are critically scrutinized.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description** No / 20 % / Midterm
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Energy Systems: Core Qualification: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0523: Boundary Element Methods	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	SoSe
Content	- Boundary value problems - Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines) - Applications
Literature	Gaul, L.; Fiedler, Ch. (1997): Methode der Randelemente in Statik und Dynamik. Vieweg, Braunschweig, Wiesbaden Bathe, K.-J. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

Course L0524: Boundary Element Methods	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1203: Applied Dynamics: Numerical and experimental methods

Courses

Title	Typ	Hrs/wk	CP
Lab Applied Dynamics (L1631)	Practical Course	3	3
Applied Dynamics (L1630)	Lecture	2	3

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	Mathematics I, II, III, Mechanics I, II, III, IV Numerical Treatment of Ordinary Differential Equations
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can represent the most important methods of dynamics after successful completion of the module Technical dynamics and have a good understanding of the main concepts in the technical dynamics.
Skills	Students are able + to think holistically + to independently, securly and critically analyze and optimize basic problems of the dynamics of rigid and flexible multibody systems + to describe dynamics problems mathematically + to investigate dynamics problems both experimentally and numerically
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups and to document the corresponding results.
Autonomy	Students are able to + assess their knowledge by means of exercises and experiments. + acquaint themselves with the necessary knowledge to solve research oriented tasks.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	Compulsory: Yes; Bonus: None; Form: Subject theoretical and practical work; Description: Versuche Fachlabor
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Theoretical Mechanical Engineering: Core Qualification: Compulsory

Course L1631: Lab Applied Dynamics

Typ	Practical Course
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Marc-André Pick
Language	DE
Cycle	SoSe
Content	Practical exercises are performed in groups. The examples are taken from different areas of applied dynamics, such as numerical simulation, experimental validation and experimental vibration analysis.
Literature	Schiehlen, W.; Eberhard, P.: Technische Dynamik, 4. Auflage, Vieweg+Teubner: Wiesbaden, 2014.

Course L1630: Applied Dynamics	
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	SoSe
Content	1. Modelling of Multibody Systems 2. Basics from kinematics and kinetics 3. Constraints 4. Multibody systems in minimal coordinates 5. State space, linearization and modal analysis 6. Multibody systems with kinematic constraints 7. Multibody systems as DAE 8. Non-holonomic multibody systems 9. Experimental Methods in Dynamics
Literature	Schiehlen, W.; Eberhard, P.: Technische Dynamik, 4. Auflage, Vieweg+Teubner: Wiesbaden, 2014. Woernle, C.: Mehrkörpersysteme, Springer: Heidelberg, 2011. Seifried, R.: Dynamics of Underactuated Multibody Systems, Springer, 2014.

Module M0752: Nonlinear Dynamics

Courses

Title	Typ	Hrs/wk	CP
Nonlinear Dynamics (L0702)	Integrated Lecture	4	6

Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	• Calculus • Linear Algebra • Engineering Mechanics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to reflect existing terms and concepts in Nonlinear Dynamics and to develop and research new terms and concepts.
Skills	Students are able to apply existing methods and procesures of Nonlinear Dynamics and to develop novel methods and procedures.
Personal Competence	
Social Competence	Students can reach working results also in groups.
Autonomy	Students are able to approach given research tasks individually and to identify and follow up novel research tasks by themselves.
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	2 Hours
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L0702: Nonlinear Dynamics

Typ	Integrated Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	SoSe
Content	Fundamentals of Nonlinear Dynamics.
Literature	S. Strogatz: Nonlinear Dynamics and Chaos. Perseus, 2013.

Module M0835: Humanoid Robotics

Courses

Title	Typ	Hrs/wk	CP
Humanoid Robotics (L0663)	Seminar	2	2

Module Responsible	Patrick Göttsch
Admission Requirements	None
Recommended Previous Knowledge	• Introduction to control systems • Control theory and design
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can explain humanoid robots. • Students learn to apply basic control concepts for different tasks in humanoid robotics.
Skills	• Students acquire knowledge about selected aspects of humanoid robotics, based on specified literature • Students generalize developed results and present them to the participants • Students practice to prepare and give a presentation
Personal Competence	
Social Competence	• Students are capable of developing solutions in interdisciplinary teams and present them • They are able to provide appropriate feedback and handle constructive criticism of their own results
Autonomy	• Students evaluate advantages and drawbacks of different forms of presentation for specific tasks and select the best solution • Students familiarize themselves with a scientific field, are able of introduce it and follow presentations of other students, such that a scientific discussion develops
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Credit points	2
Course achievement	None
Examination	Presentation
Examination duration and scale	30 min
Assignment for the Following Curricula	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L0663: Humanoid Robotics

Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Patrick Göttsch
Language	DE
Cycle	SoSe
Content	• Grundlagen der Regelungstechnik • Control systems theory and design
Literature	- B. Siciliano, O. Khatib. "Handbook of Robotics. Part A: Robotics Foundations", Springer (2008).

Module M0838: Linear and Nonlinear System Identifikation

Courses

Title	Typ	Hrs/wk	CP
Linear and Nonlinear System Identification (L0660)	Lecture	2	3

Module Responsible	Prof. Herbert Werner
Admission Requirements	None
Recommended Previous Knowledge	• Classical control (frequency response, root locus) • State space methods • Discrete-time systems • Linear algebra, singular value decomposition • Basic knowledge about stochastic processes
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can explain the general framework of the prediction error method and its application to a variety of linear and nonlinear model structures • They can explain how multilayer perceptron networks are used to model nonlinear dynamics • They can explain how an approximate predictive control scheme can be based on neural network models • They can explain the idea of subspace identification and its relation to Kalman realisation theory
Skills	• Students are capable of applying the predicition error method to the experimental identification of linear and nonlinear models for dynamic systems • They are capable of implementing a nonlinear predictive control scheme based on a neural network model • They are capable of applying subspace algorithms to the experimental identification of linear models for dynamic systems • They can do the above using standard software tools (including the Matlab System Identification Toolbox)
Personal Competence	
Social Competence	Students can work in mixed groups on specific problems to arrive at joint solutions.
Autonomy	Students are able to find required information in sources provided (lecture notes, literature, software documentation) and use it to solve given problems.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L0660: Linear and Nonlinear System Identification	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	• Prediction error method • Linear and nonlinear model structures • Nonlinear model structure based on multilayer perceptron network • Approximate predictive control based on multilayer perceptron network model • Subspace identification
Literature	• Lennart Ljung, System Identification - Theory for the User, Prentice Hall 1999 • M. Norgaard, O. Ravn, N.K. Poulsen and L.K. Hansen, Neural Networks for Modeling and Control of Dynamic Systems, Springer Verlag, London 2003 • T. Kailath, A.H. Sayed and B. Hassibi, Linear Estimation, Prentice Hall 2000

Module M0657: Computational Fluid Dynamics II

Courses

Title	Typ	Hrs/wk	CP
Computational Fluid Dynamics II (L0237)	Lecture	2	3
Computational Fluid Dynamics II (L0421)	Recitation Section (large)	2	3

Module Responsible	Prof. Thomas Rung
Admission Requirements	None
Recommended Previous Knowledge	Basics of computational and general thermo/fluid dynamics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Establish a thorough understanding of Finite-Volume approaches. Familiarise with details of the theoretical background of complex CFD algorithms.
Skills	Ability to manage of interface problems and build-up of coding skills. Ability to evaluate, assess and benchmark different solution options.
Personal Competence	
Social Competence	Practice of team working during team exercises.
Autonomy	Indenpendent analysis of specific solution approaches.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	0.5h-0.75h
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0237: Computational Fluid Dynamics II

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	Computational Modelling of complex single- and multiphase flows using higher-order approximations for unstructured grids and mehsless particle-based methods.
Literature	1) Vorlesungsmanuskript und Übungsunterlagen 2) J.H. Ferziger, M. Peric: Computational Methods for Fluid Dynamics, Springer

Course L0421: Computational Fluid Dynamics II

Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0840: Optimal and Robust Control

Courses

Title	Typ	Hrs/wk	CP
Optimal and Robust Control (L0658)	Lecture	2	3
Optimal and Robust Control (L0659)	Recitation Section (small)	2	3

Module Responsible	Prof. Herbert Werner
Admission Requirements	None
Recommended Previous Knowledge	• Classical control (frequency response, root locus) • State space methods • Linear algebra, singular value decomposition
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can explain the significance of the matrix Riccati equation for the solution of LQ problems. • They can explain the duality between optimal state feedback and optimal state estimation. • They can explain how the H2 and H-infinity norms are used to represent stability and performance constraints. • They can explain how an LQG design problem can be formulated as special case of an H2 design problem. • They can explain how model uncertainty can be represented in a way that lends itself to robust controller design • They can explain how - based on the small gain theorem - a robust controller can guarantee stability and performance for an uncertain plant. • They understand how analysis and synthesis conditions on feedback loops can be represented as linear matrix inequalities.
Skills	• Students are capable of designing and tuning LQG controllers for multivariable plant models. • They are capable of representing a H2 or H-infinity design problem in the form of a generalized plant, and of using standard software tools for solving it. • They are capable of translating time and frequency domain specifications for control loops into constraints on closed-loop sensitivity functions, and of carrying out a mixed-sensitivity design. • They are capable of constructing an LFT uncertainty model for an uncertain system, and of designing a mixed-objective robust controller. • They are capable of formulating analysis and synthesis conditions as linear matrix inequalities (LMI), and of using standard LMI-solvers for solving them. • They can carry out all of the above using standard software tools (Matlab robust control toolbox).
Personal Competence	
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.
Autonomy	Students are able to find required information in sources provided (lecture notes, literature, software documentation) and use it to solve given problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L0658: Optimal and Robust Control	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	• Optimal regulator problem with finite time horizon, Riccati differential equation • Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system • Kalman's identity, phase margin of LQR controllers, spectral factorization • Optimal state estimation, Kalman filter, LQG control • Generalized plant, review of LQG control • Signal and system norms, computing H2 and H∞ norms • Singular value plots, input and output directions • Mixed sensitivity design, H∞ loop shaping, choice of weighting filters • Case study: design example flight control • Linear matrix inequalities, design specifications as LMI constraints (H2, H∞ and pole region) • Controller synthesis by solving LMI problems, multi-objective design • Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty
Literature	• Werner, H., Lecture Notes: "Optimale und Robuste Regelung" • Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 • Skogestad, S. and I. Postlewhaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 • Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 • Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998

Course L0659: Optimal and Robust Control	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0605: Computational Structural Dynamics

Courses

Title	Typ	Hrs/wk	CP
Computational Structural Dynamics (L0282)	Lecture	3	4
Computational Structural Dynamics (L0283)	Recitation Section (small)	1	2

Module Responsible	Prof. Alexander Düster
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to + give an overview of the computational procedures for problems of structural dynamics. + explain the application of finite element programs to solve problems of structural dynamics. + specify problems of computational structural dynamics, to identify them in a given situation and to explain their mathematical and mechanical background.
Skills	Students are able to + model problems of structural dynamics. + select a suitable solution procedure for a given problem of structural dynamics. + apply computational procedures to solve problems of structural dynamics. + verify and critically judge results of computational structural dynamics.
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups and to document the corresponding results.
Autonomy	Students are able to + acquire independently knowledge to solve complex 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	2h
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L0282: Computational Structural Dynamics

Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	DE
Cycle	SoSe
Content	1. Motivation 2. Basics of dynamics 3. Time integration methods 4. Modal analysis 5. Fourier transform 6. Applications
Literature	[1] K.-J. Bathe, Finite-Elemente-Methoden, Springer, 2002. [2] J.L. Humar, Dynamics of Structures, Taylor & Francis, 2012.

Course L0283: Computational Structural Dynamics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1339: Design optimization and probabilistic approaches in structural analysis

Courses

Title	Typ	Hrs/wk	CP
Design Optimization and Probabilistic Approaches in Structural Analysis (L1873)	Lecture	2	3
Design Optimization and Probabilistic Approaches in Structural Analysis (L1874)	Recitation Section (large)	2	3

Module Responsible	Prof. Benedikt Kriegesmann
Admission Requirements	None
Recommended Previous Knowledge	• Technical mechanics • Higher math
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	

Knowledge	• Design optimization
	  ◦ Gradient based methods
	  ◦ Genetic algorithms
	  ◦ Optimization with constraints
	  ◦ Topology optimization
	• Reliability analysis
	  ◦ Stochastic basics
	  ◦ Monte Carlo methods
	  ◦ Semi-analytic approaches
	• robust design optimization
	  ◦ Robustness measures
	  ◦ Coupling of design optimization and reliability analysis

Skills	• Application of optimization algorithms and probabilistic methods in the design of structures • Programming with Matlab • Implementation of algorithms • Debugging
Personal Competence	
Social Competence	• Team work • Oral explanation of the the work
Autonomy	• Application of methods learned in the framework of a home work • Familiarizing with source code provided • Description of approaches and results
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	10 pages
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L1873: Design Optimization and Probabilistic Approaches in Structural Analysis	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Benedikt Kriegesmann
Language	DE
Cycle	SoSe

Content	In the course the theoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization.
	
	The following contents will be considered:
	
	• Design optimization
	  ◦ Gradient based methods
	  ◦ Genetic algorithms
	  ◦ Optimization with constraints
	  ◦ Topology optimization
	• Reliability analysis
	  ◦ Stochastic basics
	  ◦ Monte Carlo methods
	  ◦ Semi-analytic approaches
	• robust design optimization
	  ◦ Robustness measures
	  ◦ Coupling of design optimization and reliability analysis

Literature	[1] Arora, Jasbir. Introduction to Optimum Design. 3rd ed. Boston, MA: Academic Press, 2011. [2] Haldar, A., and S. Mahadevan. Probability, Reliability, and Statistical Methods in Engineering Design. John Wiley & Sons New York/Chichester, UK, 2000.

Course L1874: Design Optimization and Probabilistic Approaches in Structural Analysis	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Benedikt Kriegesmann
Language	DE
Cycle	SoSe
Content	Matlab exercises complementing the lecture
Literature	siehe Vorlesung

Module M0604: High-Order FEM

Courses

Title	Typ	Hrs/wk	CP
High-Order FEM (L0280)	Lecture	3	4
High-Order FEM (L0281)	Recitation Section (large)	1	2

Module Responsible	Prof. Alexander Düster
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to + give an overview of the different (h, p, hp) finite element procedures. + explain high-order finite element procedures. + specify problems of finite element procedures, to identify them in a given situation and to explain their mathematical and mechanical background.
Skills	Students are able to + apply high-order finite elements to problems of structural mechanics. + select for a given problem of structural mechanics a suitable finite element procedure. + critically judge results of high-order finite elements. + transfer their knowledge of high-order finite elements to new problems.
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups and to document the corresponding results.
Autonomy	Students are able to + assess their knowledge by means of exercises and E-Learning. + acquaint themselves with the necessary knowledge to solve research oriented tasks.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	Compulsory: No; Bonus: 10 %; Form: Presentation; Description: Forschendes Lernen
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L0280: High-Order FEM	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	1. Introduction 2. Motivation 3. Hierarchic shape functions 4. Mapping functions 5. Computation of element matrices, assembly, constraint enforcement and solution 6. Convergence characteristics 7. Mechanical models and finite elements for thin-walled structures 8. Computation of thin-walled structures 9. Error estimation and hp-adaptivity 10. High-order fictitious domain methods
Literature	[1] Alexander Düster, High-Order FEM, Lecture Notes, Technische Universität Hamburg-Harburg, 164 pages, 2014 [2] Barna Szabo, Ivo Babuska, Introduction to Finite Element Analysis – Formulation, Verification and Validation, John Wiley & Sons, 2011

Course L0281: High-Order FEM	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1398: Selected Topics in Multibody Dynamics and Robotics

Courses

Title	Typ	Hrs/wk	CP
Formulas and Vehicles - Mathematics and Mechanics in Autonomous Driving (L1981)	Project-/problem-based Learning	2	6

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	Mechanics IV, Applied Dynamics or Robotics Numerical Treatment of Ordinary Differential Equations Control Systems Theory and Design
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completion of the module students demonstrate deeper knowledge and understanding in selected application areas of multibody dynamics and robotics
Skills	Students are able + to think holistically + to independently, securly and critically analyze and optimize basic problems of the dynamics of rigid and flexible multibody systems + to describe dynamics problems mathematically + to implement dynamical problems on hardware
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups and to document the corresponding results and present them
Autonomy	Students are able to + assess their knowledge by means of exercises and projects. + acquaint themselves with the necessary knowledge to solve research oriented tasks.
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Credit points	6
Course achievement	None
Examination	Presentation
Examination duration and scale	TBA
Assignment for the Following Curricula	Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L1981: Formulas and Vehicles - Mathematics and Mechanics in Autonomous Driving

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	6
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried, Daniel-André Dücker
Language	DE
Cycle	WiSe
Content	
Literature	Seifried, R.: Dynamics of underactuated multibody systems, Springer, 2014 Popp, K.; Schiehlen, W.: Ground vehicle dynamics, Springer, 2010

Module M1181: Research Project Theoretical Mechanical Engineering

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Dozenten des SD M
Admission Requirements	None
Recommended Previous Knowledge	• Finite-element-methods • Control systems theory and design • Applied dynamics • Numerics of ordinary differential equations
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to demonstrate their detailed knowledge in the field of theoretical mechanical engineering. They can exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions of science and society. The students can develop solving strategies and approaches for fundamental and practical problems in theoretical mechanical engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, and economic view points of science and society. Scientific work techniques that are used can be described and critically reviewed.
Skills	The students are able to independently select methods for the project work and to justify this choice. They can explain how these methods relate to the field of work and how the context of application has to be adjusted. General findings and further developments may essentially be outlined.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to their colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0
Credit points	12
Course achievement	None
Examination	Study work
Examination duration and scale	according to FSPO
Assignment for the Following Curricula	Theoretical Mechanical Engineering: Core Qualification: Compulsory

Module M0603: Nonlinear Structural Analysis

Courses

Title	Typ	Hrs/wk	CP
Nonlinear Structural Analysis (L0277)	Lecture	3	4
Nonlinear Structural Analysis (L0279)	Recitation Section (small)	1	2

Module Responsible	Prof. Alexander Düster
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to + give an overview of the different nonlinear phenomena in structural mechanics. + explain the mechanical background of nonlinear phenomena in structural mechanics. + to specify problems of nonlinear structural analysis, to identify them in a given situation and to explain their mathematical and mechanical background.
Skills	Students are able to + model nonlinear structural problems. + select for a given nonlinear structural problem a suitable computational procedure. + apply finite element procedures for nonlinear structural analysis. + critically verify and judge results of nonlinear finite elements. + to transfer their knowledge of nonlinear solution procedures to new problems.
Personal Competence	
Social Competence	Students are able to + solve problems in heterogeneous groups and to document the corresponding results. + share new knowledge with group members.
Autonomy	Students are able to + acquire independently knowledge to solve complex 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	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L0277: Nonlinear Structural Analysis	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	DE/EN
Cycle	WiSe
Content	1. Introduction 2. Nonlinear phenomena 3. Mathematical preliminaries 4. Basic equations of continuum mechanics 5. Spatial discretization with finite elements 6. Solution of nonlinear systems of equations 7. Solution of elastoplastic problems 8. Stability problems 9. Contact problems
Literature	[1] Alexander Düster, Nonlinear Structrual Analysis, Lecture Notes, Technische Universität Hamburg-Harburg, 2014. [2] Peter Wriggers, Nonlinear Finite Element Methods, Springer 2008. [3] Peter Wriggers, Nichtlineare Finite-Elemente-Methoden, Springer 2001. [4] Javier Bonet and Richard D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge University Press, 2008.

Course L0279: Nonlinear Structural Analysis	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0832: Advanced Topics in Control

Courses

Title	Typ	Hrs/wk	CP
Advanced Topics in Control (L0661)	Lecture	2	3
Advanced Topics in Control (L0662)	Recitation Section (small)	2	3

Module Responsible	Prof. Herbert Werner
Admission Requirements	None
Recommended Previous Knowledge	H-infinity optimal control, mixed-sensitivity design, linear matrix inequalities
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can explain the advantages and shortcomings of the classical gain scheduling approach • They can explain the representation of nonlinear systems in the form of quasi-LPV systems • They can explain how stability and performance conditions for LPV systems can be formulated as LMI conditions • They can explain how gridding techniques can be used to solve analysis and synthesis problems for LPV systems • They are familiar with polytopic and LFT representations of LPV systems and some of the basic synthesis techniques associated with each of these model structures • Students can explain how graph theoretic concepts are used to represent the communication topology of multiagent systems • They can explain the convergence properties of first order consensus protocols • They can explain analysis and synthesis conditions for formation control loops involving either LTI or LPV agent models • Students can explain the state space representation of spatially invariant distributed systems that are discretized according to an actuator/sensor array • They can explain (in outline) the extension of the bounded real lemma to such distributed systems and the associated synthesis conditions for distributed controllers
Skills	• Students are capable of constructing LPV models of nonlinear plants and carry out a mixed-sensitivity design of gain-scheduled controllers; they can do this using polytopic, LFT or general LPV models • They are able to use standard software tools (Matlab robust control toolbox) for these tasks • Students are able to design distributed formation controllers for groups of agents with either LTI or LPV dynamics, using Matlab tools provided • Students are able to design distributed controllers for spatially interconnected systems, using the Matlab MD-toolbox
Personal Competence	
Social Competence	Students can work in small groups and arrive at joint results.
Autonomy	Students are able to find required information in sources provided (lecture notes, literature, software documentation) and use it to solve given problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

	Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Course L0661: Advanced Topics in Control	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	• Linear Parameter-Varying (LPV) Gain Scheduling - Linearizing gain scheduling, hidden coupling - Jacobian linearization vs. quasi-LPV models - Stability and induced L2 norm of LPV systems - Synthesis of LPV controllers based on the two-sided projection lemma - Simplifications: controller synthesis for polytopic and LFT models - Experimental identification of LPV models - Controller synthesis based on input/output models - Applications: LPV torque vectoring for electric vehicles, LPV control of a robotic manipulator • Control of Multi-Agent Systems - Communication graphs - Spectral properties of the graph Laplacian - First and second order consensus protocols - Formation control, stability and performance - LPV models for agents subject to nonholonomic constraints - Application: formation control for a team of quadrotor helicopters • Control of Spatially Interconnected Systems - Multidimensional signals, l2 and L2 signal norm - Multidimensional systems in Roesser state space form - Extension of real-bounded lemma to spatially interconnected systems - LMI-based synthesis of distributed controllers - Spatial LPV control of spatially varying systems - Applications: control of temperature profiles, vibration damping for an actuated beam
Literature	• Werner, H., Lecture Notes "Advanced Topics in Control" • Selection of relevant research papers made available as pdf documents via StudIP

Course L0662: Advanced Topics in Control	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1614: Optics for Engineers

Courses

Title	Typ	Hrs/wk	CP
Optics for Engineers (L2437)	Lecture	2	2
Optics for Engineers (L2438)	Project-/problem-based Learning	2	2

Module Responsible	Prof. Thorsten Kern
Admission Requirements	None
Recommended Previous Knowledge	- Basics of physics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Teaching subject ist the design of simple optical systems for illumination and imaging optics • Basic values for optical systems and lighting technology • Spectrum, black-bodies, color-perception • Light-Sources und their characterization • Photometrics • Ray-Optics • Matrix-Optics • Stops, Pupils and Windows • Light-field Technology • Introduction to Wave-Optics • Introduction to Holography
Skills	Understandings of optics as part of light and electromagnetic spectrum. Design rules, approach to designing optics
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Credit points	4
Course achievement	None
Examination	Oral exam
Examination duration and scale	20 min
Assignment for the Following Curricula	Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory

Course L2437: Optics for Engineers

Typ	Lecture
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
Content	• Basic values for optical systems and lighting technology • Spectrum, black-bodies, color-perception • Light-Sources und their characterization • Photometrics • Ray-Optics • Matrix-Optics • Stops, Pupils and Windows • Light-field Technology • Introduction to Wave-Optics • Introduction to Holography
Literature	

Course L2438: Optics for Engineers	
Typ	Project-/problem-based Learning
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
Content	See interlocking course
Literature	See interlocking course

Specialization Bio- and Medical Technology

The specialization „biotechnology and medical technology“ consists of modules for Intelligent Systems, Robotics and Navigation in medicine, supplemented by Endoprostheses and Materials and Regenerative Medicine, and completed by the modules Imaging Systems in medicine and Industrial Image Transformations in electives. Thus, the acquisition of knowledge and skills in engineering specific aspects of biotechnology and medical technology is at the heart of this specialization. In addition, subjects in the Technical Supplement Course for TMBMS (according FSPO) are freely selectable.

Module M1173: Applied Statistics

Courses

Title	Typ	Hrs/wk	CP
Applied Statistics (L1584)	Lecture	2	3
Applied Statistics (L1586)	Project-/problem-based Learning	2	2
Applied Statistics (L1585)	Recitation Section (small)	1	1

Module Responsible	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of statistical methods
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain the statistical methods and the conditions of their use.
Skills	Students are able to use the statistics program to solve statistics problems and to interpret and depict the results
Personal Competence	
Social Competence	Team Work, joined presentation of results
Autonomy	To understand and interpret the question and solve
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description**: Yes / None / Written elaboration
Examination	Written exam
Examination duration and scale	90 minutes, 28 questions
Assignment for the Following Curricula	Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Core Qualification: Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L1584: Applied Statistics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	The goal is to introduce students to the basic statistical methods and their application to simple problems. The topics include: • Chi square test • Simple regression and correlation • Multiple regression and correlation • One way analysis of variance • Two way analysis of variance • Discriminant analysis • Analysis of categorial data • Chossing the appropriate statistical method • Determining critical sample sizes
Literature	Applied Regression Analysis and Multivariable Methods, 3rd Edition, David G. Kleinbaum Emory University, Lawrence L. Kupper University of North Carolina at Chapel Hill, Keith E. Muller University of North Carolina at Chapel Hill, Azhar Nizam Emory University, Published by Duxbury Press, CB © 1998, ISBN/ISSN: 0-534-20910-6

Course L1586: Applied Statistics	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	The students receive a problem task, which they have to solve in small groups (n=5). They do have to collect their own data and work with them. The results have to be presented in an executive summary at the end of the course.
Literature	Selbst zu finden

Course L1585: Applied Statistics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	The different statistical tests are applied for the solution of realistic problems using actual data sets and the most common used commercial statistical software package (SPSS).
Literature	Student Solutions Manual for Kleinbaum/Kupper/Muller/Nizam's Applied Regression Analysis and Multivariable Methods, 3rd Edition, David G. Kleinbaum Emory University Lawrence L. Kupper University of North Carolina at Chapel Hill, Keith E. Muller University of North Carolina at Chapel Hill, Azhar Nizam Emory University, Published by Duxbury Press, Paperbound © 1998, ISBN/ISSN: 0-534-20913-0

Module M1334: BIO II: Biomaterials

Courses

Title	Typ	Hrs/wk	CP
Biomaterials (L0593)	Lecture	2	3

Module Responsible	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of orthopedic and surgical techniques is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can describe the materials of the human body and the materials being used in medical engineering, and their fields of use.
Skills	The students can explain the advantages and disadvantages of different kinds of biomaterials.
Personal Competence	
Social Competence	The students are able to discuss issues related to materials being present or being used for replacements with student mates and the teachers.
Autonomy	The students are able to acquire information on their own. They can also judge the information with respect to its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0593: Biomaterials	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	EN
Cycle	WiSe
Content	Topics to be covered include: 1. Introduction (Importance, nomenclature, relations) 2. Biological materials 2.1 Basics (components, testing methods) 2.2 Bone (composition, development, properties, influencing factors) 2.3 Cartilage (composition, development, structure, properties, influencing factors) 2.4 Fluids (blood, synovial fluid) 3 Biological structures 3.1 Menisci of the knee joint 3.2 Intervertebral discs 3.3 Teeth 3.4 Ligaments 3.5 Tendons 3.6 Skin 3.7 Nervs 3.8 Muscles 4. Replacement materials 4.1 Basics (history, requirements, norms) 4.2 Steel (alloys, properties, reaction of the body) 4.3 Titan (alloys, properties, reaction of the body) 4.4 Ceramics and glas (properties, reaction of the body) 4.5 Plastics (properties of PMMA, HDPE, PET, reaction of the body) 4.6 Natural replacement materials Knowledge of composition, structure, properties, function and changes/adaptations of biological and technical materials (which are used for replacements in-vivo). Acquisition of basics for theses work in the area of biomechanics.
Literature	Hastings G and Ducheyne P.: Natural and living biomaterials. Boca Raton: CRC Press, 1984. Williams D.: Definitions in biomaterials. Oxford: Elsevier, 1987. Hastings G.: Mechanical properties of biomaterials: proceedings held at Keele University, September 1978. New York: Wiley, 1998. Black J.: Orthopaedic biomaterials in research and practice. New York: Churchill Livingstone, 1988. Park J. Biomaterials: an introduction. New York: Plenum Press, 1980. Wintermantel, E. und Ha, S.-W : Biokompatible Werkstoffe und Bauweisen. Berlin, Springer, 1996.

Module M1302: Applied Humanoid Robotics

Courses

Title	Typ	Hrs/wk	CP
Applied Humanoid Robotics (L1794)	Project-/problem-based Learning	6	6

Module Responsible	Patrick Göttsch
Admission Requirements	None
Recommended Previous Knowledge	• Object oriented programming; algorithms and data structures • Introduction to control systems • Control systems theory and design • Mechanics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can explain humanoid robots. • Students can explain the basic concepts, relationships and methods of forward- and inverse kinematics • Students learn to apply basic control concepts for different tasks in humanoid robotics.
Skills	• Students can implement models for humanoid robotic systems in Matlab and C++, and use these models for robot motion or other tasks. • They are capable of using models in Matlab for simulation and testing these models if necessary with C++ code on the real robot system. • They are capable of selecting methods for solving abstract problems, for which no standard methods are available, and apply it successfully.
Personal Competence	
Social Competence	• Students can develop joint solutions in mixed teams and present these. • They can provide appropriate feedback to others, and constructively handle feedback on their own results
Autonomy	• Students are able to obtain required information from provided literature sources, and to put in into the context of the lecture. • They can independently define tasks and apply the appropriate means to solve them.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and scale	5-10 pages
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1794: Applied Humanoid Robotics

Typ	Project-/problem-based Learning
Hrs/wk	6
CP	6
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Lecturer	Patrick Göttsch
Language	DE/EN
Cycle	WiSe/SoSe
Content	• Fundamentals of kinematics • Static and dynamic stability of humanoid robotic systems • Combination of different software environments (Matlab, C++, etc.) • Introduction to the necessary software frameworks • Team project • Presentation and Demonstration of intermediate and final results
Literature	• B. Siciliano, O. Khatib. "Handbook of Robotics. Part A: Robotics Foundations", Springer (2008)

Module M0811: Medical Imaging Systems

Courses

Title	Typ	Hrs/wk	CP
Medical Imaging Systems (L0819)	Lecture	4	6

Module Responsible	Dr. Michael Grass
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: • Describe the system configuration and components of the main clinical imaging systems; • Explain how the system components and the overall system of the imaging systems function; • Explain and apply the physical processes that make imaging possible and use with the fundamental physical equations; • Name and describe the physical effects required to generate image contrasts; • Explain how spatial and temporal resolution can be influenced and how to characterize the images generated; • Explain which image reconstruction methods are used to generate images; Describe and explain the main clinical uses of the different systems.

Skills	Students are able to:
	• Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required;
	  ◦ Calculate the parameters of imaging systems using the mathematical or physical equations;
	  ◦ Determine the influence of different system components on the spatial and temporal resolution of imaging systems;
	  ◦ Explain the importance of different imaging systems for a number of clinical applications;
	
	Select a suitable imaging system for an application.

Personal Competence	
Social Competence	none
Autonomy	Students can: • Understand which physical effects are used in medical imaging; • Decide independently for which clinical issue a measuring system can be used.
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	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Biomedical Engineering: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0819: Medical Imaging Systems	
Typ	Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Dr. Michael Grass, Dr. Tim Nielsen, Dr. Sven Prevrhal, Frank Michael Weber
Language	DE
Cycle	SoSe
Content	
Literature	Primary book: 1. P. Suetens, "Fundamentals of Medical Imaging", Cambridge Press Secondary books: - A. Webb, "Introduction to Biomedical Imaging", IEEE Press 2003. - W.R. Hendee and E.R. Ritenour, "Medical Imaging Physics", Wiley-Liss, New York, 2002. - H. Morneburg (Edt), "Bildgebende Systeme für die medizinische Diagnostik", Erlangen: Siemens Publicis MCD Verlag, 1995. - O. Dössel, "Bildgebende Verfahren in der Medizin", Springer Verlag Berlin, 2000.

Module M1335: BIO II: Artificial Joint Replacement

Courses

Title	Typ	Hrs/wk	CP
Artificial Joint Replacement (L1306)	Lecture	2	3

Module Responsible	Prof. Michael Morlock
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of orthopedic and surgical techniques is recommended.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can name the different kinds of artificial limbs.
Skills	The students can explain the advantages and disadvantages of different kinds of endoprotheses.
Personal Competence	
Social Competence	The students are able to discuss issues related to endoprothese with student mates and the teachers.
Autonomy	The students are able to acquire information on their own. They can also judge the information with respect to its credibility.
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Orientierungsstudium: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L1306: Artificial Joint Replacement

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE
Cycle	SoSe
Content	Inhalt (deutsch) 1. EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenker-satzes) 2. FUNKTIONSANALYSE (Der menschliche Gang, die menschliche Arbeit, die sportliche Aktivität) 3. DAS HÜFTGELENK (Anatomie, Biomechanik, Gelenkersatz Schaftseite und Pfannenseite, Evolution der Implantate) 4. DAS KNIEGELENK (Anatomie, Biomechanik, Bandersatz, Gelenkersatz femorale, tibiale und patelläre Komponenten) 5. DER FUß (Anatomie, Biomechanik, Gelen-kersatz, orthopädische Verfahren) 6. DIE SCHULTER (Anatomie, Biomechanik, Gelenkersatz) 7. DER ELLBOGEN (Anatomie, Biomechanik, Gelenkersatz) 8. DIE HAND (Anatomie, Biomechanik, Ge-lenkersatz) 9. TRIBOLOGIE NATÜRLICHER UND KÜNST-LICHER GELENKE (Korrosion, Reibung, Verschleiß)
Literature	Literatur: Kapandji, I..: Funktionelle Anatomie der Gelenke (Band 1-4), Enke Verlag, Stuttgart, 1984. Nigg, B., Herzog, W.: Biomechanics of the musculo-skeletal system, John Wiley&Sons, New York 1994 Nordin, M., Frankel, V.: Basic Biomechanics of the Musculoskeletal System, Lea&Febiger, Philadelphia, 1989. Czichos, H.: Tribologiehandbuch, Vieweg, Wiesbaden, 2003. Sobotta und Netter für Anatomie der Gelenke

Module M0630: Robotics and Navigation in Medicine

Courses

Title	Typ	Hrs/wk	CP
Robotics and Navigation in Medicine (L0335)	Lecture	2	3
Robotics and Navigation in Medicine (L0338)	Project Seminar	2	2
Robotics and Navigation in Medicine (L0336)	Recitation Section (small)	1	1

Module Responsible	Prof. Alexander Schlaefer
Admission Requirements	None
Recommended Previous Knowledge	• principles of math (algebra, analysis/calculus) • principles of programming, e.g., in Java or C++ • solid R or Matlab skills
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.
Skills	The students are able to design and evaluate navigation systems and robotic systems for medical applications.
Personal Competence	
Social Competence	The students discuss the results of other groups, provide helpful feedback and can incoorporate feedback into their work.
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description** Yes / 10 % / Written elaboration Yes / 10 % / Presentation
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0335: Robotics and Navigation in Medicine	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	- kinematics - calibration - tracking systems - navigation and image guidance - motion compensation The seminar extends and complements the contents of the lecture with respect to recent research results.
Literature	Spong et al.: Robot Modeling and Control, 2005 Troccaz: Medical Robotics, 2012 Further literature will be given in the lecture.

Course L0338: Robotics and Navigation in Medicine	
Typ	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0336: Robotics and Navigation in Medicine	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0548: Bioelectromagnetics: Principles and Applications

Courses

Title	Typ	Hrs/wk	CP
Bioelectromagnetics: Principles and Applications (L0371)	Lecture	3	5
Bioelectromagnetics: Principles and Applications (L0373)	Recitation Section (small)	2	1

Module Responsible	Prof. Christian Schuster
Admission Requirements	None
Recommended Previous Knowledge	Basic principles of physics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain the basic principles, relationships, and methods of bioelectromagnetics, i.e. the quantification and application of electromagnetic fields in biological tissue. They can define and exemplify the most important physical phenomena and order them corresponding to wavelength and frequency of the fields. They can give an overview over measurement and numerical techniques for characterization of electromagnetic fields in practical applications . They can give examples for therapeutic and diagnostic utilization of electromagnetic fields in medical technology.
Skills	Students know how to apply various methods to characterize the behavior of electromagnetic fields in biological tissue. In order to do this they can relate to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the most important effects that these models predict for biological tissue, they can order the effects corresponding to wavelength and frequency, respectively, and they can analyze them in a quantitative way. They are able to develop validation strategies for their predictions. They are able to evaluate the effects of electromagnetic fields for therapeutic and diagnostic applications and make an appropriate choice.
Personal Competence	
Social Competence	Students are able to work together on subject related tasks in small groups. They are able to present their results effectively in English (e.g. during small group exercises).
Autonomy	Students are capable to gather information from subject related, professional publications and relate that information to the context of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content of other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communicate problems and effects in the field of bioelectromagnetics in English.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description**: Yes / 10 % / Presentation
Examination	Oral exam
Examination duration and scale	45 min
Assignment for the Following Curricula	Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0371: Bioelectromagnetics: Principles and Applications	
Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
Content	- Fundamental properties of electromagnetic fields (phenomena) - Mathematical description of electromagnetic fields (Maxwell's Equations) - Electromagnetic properties of biological tissue - Principles of energy absorption in biological tissue, dosimetry - Numerical methods for the computation of electromagnetic fields (especially FDTD) - Measurement techniques for characterization of electromagnetic fields - Behavior of electromagnetic fields of low frequency in biological tissue - Behavior of electromagnetic fields of medium frequency in biological tissue - Behavior of electromagnetic fields of high frequency in biological tissue - Behavior of electromagnetic fields of very high frequency in biological tissue - Diagnostic applications of electromagnetic fields in medical technology - Therapeutic applications of electromagnetic fields in medical technology - The human body as a generator of electromagnetic fields
Literature	- C. Furse, D. Christensen, C. Durney, "Basic Introduction to Bioelectromagnetics", CRC (2009) - A. Vorst, A. Rosen, Y. Kotsuka, "RF/Microwave Interaction with Biological Tissues", Wiley (2006) - S. Grimnes, O. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008) - F. Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnetic Fields", CRC (2006)

Course L0373: Bioelectromagnetics: Principles and Applications	
Typ	Recitation Section (small)
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Christian Schuster
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1182: Technical Elective Course for TMBMS (according to Subject Specific Regulations)

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	see FSPO
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	see FSPO
Skills	see FSPO
Personal Competence	
Social Competence	see FSPO
Autonomy	see FSPO
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the Following Curricula	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Module M1249: Medical Imaging

Courses

Title	Typ	Hrs/wk	CP
Medical Imaging (L1694)	Lecture	2	3
Medical Imaging (L1695)	Recitation Section (small)	2	3

Module Responsible	Prof. Tobias Knopp
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge* *Skills* **Personal Competence** *Social Competence* *Autonomy*	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1694: Medical Imaging

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Tobias Knopp
Language	DE
Cycle	WiSe
Content	
Literature	**Bildgebende Verfahren in der Medizin**; O. Dössel; Springer, Berlin, 2000 **Bildgebende Systeme für die medizinische Diagnostik**; H. Morneburg (Hrsg.); Publicis MCD, München, 1995 **Introduction to the Mathematics of Medical Imaging**; C. L.Epstein; Siam, Philadelphia, 2008 **Medical Image Processing, Reconstruction and Restoration**; J. Jan; Taylor and Francis, Boca Raton, 2006 **Principles of Magnetic Resonance Imaging**; Z.-P. Liang and P. C. Lauterbur; IEEE Press, New York, 1999

Course L1695: Medical Imaging

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

Module M0746: Microsystem Engineering

Courses

Title	Typ	Hrs/wk	CP
Microsystem Engineering (L0680)	Lecture	2	4
Microsystem Engineering (L0682)	Project-/problem-based Learning	2	2

Module Responsible	Prof. Manfred Kasper
Admission Requirements	None
Recommended Previous Knowledge	Basic courses in physics, mathematics and electric engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know about the most important technologies and materials of MEMS as well as their applications in sensors and actuators.
Skills	Students are able to analyze and describe the functional behaviour of MEMS components and to evaluate the potential of microsystems.
Personal Competence	
Social Competence	Students are able to solve specific problems alone or in a group and to present the results accordingly.
Autonomy	Students are able to acquire particular knowledge using specialized literature and to integrate and associate this knowledge with other fields.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description**: No / 10 % / Presentation
Examination	Written exam
Examination duration and scale	2h
Assignment for the Following Curricula	Electrical Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Microelectronics and Microsystems: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0680: Microsystem Engineering	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Dr. rer. nat. Thomas Kusserow
Language	EN
Cycle	WiSe
Content	Object and goal of MEMS Scaling Rules Lithography Film deposition Structuring and etching Energy conversion and force generation Electromagnetic Actuators Reluctance motors Piezoelectric actuators, bi-metal-actuator Transducer principles Signal detection and signal processing Mechanical and physical sensors Acceleration sensor, pressure sensor Sensor arrays System integration Yield, test and reliability
Literature	M. Kasper: Mikrosystementwurf, Springer (2000) M. Madou: Fundamentals of Microfabrication, CRC Press (1997)

Course L0682: Microsystem Engineering	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. rer. nat. Thomas Kusserow
Language	EN
Cycle	WiSe
Content	Examples of MEMS components Layout consideration Electric, thermal and mechanical behaviour Design aspects
Literature	Wird in der Veranstaltung bekannt gegeben

Module M0623: Intelligent Systems in Medicine

Courses

Title	Typ	Hrs/wk	CP
Intelligent Systems in Medicine (L0331)	Lecture	2	3
Intelligent Systems in Medicine (L0334)	Project Seminar	2	2
Intelligent Systems in Medicine (L0333)	Recitation Section (small)	1	1

Module Responsible	Prof. Alexander Schlaefer
Admission Requirements	None
Recommended Previous Knowledge	• principles of math (algebra, analysis/calculus) • principles of stochastics • principles of programming, Java/C++ and R/Matlab • advanced programming skills
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to analyze and solve clinical treatment planning and decision support problems using methods for search, optimization, and planning. They are able to explain methods for classification and their respective advantages and disadvantages in clinical contexts. The students can compare different methods for representing medical knowledge. They can evaluate methods in the context of clinical data and explain challenges due to the clinical nature of the data and its acquisition and due to privacy and safety requirements.
Skills	The students can give reasons for selecting and adapting methods for classification, regression, and prediction. They can assess the methods based on actual patient data and evaluate the implemented methods.
Personal Competence	
Social Competence	The students discuss the results of other groups, provide helpful feedback and can incoorporate feedback into their work.
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	Compulsory / Bonus / Form / Description Yes / 10 % / Written elaboration Yes / 10 % / Presentation
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Course L0331: Intelligent Systems in Medicine

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	WiSe
Content	- methods for search, optimization, planning, classification, regression and prediction in a clinical context - representation of medical knowledge - understanding challenges due to clinical and patient related data and data acquisition The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Russel & Norvig: Artificial Intelligence: a Modern Approach, 2012 Berner: Clinical Decision Support Systems: Theory and Practice, 2007 Greenes: Clinical Decision Support: The Road Ahead, 2007 Further literature will be given in the lecture

Course L0334: Intelligent Systems in Medicine	
Typ	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0333: Intelligent Systems in Medicine	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Specialization Energy Systems

The focus of the specialization „energy technology“ lies on the acquisition of knowledge and skills on an economically and ecologically sensible provision of electricity, heating and coooling on the basis of conventional and renewable energy systems. This is made possible by modules in the areas of fluid mechanics and ocean energy, solar energy, electric energy, heating technology, air conditioners, power plants, steam and Cogeneration and combustion technology electives. In addition, subjects in the Technical Supplement Course for TMBMS (according FSPO) are freely selectable.

Module M1235: Electrical Power Systems I: Introduction to Electrical Power Systems

Courses

Title	Typ	Hrs/wk	CP
Electrical Power Systems I: Introduction to Electrical Power Systems (L1670)	Lecture	3	4
Electrical Power Systems I: Introduction to Electrical Power Systems (L1671)	Recitation Section (large)	2	2

Module Responsible	Prof. Christian Becker
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals of Electrical Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to give an overview of conventional and modern electric power systems. They can explain in detail and critically evaluate technologies of electric power generation, transmission, storage, and distribution as well as integration of equipment into electric power systems.
Skills	With completion of this module the students are able to apply the acquired skills in applications of the design, integration, development of electric power systems and to assess the results.
Personal Competence	
Social Competence	The students can participate in specialized and interdisciplinary discussions, advance ideas and represent their own work results in front of others.
Autonomy	Students can independently tap knowledge of the emphasis of the lectures.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 - 150 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Course L1670: Electrical Power Systems I: Introduction to Electrical Power Systems	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe

Content	• fundamentals and current development trends in electric power engineering
	• tasks and history of electric power systems
	• symmetric three-phase systems
	• fundamentals and modelling of eletric power systems
	  ◦ lines
	  ◦ transformers
	  ◦ synchronous machines
	  ◦ induction machines
	  ◦ loads and compensation
	  ◦ grid structures and substations
	• fundamentals of energy conversion
	  ◦ electro-mechanical energy conversion
	  ◦ thermodynamics
	  ◦ power station technology
	  ◦ renewable energy conversion systems
	• steady-state network calculation
	  ◦ network modelling
	  ◦ load flow calculation
	  ◦ (n-1)-criterion
	• symmetric failure calculations, short-circuit power
	• control in networks and power stations
	• grid protection
	• grid planning
	• power economy fundamentals

Literature	K. Heuck, K.-D. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013 A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017 R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008

Course L1671: Electrical Power Systems I: Introduction to Electrical Power Systems	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe

Content	• fundamentals and current development trends in electric power engineering
	• tasks and history of electric power systems
	• symmetric three-phase systems
	• fundamentals and modelling of eletric power systems
	  ◦ lines
	  ◦ transformers
	  ◦ synchronous machines
	  ◦ induction machines
	  ◦ loads and compensation
	  ◦ grid structures and substations
	• fundamentals of energy conversion
	  ◦ electro-mechanical energy conversion
	  ◦ thermodynamics
	  ◦ power station technology
	  ◦ renewable energy conversion systems
	• steady-state network calculation
	  ◦ network modelling
	  ◦ load flow calculation
	  ◦ (n-1)-criterion
	• symmetric failure calculations, short-circuit power
	• control in networks and power stations
	• grid protection
	• grid planning
	• power economy fundamentals

Literature	K. Heuck, K.-D. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2013 A. J. Schwab: "Elektroenergiesysteme", Springer, 5. Auflage, 2017 R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2008

Module M0742: Thermal Engineering

Courses

Title	Typ	Hrs/wk	CP
Thermal Engineering (L0023)	Lecture	3	5
Thermal Engineering (L0024)	Recitation Section (large)	1	1

Module Responsible	Prof. Gerhard Schmitz
Admission Requirements	None
Recommended Previous Knowledge	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students know the different energy conversion stages and the difference between efficiency and annual efficiency. They have increased knowledge in heat and mass transfer, especially in regard to buildings and mobile applications. They are familiar with German energy saving code and other technical relevant rules. They know to differ different heating systems in the domestic and industrial area and how to control such heating systems. They are able to model a furnace and to calculate the transient temperatures in a furnace. They have the basic knowledge of emission formations in the flames of small burners and how to conduct the flue gases into the atmosphere. They are able to model thermodynamic systems with object oriented languages.
Skills	Students are able to calculate the heating demand for different heating systems and to choose the suitable components. They are able to calculate a pipeline network and have the ability to perform simple planning tasks, regarding solar energy. They can write Modelica programs and can transfer research knowledge into practice. They are able to perform scientific work in the field of thermal engineering.
Personal Competence	
Social Competence	The students are able to discuss in small groups and develop an approach.
Autonomy	Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.
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	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0023: Thermal Engineering	
Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	WiSe
Content	1. Introduction 2. Fundamentals of Thermal Engineering 2.1 Heat Conduction 2.2 Convection 2.3 Radiation 2.4 Heat transition 2.5 Combustion parameters 2.6 Electrical heating 2.7 Water vapor transport 3. Heating Systems 3.1 Warm water heating systems 3.2 Warm water supply 3.3 piping calculation 3.4 boilers, heat pumps, solar collectors 3.5 Air heating systems 3.6 radiative heating systems 4. Thermal traetment systems 4.1 Industrial furnaces 4.2 Melting furnaces 4.3 Drying plants 4.4 Emission control 4.5 Chimney calculation 4.6 Energy measuring 5. Laws and standards 5.1 Buildings 5.2 Industrial plants
Literature	• Schmitz, G.: Klimaanlagen, Skript zur Vorlesung • VDI Wärmeatlas, 11. Auflage, Springer Verlag, Düsseldorf 2013 • Herwig, H.; Moschallski, A.: Wärmeübertragung, Vieweg+Teubner Verlag, Wiesbaden 2009 • Recknagel, H.; Sprenger, E.; Schrammek, E.-R.: Taschenbuch für Heizung- und Klimatechnik 2013/2014, 76. Auflage, Deutscher Industrieverlag, 2013

Course L0024: Thermal Engineering	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1037: Steam Turbines in Energy, Environmental and Power Train Engineering

Courses

Title	Typ	Hrs/wk	CP
Steam turbines in energy, environmental and Power Train Engineering (L1286)	Lecture	3	5
Steam turbines in energy, environmental and Power Train Engineering (L1287)	Recitation Section (small)	1	1

Module Responsible	Prof. Alfons Kather
Admission Requirements	None
Recommended Previous Knowledge	• "Gas and Steam Power Plants" • "Technical Thermodynamics I & II" • "Fluid Mechanics"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completion of the module the students must be in a position to: • name and identify the various parts and constructive groups of steam turbines • describe and explain the key operating conditions for the application of steam turbines • classify different construction types and differentiate among steam turbines according to size and operating ranges • describe the thermodynamic processes and the constructive and operational repercussions resulting from the latter • calculate thermodynamically a turbine stage and a stage assembly • calculate or estimate and further evaluate sections of the turbine • outline diagrams describing the operating range and the constructive characteristics • investigate the constructive aspects and develop from the thermodynamic requirements the required construction characteristics • discuss and argue on the operation characteristics of different turbine types • evaluate thermodynamically the integration of different turbine designs in heat cycles.
Skills	In the module the students learn the fundamental approaches and methods for the design and operational evaluation of complex plant, and gain in particular confidence in seeking optimisations. They specifically: • obtain the ability to analyse the potential of various energy sources that can be utilised thermodynamically, from the energetic-economic and technical viewpoints • can evaluate the performance and technical limitations in using various energy sources, for supplying base load and balancing reserve power to the electricity grid • on the basis of the impact of power plant operation on the integrity of components, can describe the precautionary principles for damage prevention • can describe the key requirements for the Management and Design of Thermal Power Plants, based on the overriding demands imposed by various legislative frameworks.
Personal Competence	
Social Competence	In the module the students learn: • to work together with others whilst seeking a solution • to assist each other in problem solving • to conduct discussions • to present work results • to work respectfully within the team.
Autonomy	In the module the students learn the independent working of a complex theme whilst considering various aspects. They also learn how to combine independent functions in a system. The students become the ability to gain independently knowledge and transfer it also to new problem solving.
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 min
Assignment for the Following Curricula	Energy and Environmental Engineering: Specialisation Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1286: Steam turbines in energy, environmental and Power Train Engineering	
Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Dr. Christian Scharfetter
Language	DE
Cycle	WiSe
Content	• Introduction • Construction Aspects of a Steam Turbine • Energy Conversion in a Steam Turbine • Construction Types of Steam Turbines • Behaviour of Steam Turbines • Sealing Systems for Steam Turbines • Axial Thrust • Regulation of Steam Turbines • Stiffness Calculation of the Blades • Blade and Rotor Oscillations • Fundamentals of a Safe Steam Turbine Operation • Application in Conventional and Renewable Power Stations • Connection to thermal and electrical energy networks, interfaces • Conventional and regenerative power plant concepts, drive technology • Analysis of the global energy supply market • Applications in conventional and regenerative power plants • Different power plant concepts and their influence on the steam turbine (engine and gas turbine power plants with waste heat utilization, geothermal energy, solar thermal energy, biomass, biogas, waste incineration). • Classic combined heat and power generation as a combined product of the manufacturing industry • Impact of change in the energy market, operating profiles • Applications in drive technology • Operating and maintenance concepts The lecture will be deepened by means of examples, tasks and two excursions
Literature	• Traupel, W.: Thermische Turbomaschinen. Berlin u. a., Springer (TUB HH: Signatur MSI-105) • Menny, K.: Strömungsmaschinen: hydraulische und thermische Kraft- und Arbeitsmaschinen. Ausgabe: 5. Wiesbaden, Teubner, 2006 (TUB HH: Signatur MSI-121) • Bohl, W.: Aufbau und Wirkungsweise. Ausgabe 6. Würzburg, Vogel, 1994 (TUB HH: Signatur MSI-109) • Bohl, W.: Berechnung und Konstruktion. Ausgabe 6. Aufl. Würzburg, Vogel, 1999 (TUB HH: Signatur MSI-110)

Course L1287: Steam turbines in energy, environmental and Power Train Engineering	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Christian Scharfetter
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0512: Use of Solar Energy

Courses

Title	Typ	Hrs/wk	CP
Energy Meteorology (L0016)	Lecture	1	1
Energy Meteorology (L0017)	Recitation Section (small)	1	1
Collector Technology (L0018)	Lecture	2	2
Solar Power Generation (L0015)	Lecture	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	With the completion of this module, students will be able to deal with technical foundations and current issues and problems in the field of solar energy and explain and evaulate these critically in consideration of the prior curriculum and current subject specific issues. In particular they can professionally describe the processes within a solar cell and explain the specific features of application of solar modules. Furthermore, they can provide an overview of the collector technology in solar thermal systems.
Skills	Students can apply the acquired theoretical foundations of exemplary energy systems using solar radiation. In this context, for example they can assess and evaluate potential and constraints of solar energy systems with respect to different geographical assumptions. They are able to dimension solar energy systems in consideration of technical aspects and given assumptions. Using module-comprehensive knowledge students can evalute the economic and ecologic conditions of these systems. They can select calculation methods within the radiation theory for these topics.
Personal Competence	
Social Competence	Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module.
Autonomy	Students can independently exploit sources and acquire the particular knowledge about the subject area with respect to emphasis fo the lectures. Furthermore, with the assistance of lecturers, they can discrete use calculation methods for analysing and dimensioning solar energy systems. Based on this procedure they can concrete assess their specific learning level and can consequently define the further workflow.
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	3 hours written exam
Assignment for the Following Curricula	Energy and Environmental Engineering: Specialisation Energy and Environmental Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory

Course L0016: Energy Meteorology	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Matthias, Dr. Beate Geyer
Language	DE
Cycle	SoSe

Content	• Introduction: radiation source Sun, Astronomical Foundations, Fundamentals of radiation
	• Structure of the atmosphere
	• Properties and laws of radiation
	  ◦ Polarization
	  ◦ Radiation quantities
	  ◦ Planck's radiation law
	  ◦ Wien's displacement law
	  ◦ Stefan-Boltzmann law
	  ◦ Kirchhoff's law
	  ◦ Brightness temperature
	  ◦ Absorption, reflection, transmission
	• Radiation balance, global radiation, energy balance
	• Atmospheric extinction
	• Mie and Rayleigh scattering
	• Radiative transfer
	• Optical effects in the atmosphere
	• Calculation of the sun and calculate radiation on inclined surfaces

Literature	• Helmut Kraus: Die Atmosphäre der Erde • Hans Häckel: Meteorologie • Grant W. Petty: A First Course in Atmosheric Radiation • Martin Kaltschmitt, Wolfgang Streicher, Andreas Wiese: Renewable Energy • Alexander Löw, Volker Matthias: Skript Optik Strahlung Fernerkundung

Course L0017: Energy Meteorology	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Beate Geyer
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0018: Collector Technology	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Agis Papadopoulos
Language	DE
Cycle	SoSe
Content	• Introduction: Energy demand and application of solar energy. • Heat transfer in the solar thermal energy: conduction, convection, radiation. • Collectors: Types, structure, efficiency, dimensioning, concentrated systems. • Energy storage: Requirements, types. • Passive solar energy: components and systems. • Solar thermal low temperature systems: collector variants, construction, calculation. • Solar thermal high temperature systems: Classification of solar power plants construction. • Solar air conditioning.
Literature	• Vorlesungsskript. • Kaltschmitt, Streicher und Wiese (Hrsg.). Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte, 5. Auflage, Springer, 2013. • Stieglitz und Heinzel .Thermische Solarenergie: Grundlagen, Technologie, Anwendungen. Springer, 2012. • Von Böckh und Wetzel. Wärmeübertragung: Grundlagen und Praxis, Springer, 2011. • Baehr und Stephan. Wärme- und Stoffübertragung. Springer, 2009. • de Vos. Thermodynamics of solar energy conversion. Wiley-VCH, 2008. • Mohr, Svoboda und Unger. Praxis solarthermischer Kraftwerke. Springer, 1999.

Course L0015: Solar Power Generation	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alf Mews, Martin Schlecht, Roman Fritsches-Baguhl
Language	DE
Cycle	SoSe
Content	1. Introduction 2. Primary energy and consumption, available solar energy 3. Physics of the ideal solar cell 4. Light absorption PN junction characteristic values of the solar cell efficiency 5. Physics of the real solar cell 6. Charge carrier recombination characteristics, junction layer recombination, equivalent circuit 7. Increasing the efficiency 8. Methods for increasing the quantum yield, and reduction of recombination 9. Straight and tandem structures 10. Hetero-junction, Schottky, electrochemical, MIS and SIS-cell tandem cell 11. Concentrator 12. Concentrator optics and tracking systems 13. Technology and properties: types of solar cells, manufacture, single crystal silicon and gallium arsenide, polycrystalline silicon, and silicon thin film cells, thin-film cells on carriers (amorphous silicon, CIS, electrochemical cells) 14. Modules 15. Circuits
Literature	• A. Götzberger, B. Voß, J. Knobloch: Sonnenenergie: Photovoltaik, Teubner Studienskripten, Stuttgart, 1995 • A. Götzberger: Sonnenenergie: Photovoltaik : Physik und Technologie der Solarzelle, Teubner Stuttgart, 1994 • H.-J. Lewerenz, H. Jungblut: Photovoltaik, Springer, Berlin, Heidelberg, New York, 1995 • A. Götzberger: Photovoltaic solar energy generation, Springer, Berlin, 2005 • C. Hu, R. M. White: Solar Cells, Mc Graw Hill, New York, 1983 • H.-G. Wagemann: Grundlagen der photovoltaischen Energiewandlung: Solarstrahlung, Halbleitereigenschaften und Solarzellenkonzepte, Teubner, Stuttgart, 1994 • R. J. van Overstraeten, R.P. Mertens: Physics, technology and use of photovoltaics, Adam Hilger Ltd, Bristol and Boston, 1986 • B. O. Seraphin: Solar energy conversion Topics of applied physics V 01 31, Springer, Berlin, Heidelberg, New York, 1995 • P. Würfel: Physics of Solar cells, Principles and new concepts, Wiley-VCH, Weinheim 2005 • U. Rindelhardt: Photovoltaische Stromversorgung, Teubner-Reihe Umwelt, Stuttgart 2001 • V. Quaschning: Regenerative Energiesysteme, Hanser, München, 2003 • G. Schmitz: Regenerative Energien, Ringvorlesung TU Hamburg-Harburg 1994/95, Institut für Energietechnik

Module M1161: Turbomachinery

Courses

Title	Typ	Hrs/wk	CP
Turbomachines (L1562)	Lecture	3	4
Turbomachines (L1563)	Recitation Section (large)	1	2

Module Responsible	Prof. Franz Joos
Admission Requirements	None
Recommended Previous Knowledge	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can • distinguish the physical phenomena of conversion of energy, • understand the different mathematic modelling of turbomachinery, • calculate and evaluate turbomachinery.
Skills	The students are able to - understand the physics of Turbomachinery, - solve excersises self-consistent.
Personal Competence	
Social Competence	The students are able to • discuss in small groups and develop an approach.
Autonomy	The students are able to • develop a complex problem self-consistent, • analyse the results in a critical way, • have an qualified exchange with other students.
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	Energy Systems: Specialisation Marine Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Course L1562: Turbomachines	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Markus Schatz, Prof. Dr. Karsten Meier
Language	DE
Cycle	SoSe
Content	Topics to be covered will include: • Application cases of turbomachinery • Fundamentals of thermodynamics and fluid mechanics • Design fundamentals of turbomachinery • Introduction to the theory of turbine stage • Design and operation of the turbocompressor • Design and operation of the steam turbine • Design and operation of the gas turbine • Physical limits of the turbomachines
Literature	• Traupel: Thermische Turbomaschinen, Springer. Berlin, Heidelberg, New York • Bräunling: Flugzeuggasturbinen, Springer., Berlin, Heidelberg, New York • Seume: Stationäre Gasturbinen, Springer., Berlin, Heidelberg, New York • Menny: Strömungsmaschinen, Teubner., Stuttgart

Course L1563: Turbomachines	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Markus Schatz, Prof. Dr. Karsten Meier
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1000: Combined Heat and Power and Combustion Technology

Courses

Title	Typ	Hrs/wk	CP
Combined Heat and Power and Combustion Technology (L0216)	Lecture	3	5
Combined Heat and Power and Combustion Technology (L0220)	Recitation Section (large)	1	1

Module Responsible	Prof. Alfons Kather
Admission Requirements	None
Recommended Previous Knowledge	• "Gas-Steam Power Plants" • "Technical Thermodynamics I and II" • "Heat Transfer" • "Fluid Mechanics"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students outline the thermodynamic and chemical fundamentals of combustion processes. From the knowledge of the characteristics and reaction kinetics of various fuels they can describe the behaviour of premixed flames and non-premixed flames, in order to describe the fundamentals of furnace design in gas-, oil- and coal combustion plant. The students are furthermore able to describe the formation of NO_x and the primary NO_x reduction measures, and evaluate the impact of regulations and allowable limit levels. The students present the layout, design and operation of Combined Heat and Power plants and are in a position to compare with each other district heating plants with back-pressure steam turbine or condensing turbine with pressure-controlled extraction tapping, CHP plants with gas turbine or with combined steam and gas turbine, or even district heating plants with an internal combustion engine. They can explain and analyse aspects of combined heat, power and cooling (CCHP) and describe the layout of the key components needed. Through this specialised knowledge they are able to evaluate the ecological significance of district CHP generation, as well as its economics.
Skills	Using thermodynamic calculations and considering the reaction kinetics the students will be able to determine interdisciplinary correlations between thermodynamic and chemical processes during combustion. This then enables quantitative analysis of the combustion of gaseous, liquid and solid fuels and determination of the quantities and concentrations of the exhaust gases. In this module the first step toward the utilisation of an energy source (combustion) to provide usable energy (electricity and heat) is taught. An understanding of both procedures enables the students to holistically consider energy utilisation. Examples taken from the praxis, such as the CHP energy supply facility of the TUHH and the district heating network of Hamburg will be used, to highlight the potential from electricity generation plants with simultaneous heat extraction. Within the framework of the exercises the students will first learn to calculate the energetic and mass balances of combustion processes. Moreover, the students will gain a deeper understanding of the combustion processes by the calculation of reaction kinetics.
Personal Competence	
Social Competence	Especially during the exercises the focus is placed on communication with the tutor. This animates the students to reflect on their existing knowledge and ask specific questions for improving further this knowledge level.
Autonomy	The students assisted by the tutors will be able to perform estimating calculations. In this manner the theoretical and practical knowledge from the lecture is consolidated and the potential impact of different process arrangements and boundary conditions highlighted.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6

Course achievement

Compulsory	Bonus	Form	Description
No	10 %	Written elaboration	Am Ende jeder Vorlesung wird schriftlich eine zu auswertende Kurzfrage (5-10 min) zu der Vorlesung der Vorwoche gestellt. In den Kurzfragen werden kleine Rechenaufgaben, Skizzen oder auch kleine Freitexte zur Beantwortung gestellt.

Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0216: Combined Heat and Power and Combustion Technology	
Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Alfons Kather
Language	DE
Cycle	SoSe
Content	The subject area of "Combined Heat and Power" covers the following themes: • Layout, design and operation of Combined Heat and Power plants • District heating plants with back-pressure steam turbine and condensing turbine with pressure-controlled extraction tapping • District heating plants with gas turbine • District heating plants with combined steam and gas turbine • District heating plants with motor engine • Combined cooling heat and power (CCHP) • Layout of the key components • Regulatory framework and allowable limits • Economic significance and calculation of the profitability of district CHP plant whereas the subject of Combustion Technology includes: • Thermodynamic and chemical fundamentals • Fuels • Reaction kinetics • Premixed flames • Non-premixed flames • Combustion of gaseous fuels • Combustion of liquid fuels • Combustion of solid fuels • Combustion Chamber design • NO_x reduction
Literature	Bezüglich des Themenbereichs "Kraft-Wärme-Kopplung": • W. Piller, M. Rudolph: Kraft-Wärme-Kopplung, VWEW Verlag • Kehlhofer, Kunze, Lehmann, Schüller: Handbuch Energie, Band 7, Technischer Verlag Resch • W. Suttor: Praxis Kraft-Wärme-Kopplung, C.F. Müller Verlag • K.W. Schmitz, G. Koch: Kraft-Wärme-Kopplung, VDI Verlag • K.-H. Suttor, W. Suttor: Die KWK Fibel, Resch Verlag und für die Grundlagen der "Verbrennungstechnik": • J. Warnatz, U. Maas, R.W. Dibble; Technische Verbrennung: physikalisch-chemische Grundlagen, Modellbildung, Schadstoffentstehung. Springer, Berlin [u. a.], 2001

Course L0220: Combined Heat and Power and Combustion Technology	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alfons Kather
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1182: Technical Elective Course for TMBMS (according to Subject Specific Regulations)

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	see FSPO
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	see FSPO
Skills	see FSPO
Personal Competence	
Social Competence	see FSPO
Autonomy	see FSPO
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the Following Curricula	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Numerics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Module M0721: Air Conditioning

Courses

Title	Typ	Hrs/wk	CP
Air Conditioning (L0594)	Lecture	3	5
Air Conditioning (L0595)	Recitation Section (large)	1	1

Module Responsible	Prof. Gerhard Schmitz
Admission Requirements	None
Recommended Previous Knowledge	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students know the different kinds of air conditioning systems for buildings and mobile applications and how these systems are controlled. They are familiar with the change of state of humid air and are able to draw the state changes in a h1+x,x-diagram. They are able to calculate the minimum airflow needed for hygienic conditions in rooms and can choose suitable filters. They know the basic flow pattern in rooms and are able to calculate the air velocity in rooms with the help of simple methods. They know the principles to calculate an air duct network. They know the different possibilities to produce cold and are able to draw these processes into suitable thermodynamic diagrams. They know the criteria for the assessment of refrigerants.
Skills	Students are able to configure air condition systems for buildings and mobile applications. They are able to calculate an air duct network and have the ability to perform simple planning tasks, regarding natural heat sources and heat sinks. They can transfer research knowledge into practice. They are able to perform scientific work in the field of air conditioning.
Personal Competence	
Social Competence	The students are able to discuss in small groups and develop an approach.
Autonomy	Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.
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	Energy and Environmental Engineering: Specialisation Energy and Environmental Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0594: Air Conditioning	
Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	SoSe
Content	1. Overview 1.1 Kinds of air conditioning systems 1.2 Ventilating 1.3 Function of an air condition system 2. Thermodynamic processes 2.1 Psychrometric chart 2.2 Mixer preheater, heater 2.3 Cooler 2.4 Humidifier 2.5 Air conditioning process in a Psychrometric chart 2.6 Desiccant assisted air conditioning 3. Calculation of heating and cooling loads 3.1 Heating loads 3.2 Cooling loads 3.3 Calculation of inner cooling load 3.4 Calculation of outer cooling load 4. Ventilating systems 4.1 Fresh air demand 4.2 Air flow in rooms 4.3 Calculation of duct systems 4.4 Fans 4.5 Filters 5. Refrigeration systems 5.1. compression chillers 5.2Absorption chillers
Literature	• Schmitz, G.: Klimaanlagen, Skript zur Vorlesung • VDI Wärmeatlas, 11. Auflage, Springer Verlag, Düsseldorf 2013 • Herwig, H.; Moschallski, A.: Wärmeübertragung, Vieweg+Teubner Verlag, Wiesbaden 2009 • Recknagel, H.; Sprenger, E.; Schrammek, E.-R.: Taschenbuch für Heizung- und Klimatechnik 2013/2014, 76. Auflage, Deutscher Industrieverlag, 2013

Course L0595: Air Conditioning	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0906: Numerical Simulation and Lagrangian Transport

Courses

Title	Typ	Hrs/wk	CP
Lagrangian transport in turbulent flows (L2301)	Lecture	2	3
Computational Fluid Dynamics - Exercises in OpenFoam (L1375)	Recitation Section (small)	1	1
Computational Fluid Dynamics in Process Engineering (L1052)	Lecture	2	2

Module Responsible	Prof. Michael Schlüter
Admission Requirements	None
Recommended Previous Knowledge	• Mathematics I-IV • Basic knowledge in Fluid Mechanics • Basic knowledge in chemical thermodynamics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completion of the module the students are able to • explain the the basic principles of statistical thermodynamics (ensembles, simple systems) • describe the main approaches in classical Molecular Modeling (Monte Carlo, Molecular Dynamics) in various ensembles • discuss examples of computer programs in detail, • evaluate the application of numerical simulations, • list the possible start and boundary conditions for a numerical simulation.
Skills	The students are able to: • set up computer programs for solving simple problems by Monte Carlo or molecular dynamics, • solve problems by molecular modeling, • set up a numerical grid, • perform a simple numerical simulation with OpenFoam, • evaluate the result of a numerical simulation.
Personal Competence	
Social Competence	The students are able to • develop joint solutions in mixed teams and present them in front of the other students, • to collaborate in a team and to reflect their own contribution toward it.
Autonomy	The students are able to: • evaluate their learning progress and to define the following steps of learning on that basis, • evaluate possible consequences for their profession.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation B - Industrial Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy and Environmental Engineering: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L2301: Lagrangian transport in turbulent flows	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexandra von Kameke
Language	EN
Cycle	SoSe
Content	
Literature	

Course L1375: Computational Fluid Dynamics - Exercises in OpenFoam	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Michael Schlüter
Language	EN
Cycle	SoSe
Content	• generation of numerical grids with a common grid generator • selection of models and boundary conditions • basic numerical simulation with OpenFoam within the TUHH CIP-Pool
Literature	OpenFoam Tutorials (StudIP)

Course L1052: Computational Fluid Dynamics in Process Engineering	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	EN
Cycle	SoSe
Content	• Introduction into partial differential equations • Basic equations • Boundary conditions and grids • Numerical methods • Finite difference method • Finite volume method • Time discretisation and stability • Population balance • Multiphase Systems • Modeling of Turbulent Flows • Exercises: Stability Analysis • Exercises: Example on CFD - analytically/numerically
Literature	Paschedag A.R.: CFD in der Verfahrenstechnik: Allgemeine Grundlagen und mehrphasige Anwendungen, Wiley-VCH, 2004 ISBN 3-527-30994-2. Ferziger, J.H.; Peric, M.: Numerische Strömungsmechanik. Springer-Verlag, Berlin, 2008, ISBN: 3540675868. Ferziger, J.H.; Peric, M.: Computational Methods for Fluid Dynamics. Springer, 2002, ISBN 3-540-42074-6

Module M0641: Steam Generators

Courses

Title	Typ	Hrs/wk	CP
Steam Generators (L0213)	Lecture	3	5
Steam Generators (L0214)	Recitation Section (large)	1	1

Module Responsible	Prof. Alfons Kather
Admission Requirements	None
Recommended Previous Knowledge	• "Technical Thermodynamics I and II" • "Heat Transfer" • "Fluid Mechanics" • "Steam Power Plants"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the thermodynamic base principles for steam generators and their types. They are able to describe the basic principles of steam generators and sketch the combustion and fuel supply aspects of fossil-fuelled power plants. They can perform thermal design calculations and conceive the water-steam side, as well as they are able to define the constructive details of the steam generator. The students can describe and evaluate the operational behaviour of steam generators and explain these in the context of related disciplines.
Skills	The students will be able, using detailed knowledge on the calculation, design, and construction of steam generators, linked with a wide theoretical and methodical foundation, to understand the main design and construction aspects of steam generators. Through problem definition and formalisation, modelling of processes, and training in the solution methodology for partial problems a good overview of this key component of the power plant will be obtained. Within the framework of the exercise the students obtain the ability to draw the balances, and design the steam generator and its components. For this purpose small but close to lifelike tasks are solved, to highlight aspects of the design of steam generators.
Personal Competence	
Social Competence	Especially during the exercises the focus is placed on communication with the tutor. This animates the students to reflect on their existing knowledge and ask specific questions to further improve their understanding.
Autonomy	The students will be able to perform basic calculations covering aspects of the steam generator, with only the help of smaller clues, on their own. This way the theoretical and practical knowledge from the lecture is consolidated and the potential effects from different process schemata and boundary conditions are highlighted.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6

Course achievement

Compulsory	Bonus	Form	Description
No	5 %	Excercises	Den Studierenden wird eine kleine Aufgabe (in ca. 5 min lösbar) zur Vorlesung der Vorwoche gestellt. Die Antworten müssen üblicherweise als Freitext gegeben werden, aber auch Zeichnungen, Stichpunkte oder, in seltenen Fällen, Multiple Choice sind möglich.

Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0213: Steam Generators	
Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Alfons Kather
Language	DE
Cycle	SoSe
Content	• Thermodynamics of steam • Basic principles of steam generators • Types of steam generators • Fuels and combustion systems • Coal pulverisers and coal drying • Modes of operation • Thermal analysis and design • Fluid dynamics in steam generators • Design of the water-steam side • Construction aspects • Stress analysis • Feed water for steam generators • Operating behaviour of steam Generators
Literature	• Dolezal, R.: Dampferzeugung. Springer-Verlag, 1985 • Thomas, H.J.: Thermische Kraftanlagen. Springer-Verlag, 1985 • Steinmüller-Taschenbuch: Dampferzeuger-Technik. Vulkan-Verlag, Essen, 1992 • Kakaç, Sadık: Boilers, Evaporators and Condensers. John Wiley & Sons, New York, 1991 • Stultz, S.C. and Kitto, J.B. (Ed.): Steam - its generation and use. 40th edition, The Babcock & Wilcox Company, Barberton, Ohio, USA, 1992

Course L0214: Steam Generators	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alfons Kather
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0511: Electricity Generation from Wind and Hydro Power

Courses

Title	Typ	Hrs/wk	CP
Renewable Energy Projects in Emerged Markets (L0014)	Project Seminar	1	1
Hydro Power Use (L0013)	Lecture	1	1
Wind Turbine Plants (L0011)	Lecture	2	3
Wind Energy Use - Focus Offshore (L0012)	Lecture	1	1

Module Responsible	Dr. Joachim Gerth
Admission Requirements	None
Recommended Previous Knowledge	Module: Technical Thermodynamics I, Module: Technical Thermodynamics II, Module: Fundamentals of Fluid Mechanics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use in offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are able to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedure in the implementation of renewable energy projects in countries outside Europe. Through active discussions of various topics within the seminar of the module, students improve their understanding and the application of the theoretical background and are thus able to transfer what they have learned in practice.
Skills	Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate and assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can in compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with the in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects.
Personal Competence	
Social Competence	Students can discuss scientific tasks subjet-specificly and multidisciplinary within a seminar.
Autonomy	Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of the lecture and to acquire the particular knowledge about the subject area.
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	3 hours written exam
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory

Course L0014: Renewable Energy Projects in Emerged Markets	
Typ	Project Seminar
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Andreas Wiese
Language	DE
Cycle	SoSe

Content	1. Introduction
	  ◦ Development of renewable energies worldwide
	  ▪ History
	  ▪ Future markets
	  ◦ Special challenges in new markets - Overview
	2. Sample project wind farm Korea
	  ◦ Survey
	  ◦ Technical Description
	  ◦ Project phases and characteristics
	3. Funding and financing instruments for EE projects in new markets
	  ◦ Overview funding opportunitie
	  ◦ Overview countries with feed-in laws
	  ◦ Major funding programs
	4. CDM projects - why, how , examples
	  ◦ Overview CDM process
	  ◦ Examples
	  ◦ Exercise CDM
	5. Rural electrification and hybrid systems - an important future market for EE
	  ◦ Rural Electrification - Introduction
	  ◦ Types of Elektrizifierungsprojekten
	  ◦ The role of the EEInterpretation of hybrid systems
	  ◦ Project example: hybrid system Galapagos Islands
	6. Tendering process for EE projects - examples
	  ◦ South Africa
	  ◦ Brazil
	7. Selected projects from the perspective of a development bank - Wesley Urena Vargas, KfW Development Bank
	  ◦ Geothermal
	  ◦ Wind or CSP
	
	Within the seminar, the various topics are actively discussed and applied to various cases of application.

Literature	Folien der Vorlesung

Course L0013: Hydro Power Use	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner
Language	DE
Cycle	SoSe
Content	• Introduction, importance of water power in the national and global context • Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies • Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems • Construction of hydroelectric power plants: description of the individual components and their technical system interaction • Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc. • Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection • Hydropower and the Environment • Examples from practice
Literature	• Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage • Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage • Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage • von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage • Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006

Course L0011: Wind Turbine Plants	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rudolf Zellermann, Dr. Jochen Oexmann
Language	DE
Cycle	SoSe
Content	• Historical development • Wind: origins, geographic and temporal distribution, locations • Power coefficient, rotor thrust • Aerodynamics of the rotor • Operating performance • Power limitation, partial load, pitch and stall control • Plant selection, yield prediction, economy • Excursion
Literature	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005

Course L0012: Wind Energy Use - Focus Offshore	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	• Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering • Physical fundamentals for utilization of wind energy • Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships • Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures • Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection • Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics • Development and planning of offshore wind farms • Operation and optimization of offshore wind farms • Day excursion
Literature	• Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage • Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage • Hau, E.: Windkraftanalagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage • Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage • Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage

Module M0508: Fluid Mechanics and Ocean Energy

Courses

Title	Typ	Hrs/wk	CP
Energy from the Ocean (L0002)	Lecture	2	2
Fluid Mechanics II (L0001)	Lecture	2	4

Module Responsible	Prof. Michael Schlüter
Admission Requirements	None
Recommended Previous Knowledge	Technische Thermodynamik I-II Wärme- und Stoffübertragung
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to describe different applications of fluid mechanics for the field of Renewable Energies. They are able to use the fundamentals of fluid mechanics for calculations of certain engineering problems in the field of ocean energy. The students are able to estimate if a problem can be solved with an analytical solution and what kind of alternative possibilities are available (e.g. self-similarity, empirical solutions, numerical methods).
Skills	Students are able to use the governing equations of Fluid Dynamics for the design of technical processes. Especially they are able to formulate momentum and mass balances to optimize the hydrodynamics of technical processes. They are able to transform a verbal formulated message into an abstract formal procedure.
Personal Competence	
Social Competence	The students are able to discuss a given problem in small groups and to develop an approach. They are able to solve a problem within a team, to prepare a poster with the results and to present the poster.
Autonomy	Students are able to define independently tasks for problems related to fluid mechanics. They are able to work out the knowledge that is necessary to solve the problem by themselves on the basis of the existing knowledge from the lecture.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description** Yes / 10 % / Group discussion
Examination	Written exam
Examination duration and scale	3h
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0002: Energy from the Ocean	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE
Cycle	WiSe

Content	1. Introduction to ocean energy conversion
	2. Wave properties
	  ◦ Linear wave theory
	  ◦ Nonlinear wave theory
	  ◦ Irregular waves
	  ◦ Wave energy
	  ◦ Refraction, reflection and diffraction of waves
	3. Wave energy converters
	  ◦ Overview of the different technologies
	  ◦ Methods for design and calculation
	4. Ocean current turbine

Literature	• Cruz, J., Ocean wave energy, Springer Series in Green Energy and Technology, UK, 2008. • Brooke, J., Wave energy conversion, Elsevier, 2003. • McCormick, M.E., Ocean wave energy conversion, Courier Dover Publications, USA, 2013. • Falnes, J., Ocean waves and oscillating systems, Cambridge University Press,UK, 2002. • Charlier, R. H., Charles, W. F., Ocean energy. Tide and tidal Power. Berlin, Heidelberg, 2009. • Clauss, G. F., Lehmann, E., Östergaard, C., Offshore Structures. Volume 1, Conceptual Design. Springer-Verlag, Berlin 1992

Course L0001: Fluid Mechanics II	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Michael Schlüter
Language	DE
Cycle	WiSe
Content	• Differential equations for momentum-, heat and mass transfer • Examples for simplifications of the Navier-Stokes Equations • Unsteady momentum transfer • Free shear layer, turbulence and free jets • Flow around particles - Solids Process Engineering • Coupling of momentum and heat transfer - Thermal Process Engineering • Rheology – Bioprocess Engineering • Coupling of momentum- and mass transfer – Reactive mixing, Chemical Process Engineering • Flow threw porous structures - heterogeneous catalysis • Pumps and turbines - Energy- and Environmental Process Engineering • Wind- and Wave-Turbines - Renewable Energy • Introduction into Computational Fluid Dynamics
Literature	1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. 2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972. 3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009. 4. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006. 5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley & Sons, 1994. 6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006. 7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008. 8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007 9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009. 10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007. 11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008. 12. Schlichting, H. : Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006. 13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.

Module M0658: Innovative CFD Approaches

Courses

Title	Typ	Hrs/wk	CP
Application of Innovative CFD Methods in Research and Development (L0239)	Lecture	2	3
Application of Innovative CFD Methods in Research and Development (L1685)	Recitation Section (small)	2	3

Module Responsible	Prof. Thomas Rung
Admission Requirements	None
Recommended Previous Knowledge	Attendance of a computational fluid dynamics course (CFD1/CFD2) Competent knowledge of numerical analysis in addition to general and computational thermo/fluid dynamics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Student can explain the theoretical background of different CFD strategies (e.g. Lattice-Boltzmann, Smoothed Particle-Hydrodynamics, Finite-Volume methods) and describe the fundamentals of simulation-based optimisation.
Skills	Student is able to identify an appropriate CFD-based solution strategy on a jusitfied basis.
Personal Competence	
Social Competence	Student should practice her/his team-working abilities, learn to lead team sessions and present solutions to experts.
Autonomy	Student should be able to structure and perform a simulation-based project independently,
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	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0239: Application of Innovative CFD Methods in Research and Development

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE/EN
Cycle	WiSe
Content	Computational Optimisation, Parallel Computing, Efficient CFD-Procedures for GPU Archtiectures, Alternative Approximations (Lattice-Boltzmann Methods, Particle Methods), Fluid/Structure-Interaction, Modelling of Hybrid Continua
Literature	Vorlesungsmaterialien /lecture notes

Course L1685: Application of Innovative CFD Methods in Research and Development

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

Module M0515: Energy Information Systems and Electromobility

Courses

Title	Typ	Hrs/wk	CP
Electrical Power Systems II: Operation and Information Systems of Electrical Power Grids (L1696)	Lecture	2	4
Electro mobility (L1833)	Lecture	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals of Electrical Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to give an overview of the electric power engineering in the field of renewable energies. They can explain in detail the possibilities for the integration of renewable energy systems into the existing grid, the electrical storage possibilities and the electric power transmission and distribution, and can take critically a stand on it.
Skills	With completion of this module the students are able to apply the acquired skills in applications of the design, integration, development of renewable energy systems and to assess the results.
Personal Competence	
Social Competence	The students can participate in specialized and interdisciplinary discussions, advance ideas and represent their own work results in front of others.
Autonomy	Students can independently tap knowledge of the emphasis of the lectures.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	45 min
Assignment for the Following Curricula	Energy and Environmental Engineering: Specialisation Energy and Environmental Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory

Course L1696: Electrical Power Systems II: Operation and Information Systems of Electrical Power Grids	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe

Content	• steaedy-state modelling of electric power systems
	  ◦ conventional components
	  ◦ Flexible AC Transmission Systems (FACTS) and HVDC
	  ◦ grid modelling
	• grid operation
	  ◦ electric power supply processes
	  ◦ grid and power system management
	  ◦ grid provision
	• grid control systems
	  ◦ information and communication systems for power system management
	  ◦ IT architectures of bay-, substation and network control level
	  ◦ IT integration (energy market / supply shortfall management / asset management)
	  ◦ future trends of process control technology
	  ◦ smart grids
	• functions and steady-state computations for power system operation and plannung
	  ◦ load-flow calculations
	  ◦ sensitivity analysis and power flow control
	  ◦ power system optimization
	  ◦ short-circuit calculation
	  ◦ asymmetric failure calculation
	  ▪ symmetric components
	  ▪ calculation of asymmetric failures
	  ◦ state estimation

Literature	E. Handschin: Elektrische Energieübertragungssysteme, Hüthig Verlag B. R. Oswald: Berechnung von Drehstromnetzen, Springer-Vieweg Verlag V. Crastan: Elektrische Energieversorgung Bd. 1 & 3, Springer Verlag E.-G. Tietze: Netzleittechnik Bd. 1 & 2, VDE-Verlag

Course L1833: Electro mobility	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Klaus Bonhoff
Language	DE
Cycle	WiSe
Content	• Introduction and environment • Definition of electric vehicles • Excursus: Electric vehicles with fuel cell • Market uptake of electric cars • Political / Regulatory Framework • Historical Review • Electric vehicle portfolio / application examples • Mild hybrids with 48 volt technology • Lithium-ion battery incl. Costs, roadmap, production, raw materials • Vehicle Integration • Energy consumption of electric cars • Battery life • Charging Infrastructure • Electric road transport • Electric public transport • Battery Safety
Literature	Vorlesungsunterlagen/ lecture material

Module M1149: Marine Power Engineering

Courses

Title	Typ	Hrs/wk	CP
Electrical Installation on Ships (L1531)	Lecture	2	2
Electrical Installation on Ships (L1532)	Recitation Section (large)	1	1
Marine Engineering (L1569)	Lecture	2	2
Marine Engineering (L1570)	Recitation Section (large)	1	1

Module Responsible	Prof. Christopher Friedrich Wirz
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to describe the state-of-the-art regarding the wide range of propulsion components on ships and apply their knowledge. They further know how to analyze and optimize the interaction of the components of the propulsion system and how to describe complex correlations with the specific technical terms in German and English. The students are able to name the operating behaviour of consumers, describe special requirements on the design of supply networks and to the electrical equipment in isolated networks, as e.g. onboard ships, offshore units, factories and emergency power supply systems, explain power generation and distribution in isolated grids, wave generator systems on ships, and name requirements for network protection, selectivity and operational monitoring.
Skills	The students are skilled to employ basic and detail knowledge regarding reciprocating machinery, their selection and operation on board ships. They are further able to assess, analyse and solve technical and operational problems with propulsion and auxiliary plants and to design propulsion systems. The students have the skills to describe complex correlations and bring them into context with related disciplines. Students are able to calculate short-circuit currents, switchgear, and design electrical propulsion systems for ships.
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.
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 minutes plus 20 minutes oral exam
Assignment for the Following Curricula	Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1531: Electrical Installation on Ships	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Günter Ackermann
Language	DE
Cycle	WiSe
Content	• performance in service of electrical consumers. • special requirements for power supply systems and for electrical equipment in isolated systems/networks e. g. aboard ships, offshore installations, factory systems and emergency power supply systems. • power generation and distribution in isolated networks, shaft generators for ships • calculation of short circuits and behaviour of switching devices • protective devices, selectivity monitoring • electrical Propulsion plants for ships
Literature	H. Meier-Peter, F. Bernhardt u. a.: Handbuch der Schiffsbetriebstechnik, Seehafen Verlag (engl. Version: "Compendium Marine Engineering") Gleß, Thamm: Schiffselektrotechnik, VEB Verlag Technik Berlin

Course L1532: Electrical Installation on Ships	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Günter Ackermann
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1569: Marine Engineering	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	WiSe
Content	
Literature	Wird in der Veranstaltung bekannt gegeben

Course L1570: Marine Engineering	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Specialization Aircraft Systems Engineering

Central to the specialization Aircraft Systems is learning the ability to systems engineering and cross-divisional thinking and problem solving in aeronautical engineering. This is made possible by modules in the field of physics of flight, aircraft systems and cabin systems, Aircraft Design, as well as airport planning and operation in the elective area. In addition, subjects in the Technical Supplement Course for TMBMS (according FSPO) are freely selectable.

Module M0763: Aircraft Systems I

Courses

Title	Typ	Hrs/wk	CP
Aircraft Systems I (L0735)	Lecture	3	4
Aircraft Systems I (L0739)	Recitation Section (large)	2	2

Module Responsible	Prof. Frank Thielecke
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in: • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Hydraulics • Control Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to: • Describe essential components and design points of hydraulic, electrical and high-lift systems • Give an overview of the functionality of air conditioning systems • Explain the need for high-lift systems such as ist functionality and effects • Assess the challenge during the design of supply systems of an aircraft
Skills	Students are able to: • Design hydraulic and electric supply systems of aircrafts • Design high-lift systems of aircrafts • Analyze the thermodynamic behaviour of air conditioning systems
Personal Competence	
Social Competence	Students are able to: • Perform system design in groups and present and discuss results
Autonomy	Students are able to: • Reflect the contents of lectures autonomously
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	165 Minutes
Assignment for the Following Curricula	Energy Systems: Specialisation Energy Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory

Course L0735: Aircraft Systems I	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	• Hydraulic Energy Systems (Fluids; pressure loss in valves and pipes; components of hydraulic systems like pumps, valves, etc.; pressure/flow characteristics; actuators; tanks; power and heat balances; emergency power) • Electric Energy Systems (Generators; constant-speed-drives; DC and AC converters; electrical power distribution; bus systems; monitoring; load analysis) • High Lift Systems (Principles; investigation of loads and system actuation power; principles and sizing of actuation and positioning systems; safety requirements and devices) • Environmental Control Systems (Thermodynamic analysis; expansion and compression cooling systems; control strategies; cabin pressure control systems)
Literature	• Moir, Seabridge: Aircraft Systems • Green: Aircraft Hydraulic Systems • Torenbek: Synthesis of Subsonic Airplane Design • SAE1991: ARP; Air Conditioning Systems for Subsonic Airplanes

Course L0739: Aircraft Systems I	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0812: Aircraft Design

Courses

Title	Typ	Hrs/wk	CP
Aircraft Design I (L0820)	Lecture	2	2
Aircraft Design I (L0834)	Recitation Section (large)	1	1
Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV) (L0844)	Lecture	2	2
Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV) (L0847)	Recitation Section (large)	1	1

Module Responsible	Prof. Volker Gollnick
Admission Requirements	None
Recommended Previous Knowledge	• Bachelor Mech. Eng. • Vordiplom Mech. Eng. • Module Air Transport Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	1. Principle understanding of integrated aircraft design 2. Understanding of the interactions and contributions of the various disciplines 3. Impact of the relevant design parameter on the aircraft design 4. Introduction of the principle design methods
Skills	Understanding and application of design and calculation methods Understanding of interdisciplinary and integrative interdependencies
Personal Competence	
Social Competence	Working in interdisciplinary teams Communication
Autonomy	Organization of workflows and -strategies
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	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory

Course L0820: Aircraft Design I	
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	WiSe
Content	Introduction into the aircraft design process 1. Introduction/process of aircraft design/various aircraft configurations 2. Requirements and design objectives, main design parameter (u.a. payload-range-diagramme) 3. Statistical methods in overall aircraft design/data base methods 4. Principles of aircraft performance design (stability, V-n-diagramme) 5. Principles of aerodynamic aircraft design (polar, geometry, 2D/3D aerodynamics) 6. Principles of structural fuselage and wing design (mass analysis, beam/tube models, geometry) 7. Principles of engine design and integration 8. Cruise design 9. Design of runway and landing field length 10. Cabin design (fuselage dimensioning, cabin interior, loading systems) 11. System- and equipment aspects 12. Design variations and operating cost calculation
Literature	J. Roskam: "Airplane Design" D.P. Raymer: "Aircraft Design - A Conceptual Approach" J.P. Fielding: "Intorduction to Aircraft Design" Jenkinson, Simpkon, Rhods: "Civil Jet Aircraft Design"

Course L0834: Aircraft Design I	
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	WiSe
Content	Training in applying MatLab Application of design methods for civil aircraft concerning: Fuselage and Cabin sizing and design Calculation of aircraft masses Aerodynamic and geometric wing design TakeOff, landing cruise performance calculation Manoevre and gust load calculation
Literature	J. Roskam: "Airplane Design" D.P. Raymer: "Aircraft Design - A Conceptual Approach" J.P. Fielding: "Intorduction to Aircraft Design" Jenkinson, Simpkon, Rhods: "Civil Jet Aircraft Design"

Course L0844: Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV)	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Volker Gollnick, Dr. Bernd Liebhardt
Language	DE/EN
Cycle	SoSe
Content	Take Off and landing Loads on Aircraft Operation Cost Principles of Rotorcraft Design Principles of high performance aircraft design Principles of special operations aircraft design Principles of Unmanned Air Systems design
Literature	Gareth Padfield: Helicopter Flight Dynamics Raymond Prouty: Helicopter Performance Stability and Control Klaus Hünecke: Das Kampfflugzeug von Heute

Course L0847: Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV)	
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, Dr. Bernd Liebhardt
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0771: Flight Physics

Courses

Title	Typ	Hrs/wk	CP
Aerodynamics and Flight Mechanics I (L0727)	Lecture	3	3
Flight Mechanics II (L0730)	Lecture	2	2
Flight Mechanics II (L0731)	Recitation Section (large)	1	1

Module Responsible	Prof. Frank Thielecke
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in: • Mathematics • Mechanics • Thermodynamics • Aviation
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge* *Skills* **Personal Competence** *Social Competence* *Autonomy*	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 Minutes (WS) + 90 Minutes (SS)
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0727: Aerodynamics and Flight Mechanics I

Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke, Dr. Ralf Heinrich, Mike Montel
Language	DE
Cycle	WiSe
Content	• Aerodynamics (fundamental equations of aerodynamics; compressible and incompressible flows; airfoils and wings; viscous flows) • Flight Mechanics (Equations of motion; flight performance; control surfaces; derivatives; lateral stability and control; trim conditions; flight maneuvers)
Literature	• Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II • Etkin, B.: Dynamics of Atmospheric Flight • Sachs/Hafer: Flugmechanik • Brockhaus: Flugregelung • J.D. Anderson: Introduction to flight

Course L0730: Flight Mechanics II	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke, Mike Montel
Language	DE
Cycle	SoSe
Content	• stationary asymmetric flight • dynamics of lateral movement • methods of flight simulation • eyperimental methods of flight mechanics • model validation using system identification • wind tunnel techniques
Literature	• Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II • Etkin, B.: Dynamics of Atmospheric Flight • Sachs/Hafer: Flugmechanik • Brockhaus: Flugregelung • J.D. Anderson: Introduction to flight

Course L0731: Flight Mechanics II	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Thielecke, Mike Montel
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1182: Technical Elective Course for TMBMS (according to Subject Specific Regulations)

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	see FSPO
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	see FSPO
Skills	see FSPO
Personal Competence	
Social Competence	see FSPO
Autonomy	see FSPO
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the Following Curricula	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Numerics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Module M1156: Systems Engineering

Courses

Title	Typ	Hrs/wk	CP
Systems Engineering (L1547)	Lecture	3	4
Systems Engineering (L1548)	Recitation Section (large)	1	2

Module Responsible	Prof. Ralf God
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in: • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems Previous knowledge in: • Aircraft Cabin Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to: • understand systems engineering process models, methods and tools for the development of complex Systems • describe innovation processes and the need for technology Management • explain the aircraft development process and the process of type certification for aircraft • explain the system development process, including requirements for systems reliability • identify environmental conditions and test procedures for airborne Equipment • value the methodology of requirements-based engineering (RBE) and model-based requirements engineering (MBRE)
Skills	Students are able to: • plan the process for the development of complex Systems • organize the development phases and development Tasks • assign required business activities and technical Tasks • apply systems engineering methods and tools
Personal Competence	
Social Competence	Students are able to: • understand their responsibilities within a development team and integrate themselves with their role in the overall process
Autonomy	Students are able to: • interact and communicate in a development team which has distributed 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	120 Minutes
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory

Course L1547: Systems Engineering	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	The objective of the lecture with the corresponding exercise is to accomplish the prerequisites for the development and integration of complex systems using the example of commercial aircraft and cabin systems. Competences in the systems engineering process, tools and methods is to be achieved. Regulations, guidelines and certification issues will be known. Key aspects of the course are processes for innovation and technology management, system design, system integration and certification as well as tools and methods for systems engineering: • Innovation processes • IP-protection • Technology management • Systems engineering • Aircraft program • Certification issues • Systems development • Safety objectives and fault tolerance • Environmental and operating conditions • Tools for systems engineering • Requirements-based engineering (RBE) • Model-based requirements engineering (MBRE)
Literature	- Skript zur Vorlesung - diverse Normen und Richtlinien (EASA, FAA, RTCA, SAE) - Hauschildt, J., Salomo, S.: Innovationsmanagement. Vahlen, 5. Auflage, 2010 - NASA Systems Engineering Handbook, National Aeronautics and Space Administration, 2007 - Hinsch, M.: Industrielles Luftfahrtmanagement: Technik und Organisation luftfahrttechnischer Betriebe. Springer, 2010 - De Florio, P.: Airworthiness: An Introduction to Aircraft Certification. Elsevier Ltd., 2010 - Pohl, K.: Requirements Engineering. Grundlagen, Prinzipien, Techniken. 2. korrigierte Auflage, dpunkt.Verlag, 2008

Course L1548: Systems Engineering	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0764: Aircraft Systems II

Courses

Title	Typ	Hrs/wk	CP
Aircraft Systems II (L0736)	Lecture	3	4
Aircraft Systems II (L0740)	Recitation Section (large)	2	2

Module Responsible	Prof. Frank Thielecke
Admission Requirements	None
Recommended Previous Knowledge	basic knowledge of: • mathematics • mechanics • thermo dynamics • electronics • fluid technology • control technology
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to... • describe the structure of primary flight control systems as well as actuation-, avionic-, fuel- and landing gear-systems in general along with corresponding properties and applications. • explain different configurations and designs and their origins • explain atmospheric conditions for icing such as the functionality of anti-ice systems
Skills	Students are able to... • size primary flight control actuation systems • perform a controller design process for the flight control actuators • design high-lift kinematics • design and analyse landing gear systems • design anti-ice systems
Personal Competence	
Social Competence	Students are able to: • Develop joint solutions in mixed teams
Autonomy	Students are able to: • derive requirements and perform appropriate yet simplified design processes for aircraft systems from complex issues and circumstances in a self-reliant manner
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	165 Minutes
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory

Course L0736: Aircraft Systems II	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	• Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems) • Flight Control Systems (control surfaces, hinge moments; requirements of stability and controllability, actuation power; principles of reversible and irreversible flight control systems; servo actuation systems) • Landing Gear Systems (Configurations and geometries; analysis of landing gear systems with respect to damper dynamics, dynamics of the breaking aircraft and power consumption; design and analysis of breaking systems with respect to energy and heat; anti-skit systems) • Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank) • De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)
Literature	• Moir, Seabridge: Aircraft Systems • Torenbek: Synthesis of Subsonic Airplane Design • Curry: Aircraft Landing Gear Design: Principles and Practices

Course L0740: Aircraft Systems II	
Typ	Recitation Section (large)
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	See interlocking course
Literature	See interlocking course

Module M1155: Aircraft Cabin Systems

Courses

Title	Typ	Hrs/wk	CP
Aircraft Cabin Systems (L1545)	Lecture	3	4
Aircraft Cabin Systems (L1546)	Recitation Section (large)	1	2

Module Responsible	Prof. Ralf God
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in: • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to: • describe cabin operations, equipment in the cabin and cabin Systems • explain the functional and non-functional requirements for cabin Systems • elucidate the necessity of cabin operating systems and emergency Systems • assess the challenges human factors integration in a cabin environment
Skills	Students are able to: • design a cabin layout for a given business model of an Airline • design cabin systems for safe operations • design emergency systems for safe man-machine interaction • solve comfort needs and entertainment requirements in the cabin
Personal Competence	
Social Competence	Students are able to: • understand existing system solutions and discuss their ideas with experts
Autonomy	Students are able to: • Reflect the contents of lectures and expert presentations self-dependent
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 Minutes
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1545: Aircraft Cabin Systems	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge about aircraft cabin systems and cabin operations. A basic understanding of technological and systems engineering effort to maintain an artificial but comfortable and safe travel and working environment at cruising altitude is to be achieved. The course provides a comprehensive overview of current technology and cabin systems in modern passenger aircraft. The Fulfillment of requirements for the cabin as the central system of work are covered on the basis of the topics comfort, ergonomics, human factors, operational processes, maintenance and energy supply: • Materials used in the cabin • Ergonomics and human factors • Cabin interior and non-electrical systems • Cabin electrical systems and lights • Cabin electronics, communication-, information- and IFE-systems • Cabin and passenger process chains • RFID Aircraft Parts Marking • Energy sources and energy conversion
Literature	- Skript zur Vorlesung - Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999 - Rossow, C.-C., Wolf, K., Horst, P. (Hrsg.): Handbuch der Luftfahrzeugtechnik. Carl Hanser Verlag, 2014 - Moir, I., Seabridge, A.: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Wiley 2008 - Davies, M.: The standard handbook for aeronautical and astronautical engineers. McGraw-Hill, 2003 - Kompendium der Flugmedizin. Verbesserte und ergänzte Neuauflage, Nachdruck April 2006. Fürstenfeldbruck, 2006 - Campbell, F.C.: Manufacturing Technology for Aerospace Structural Materials. Elsevier Ltd., 2006

Course L1546: Aircraft Cabin Systems	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1213: Avionics for safety-critical Systems

Courses

Title	Typ	Hrs/wk	CP
Avionics of Safty Critical Systems (L1640)	Lecture	2	3
Avionics of Safty Critical Systems (L1641)	Recitation Section (small)	1	1
Avionics of Safty Critical Systems (L1652)	Practical Course	1	2

Module Responsible	Dr. Martin Halle
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in: • Mathematics • Electrical Engineering • Informatics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can: • describe the most important principles and components of safety-critical avionics • denote processes and standards of safety-critical software development • depict the principles of Integrated Modular Avionics (IMA) • can compare hardware and bus systems used in avionics • assess the difficulties of developing a safety-critical avionics system correctly
Skills	Students can ... • operate real-time hardware and simulations • program A653 applications • plan avionics architectures up to a certain extend • create test scripts and assess test results
Personal Competence	
Social Competence	Students can: • jointly develop solutions in inhomogeneous teams • exchange information formally with other teams • present development results in a convenient way
Autonomy	Students can: • understand the requirements for an avionics system • autonomously derive concepts for systems based on safety-critical avionics
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	**Compulsory** Yes; **Bonus** None; **Form** Subject theoretical and practical work; **Description**
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Avionic Systems: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory

Course L1640: Avionics of Safty Critical Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Martin Halle
Language	DE
Cycle	WiSe
Content	Avionics are all kinds off flight electronics. Today there is no aircraft system function without avionics, and avionics are one main source of innovation in aerospace industry. Since many system functions are highly safety critical, the development of avionics hardware and software underlies mandatory constraints, technics, and processes. It is inevitable for system developers and computer engineers in aerospace industry to understand and master these. This lecture teaches the risks and techniques of developing safety critical hardware and software; major avionics components; integration; and test with a practical orientation. A focus is on Integrated Modular Avionics (IMA). The lecture is accompanied by a mandatory and laboratory exercises. Content: 1. Introduction and Fundamentals 2. History and Flight Control 3. Concepts and Redundancy 4. Digital Computers 5. Interfaces and Signals 6. Busses 7. Networks 8. Aircraft Cockpit 9. Software Development 10. Model-based Development 11. Integrated Modular Avionics I 12. Integrated Modular Avionics II
Literature	• Moir, I.; Seabridge, A. & Jukes, M., Civil Avionics Systems Civil Avionics Systems, John Wiley & Sons, Ltd, 2013 • Spitzer, C. R. Spitzer, Digital Avionics Handbook, CRC Press, 2007 • FAA, Advanced Avionics Handbook U.S. Department of Transportation Federal Aviation Administration, 2009 • Moir, I. & Seabridge, A. Aircraft Systems, Wiley, 2008, 3

Course L1641: Avionics of Safty Critical Systems	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Martin Halle
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1652: Avionics of Safty Critical Systems	
Typ	Practical Course
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Martin Halle
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1043: Aircraft Systems Engineering

Courses

Title	Typ	Hrs/wk	CP
Fatigue & Damage Tolerance (L0310)	Lecture	2	3
Lightweight Design Practical Course (L1258)	Project-/problem-based Learning	3	3
Aviation Security (L1549)	Lecture	2	2
Aviation Security (L1550)	Recitation Section (small)	1	1
Mechanisms, Systems and Processes of Materials Testing (L0950)	Lecture	2	2
Turbo Jet Engines (L0908)	Lecture	2	3
Structural Mechanics of Fibre Reinforced Composites (L1514)	Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Materials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics (L0176)	Lecture	2	2
Reliability in Engineering Dynamics (L1303)	Recitation Section (small)	1	2
Reliability of avionics assemblies (L1554)	Lecture	2	2
Reliability of avionics assemblies (L1555)	Recitation Section (small)	1	1
Reliability of Aircraft Systems (L0749)	Lecture	2	3

Module Responsible	Prof. Frank Thielecke
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in: • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Hydraulics • Control Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students are able to find their way through selected special areas within systems engineering, air transportation system and material science • Students are able to explain basic models and procedures in selected special areas. • Students are able to interrelate scientific and technical knowledge.
Skills	Students are able to apply basic methods in selected areas of engineering.
Personal Competence	
Social Competence	
Autonomy	Students can chose independently, in which fields they want to deepen their knowledge and skills through the election of courses.
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory

Course L0310: Fatigue & Damage Tolerance

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Martin Flamm
Language	EN
Cycle	WiSe
Content	Design principles, fatigue strength, crack initiation and crack growth, damage calculation, counting methods, methods to improve fatigue strength, environmental influences
Literature	Jaap Schijve, Fatigue of Structures and Materials. Kluver Academic Puplisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

Course L1258: Lightweight Design Practical Course	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Dieter Krause
Language	DE/EN
Cycle	SoSe
Content	Development of a sandwich structure made of fibre reinforced plastics • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests • manufacturing of the structure in the composite lab • Testing of the developed structure • Concept presentation • Self-organised teamwork
Literature	• Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005. • Puck, A., „Festigkeitsanalsyse von Faser-Matrix-Laminaten“, Hanser, München, Wien, 1996. • R&G, „Handbuch Faserverbundwerkstoffe“, Waldenbuch, 2009. • VDI 2014 „Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund“ • Ehrenstein, G. W., „Faserverbundkunststoffe“, Hanser, München, 2006. • Klein, B., „Leichtbau-Konstruktion", Vieweg & Sohn, Braunschweig, 1989. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986. • Wiedemann, J., „Leichtbau Band 2: Konstruktion“, Springer, Berlin, Heidelberg, 1986. • Backmann, B.F., „Composite Structures, Design, Safety and Innovation”, Oxford (UK), Elsevier, 2005. • Krause, D., „Leichtbau”, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012. • Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials”, Hamburg, TUHH - TuTech Innovation GmbH, 2005.

Course L1549: Aviation Security	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge about tasks and measures for protection against attacks on the security of the commercial air transport system. Tasks and measures will be elicited in the context of the three system components man, technology and organization. The course teaches the basics of aviation security. Aviation security is a necessary prerequisite for an economically successful air transport system. Risk management for the entire system can only be successful in an integrated approach, considering man, technology and organization: • Historical development • The special role of air transport • Motive and attack vectors • The human factor • Threats and risk • Regulations and law • Organization and implementation of aviation security tasks • Passenger and baggage checks • Cargo screening and secure supply chain • Safety technologies
Literature	- Skript zur Vorlesung - Giemulla, E.M., Rothe B.R. (Hrsg.): Handbuch Luftsicherheit. Universitätsverlag TU Berlin, 2011 - Thomas, A.R. (Ed.): Aviation Security Management. Praeger Security International, 2008

Course L1550: Aviation Security	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge about tasks and measures for protection against attacks on the security of the commercial air transport system. Tasks and measures will be elicited in the context of the three system components man, technology and organization. The course teaches the basics of aviation security. Aviation security is a necessary prerequisite for an economically successful air transport system. Risk management for the entire system can only be successful in an integrated approach, considering man, technology and organization: • Historical development • The special role of air transport • Motive and attack vectors • The human factor • Threats and risk • Regulations and law • Organization and implementation of aviation security tasks • Passenger and baggage checks • Cargo screening and secure supply chain • Safety technologies
Literature	- Skript zur Vorlesung - Giemulla, E.M., Rothe B.R. (Hrsg.): Handbuch Luftsicherheit. Universitätsverlag TU Berlin, 2011 - Thomas, A.R. (Ed.): Aviation Security Management. Praeger Security International, 2008

Course L0950: Mechanisms, Systems and Processes of Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate) • Compression test, bending test, torsion test • Crack growth upon static loading (J-Integral) • Crack growth upon cyclic loading (micro- und macro cracks) • Effect of notches • Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) • Wear testing • Non destructive testing application for overhaul of jet engines
Literature	• E. Macherauch: Praktikum in Werkstoffkunde, Vieweg • G. E. Dieter: Mechanical Metallurgy, McGraw-Hill • R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg • R. Bürgel: Werkstoffe sícher beurteilen und richtig einsetzen, Vieweg

Course L0908: Turbo Jet Engines	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Burkhard Andrich
Language	DE
Cycle	WiSe
Content	• Cycle of the gas turbine • Thermodynamics of gas turbine components • Wing-, grid- and stage-sizing • Operating characteristics of gas turbine components • Sizing criteria's for jet engines • Development trends of gas turbines and jet engines • Maintenance of jet engines
Literature	• Bräunling: Flugzeugtriebwerke • Engmann: Technologie des Fliegens • Kerrebrock: Aircraft Engines and Gas Turbines

Course L1514: Structural Mechanics of Fibre Reinforced Composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	Classical laminate theory Rules of mixture Failure mechanisms and criteria of composites Boundary value problems of isotropic and anisotropic shells Stability of composite structures Optimization of laminated composites Modelling composites in FEM Numerical multiscale analysis of textile composites Progressive failure analysis
Literature	• Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, aktuelle Auflage. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, , aktuelle Auflage. • Reddy, J.N., „Mechanics of Composite Laminated Plates and Shells”, CRC Publishing, Boca Raton et al., current edition. • Jones, R.M., „Mechanics of Composite Materials“, Scripta Book Co., Washington, current edition. • Timoshenko, S.P., Gere, J.M., „Theory of elastic stability“, McGraw-Hill Book Company, Inc., New York, current edition. • Turvey, G.J., Marshall, I.H., „Buckling and postbuckling of composite plates“, Chapman and Hall, London, current edition. • Herakovich, C.T., „Mechanics of fibrous composites“, John Wiley and Sons, Inc., New York, current edition. • Mittelstedt, C., Becker, W., „Strukturmechanik ebener Laminate”, aktuelle Auflage.

Course L1820: System Simulation	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica. • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems
Literature	[1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7 [2] M. Tiller: “Modelica by Example", http://book.xogeny.com, 2014. [3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000. [4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015. [5] P. Fritzson: “Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica”, Wiley, New York, 2011.

Course L1821: System Simulation	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0949: Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	WiSe
Content	Application and analysis of basic mechanical as well as non-destructive testing of materials • Determination elastic constants • Tensile test • Fatigue test (testing with constant stress, strain, or plastiv strain amplitude, low and high cycle fatigue, mean stress effect) • Crack growth upon static loading (stress intensity factor, fracture toughness) • Creep test • Hardness test • Charpy impact test • Non destructive testing
Literature	E. Macherauch: Praktikum in Werkstoffkunde, Vieweg G. E. Dieter: Mechanical Metallurgy, McGraw-Hill

Course L0176: Reliability in Engineering Dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 min.
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	Method for calculation and testing of reliability of dynamic machine systems • Modeling • System identification • Simulation • Processing of measurement data • Damage accumulation • Test planning and execution
Literature	Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4 Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737 Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936. VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412

Course L1303: Reliability in Engineering Dynamics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1554: Reliability of avionics assemblies	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge for development, electronic packaging technology and the production of electronic components for safety-critical applications. On an item, component and system level it is shown, how the specified safety objectives for electronics in aircraft can be achieved. Current challenges, such as availability of components, component counterfeiting and the use of components off-the-shelf (COTS) will be discussed: • Survey of the role of electronics in aviation • System levels: From silicon to mechatronic systems • Semiconductor components, assemblies, systems • Challenges of electronic packaging technology (AVT) • System integration in electronics: Requirements for AVT • Methods and techniques of AVT • Error patterns for assemblies and avoidance of errors • Reliability analysis for printed circuit boards (PCBs) • Reliability of Avionics • COTS, ROTS, MOTS and the F ^{3}I concept • Future challenges for electronics
Literature	- Skript zur Vorlesung Hanke, H.-J.: Baugruppentechnologie der Elektronik. Leiterplatten. Verlag Technik, 1994 Scheel, W.: Baugruppentechnologie der Elektronik. Montage. Verlag Technik, 1999

Course L1555: Reliability of avionics assemblies	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge for development, electronic packaging technology and the production of electronic components for safety-critical applications. On an item, component and system level it is shown, how the specified safety objectives for electronics in aircraft can be achieved. Current challenges, such as availability of components, component counterfeiting and the use of components off-the-shelf (COTS) will be discussed: • Survey of the role of electronics in aviation • System levels: From silicon to mechatronic systems • Semiconductor components, assemblies, systems • Challenges of electronic packaging technology (AVT) • System integration in electronics: Requirements for AVT • Methods and techniques of AVT • Error patterns for assemblies and avoidance of errors • Reliability analysis for printed circuit boards (PCBs) • Reliability of Avionics • COTS, ROTS, MOTS and the F ^{3}I concept • Future challenges for electronics
Literature	- Skript zur Vorlesung Hanke, H.-J.: Baugruppentechnologie der Elektronik. Leiterplatten. Verlag Technik, 1994 Scheel, W.: Baugruppentechnologie der Elektronik. Montage. Verlag Technik, 1999

Course L0749: Reliability of Aircraft Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek
Language	DE
Cycle	WiSe
Content	• Functions of reliability and safety (regulations, certification requirements) • Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment) • Reliability analysis of electrical and mechanical systems
Literature	• CS 25.1309 • SAE ARP 4754 • SAE ARP 4761

Module M1193: Cabin Systems Engineering

Courses

Title	Typ	Hrs/wk	CP
Computer and communication technology in cabin electronics and avionics (L1557)	Lecture	2	2
Computer and communication technology in cabin electronics and avionics (L1558)	Recitation Section (small)	1	1
Model-Based Systems Engineering (MBSE) with SysML/UML (L1551)	Project-/problem-based Learning	3	3

Module Responsible	Prof. Ralf God
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in: • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems Previous knowledge in: • Systems Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to: • describe the structure and operation of computer architectures • explain the structure and operation of digital communication Networks • explain architectures of cabin electronics, integrated modular avionics (IMA) and Aircraft Data Communication Network (ADCN) • understand the approach of Model-Based Systems Engineering (MBSE) in the design of hardware and software-based cabin systems
Skills	Students are able to: • understand, operate and maintain a Minicomputer • build up a network communication and communicate with other network participants • connect a minicomputer with a cabin management system (A380 CIDS) and communicate over a AFDX®-Network • model system functions by means of formal languages SysML/UML and generate software code from the models • execute software code on a minicomputer
Personal Competence	
Social Competence	Students are able to: • elaborate partial results and merge with others to form a complete solution
Autonomy	Students are able to: • organize and schedule their practical tasks
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory

Course L1557: Computer and communication technology in cabin electronics and avionics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics. The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks: • History of computer and network technology • Layer model in computer technology • Computer architectures (PC, IPC, Embedded Systems) • BIOS, UEFI and operating system (OS) • Programming languages (machine code and high-level languages) • Applications and Application Programming Interfaces • External interfaces (serial, USB, Ethernet) • Layer model in network technology • Network topologies • Network components • Bus access procedures • Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN) • Cabin electronics and cabin networks
Literature	- Skript zur Vorlesung - Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003 - Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004 - Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006

Course L1558: Computer and communication technology in cabin electronics and avionics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics. The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks: • History of computer and network technology • Layer model in computer technology • Computer architectures (PC, IPC, Embedded Systems) • BIOS, UEFI and operating system (OS) • Programming languages (machine code and high-level languages) • Applications and Application Programming Interfaces • External interfaces (serial, USB, Ethernet) • Layer model in network technology • Network topologies • Network components • Bus access procedures • Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN) • Cabin electronics and cabin networks
Literature	- Skript zur Vorlesung - Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003 - Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004 - Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006

Course L1551: Model-Based Systems Engineering (MBSE) with SysML/UML	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	Objectives of the problem-oriented course are the acquisition of knowledge on system design using the formal languages SysML/UML, learning about tools for modeling and finally the implementation of a project with methods and tools of Model-Based Systems Engineering (MBSE) on a realistic hardware platform (e.g. Arduino®, Raspberry Pi®): • What is a model? • What is Systems Engineering? • Survey of MBSE methodologies • The modelling languages SysML /UML • Tools for MBSE • Best practices for MBSE • Requirements specification, functional architecture, specification of a solution • From model to software code • Validation and verification: XiL methods • Accompanying MBSE project
Literature	- Skript zur Vorlesung - Weilkiens, T.: Systems Engineering mit SysML/UML: Modellierung, Analyse, Design. 2. Auflage, dpunkt.Verlag, 2008 - Holt, J., Perry, S.A., Brownsword, M.: Model-Based Requirements Engineering. Institution Engineering & Tech, 2011

Specialization Maritime Technology

At the center of the specialization Maritime Techniques lies the acquisition of knowledge and skills to develop, calculate and evaluate shipboard and offshore structures and their components. This is done in modules on the topics of marine engine systems, marine auxiliary systems, ship vibrations, maritime technology and maritime systems, port construction and port planning, port logistics, maritime transport and marine geotechnics and numerics in electives. In addition, subjects in the Technical Supplement Course for TMBMS (according FSPO) are freely selectable.

Module M1157: Marine Auxiliaries

Courses

Title	Typ	Hrs/wk	CP
Electrical Installation on Ships (L1531)	Lecture	2	2
Electrical Installation on Ships (L1532)	Recitation Section (large)	1	1
Auxiliary Systems on Board of Ships (L1249)	Lecture	2	2
Auxiliary Systems on Board of Ships (L1250)	Recitation Section (large)	1	1

Module Responsible	Prof. Christopher Friedrich Wirz
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to • name the operating behaviour of consumers, • describe special requirements on the design of supply networks and to the electrical equipment in isolated networks, as e.g. onboard ships, offshore units, factories and emergency power supply systems, • explain power generation and distribution in isolated grids, wave generator systems on ships, • name requirements for network protection, selectivity and operational monitoring, • name the requirements regarding marine equipment and apply to product development, as well as • describe operating procedures of equipment components of standard and specialized ships and derive requirements for product development.
Skills	Students are able to • calculate short-circuit currents, switchgear, • design electrical propulsion systems for ships • design additional machinery components, as well as • to apply basic principles of hydraulics and to develop hydraulic systems.
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	20 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1531: Electrical Installation on Ships	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Günter Ackermann
Language	DE
Cycle	WiSe
Content	• performance in service of electrical consumers. • special requirements for power supply systems and for electrical equipment in isolated systems/networks e. g. aboard ships, offshore installations, factory systems and emergency power supply systems. • power generation and distribution in isolated networks, shaft generators for ships • calculation of short circuits and behaviour of switching devices • protective devices, selectivity monitoring • electrical Propulsion plants for ships
Literature	H. Meier-Peter, F. Bernhardt u. a.: Handbuch der Schiffsbetriebstechnik, Seehafen Verlag (engl. Version: "Compendium Marine Engineering") Gleß, Thamm: Schiffselektrotechnik, VEB Verlag Technik Berlin

Course L1532: Electrical Installation on Ships	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Günter Ackermann
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1249: Auxiliary Systems on Board of Ships	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	SoSe
Content	• Vorschriften zur Schiffsausrüstung • Ausrüstungsanlagen auf Standard-Schiffen • Ausrüstungsanlagen auf Spezial-Schiffen • Grundlagen und Systemtechnik der Hydraulik • Auslegung und Betrieb von Ausrüstungsanlagen
Literature	• H. Meyer-Peter, F. Bernhardt: Handbuch der Schiffsbetriebstechnik • H. Watter: Hydraulik und Pneumatik

Course L1250: Auxiliary Systems on Board of Ships	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	SoSe
Content	
Literature	Siehe korrespondierende Vorlesung

Module M1177: Maritime Technology and Maritime Systems

Courses

Title	Typ	Hrs/wk	CP
Analysis of Maritime Systems (L0068)	Lecture	2	2
Analysis of Maritime Systems (L0069)	Recitation Section (small)	1	1
Introduction to Maritime Technology (L0070)	Lecture	2	2
Introduction to Maritime Technology (L1614)	Recitation Section (small)	1	1

Module Responsible	Prof. Moustafa Abdel-Maksoud
Admission Requirements	None
Recommended Previous Knowledge	Solid knowledge and competences in mechanics, fluid dynamics and analysis (series, periodic functions, continuity, differentiability, integration, multiple variables, ordinaray and partial differential equations, boundary value problems, initial conditions and eigenvalue problems).
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completion of this class, students should have an overview about phenomena and methods in ocean engineering and the ability to apply and extend the methods presented. In detail, the students should be able to • describe the different aspects and topics in Maritime Technology, • apply existing methods to problems in Maritime Technology, • discuss limitations in present day approaches and perspectives in the future, • Techniques for the analysis of offshore systems, • Modeling and evaluation of dynamic systems, • System-oriented thinking, decomposition of complex systems.
Skills	The students learn the ability of apply and transfer existing methods and techniques on novel questions in maritime technologies. Furthermore, limits of the existing knowledge and future developments will be discussed.
Personal Competence	
Social Competence	The processing of an exercise in a group of up to four students shall strengthen the communication and team-working skills and thus promote an important working technicque of subsequent working days. The collaboration has to be illustrated in a community presentation of the results.
Autonomy	The course contents are absorbed in an exercise work in a group and individually checked in a final exam in which a self-reflection of the learned is expected without tools.
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	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L0068: Analysis of Maritime Systems	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud, Dr. Alexander Mitzlaff
Language	DE
Cycle	SoSe

Content	1. Hydrostatic analysis
	  ◦ Buoyancy,
	  ◦ Stability,
	2. Hydrodynamic analysis
	  ◦ Froude-Krylov force
	  ◦ Morison's equation,
	  ◦ Radiation and diffraction
	  ◦ transparent/compact structures
	3. Evaluation of offshore structures: Reliability techniques (security, reliability, disposability)
	  ◦ Short-term statistics
	  ◦ Long-term statistics and extreme events

Literature	• G. Clauss, E. Lehmann, C. Östergaard. Offshore Structures Volume I: Conceptual Design and Hydrodynamics. Springer Verlag Berlin, 1992 • E. V. Lewis (Editor), Principles of Naval Architecture ,SNAME, 1988 • Journal of Offshore Mechanics and Arctic Engineering • Proceedings of International Conference on Offshore Mechanics and Arctic Engineering • S. Chakrabarti (Ed.), Handbook of Offshore Engineering, Volumes 1-2, Elsevier, 2005 • S. K. Chakrabarti, Hydrodynamics of Offshore Structures , WIT Press, 2001

Course L0069: Analysis of Maritime Systems	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Moustafa Abdel-Maksoud, Dr. Alexander Mitzlaff
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0070: Introduction to Maritime Technology	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Sven Hoog
Language	DE
Cycle	WiSe
Content	1. Introduction • Ocean Engineering and Marine Research • The potentials of the seas • Industries and occupational structures 2. Coastal and offshore Environmental Conditions • Physical and chemical properties of sea water and sea ice • Flows, waves, wind, ice • Biosphere 3. Response behavior of Technical Structures 4. Maritime Systems and Technologies • General Design and Installation of Offshore-Structures • Geophysical and Geotechnical Aspects • Fixed and Floating Platforms • Mooring Systems, Risers, Pipelines • Energy conversion: Wind, Waves, Tides
Literature	• Chakrabarti, S., Handbook of Offshore Engineering, vol. I/II, Elsevier 2005. • Gerwick, B.C., Construction of Marine and Offshore Structures, CRC-Press 1999. • Wagner, P., Meerestechnik, Ernst&Sohn 1990. • Clauss, G., Meerestechnische Konstruktionen, Springer 1988. • Knauss, J.A., Introduction to Physical Oceanography, Waveland 2005. • Wright, J. et al., Waves, Tides and Shallow-Water Processes, Butterworth 2006. • Faltinsen, O.M., Sea Loads on Ships and Offshore Structures, Cambridge 1999.

Course L1614: Introduction to Maritime Technology	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Sven Hoog
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1240: Fatigue Strength of Ships and Offshore Structures

Courses

Title	Typ	Hrs/wk	CP
Fatigue Strength of Ships and Offshore Structures (L1521)	Lecture	2	3
Fatigue Strength of Ships and Offshore Structures (L1522)	Recitation Section (small)	2	3

Module Responsible	Prof. Sören Ehlers
Admission Requirements	None
Recommended Previous Knowledge	Structural analysis of ships and/or offshore structures and fundamental knowledge in mechanics and mechanics of materials
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to • describe fatigue loads and stresses, as well as • describe structural behaviour under cyclic loads.
Skills	Students are able to calculate life prediction based on the S-N approach as well as life prediction based on the crack propagation.
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1521: Fatigue Strength of Ships and Offshore Structures

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Fricke
Language	EN
Cycle	WiSe
Content	1.) Introduction 2.) Fatigue loads and stresses 3.) Structural behaviour under cyclic loads - Structural behaviour under constant amplitude loading - Influence factors on fatigue strength - Material behaviour under contant amplitude loading - Special aspects of welded joints - Structural behaviour under variable amplitude loading 4.) Life prediction based on the S-N approach - Damage accumulation hypotheses - nominal stress approach - structural stress approach - notch stress approach - notch strain approach - numerical analyses 5.) Life prediction based on the crack propagation - basic relationships in fracture mechanics - description of crack propagation - numerical analysis - safety against unstable fracture
Literature	Siehe Vorlesungsskript

Course L1522: Fatigue Strength of Ships and Offshore Structures	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Fricke
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0663: Marine Geotechnics and Numerics

Courses

Title	Typ	Hrs/wk	CP
Marine Geotechnics (L0548)	Lecture	1	2
Marine Geotechnics (L0549)	Recitation Section (large)	2	1
Numerical Methods in Geotechnics (L0375)	Lecture	3	3

Module Responsible	Prof. Jürgen Grabe
Admission Requirements	None
Recommended Previous Knowledge	complete modules: Geotechnics I-II, Mathematics I-III courses: Soil laboratory course
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge* *Skills* **Personal Competence** *Social Competence* *Autonomy*	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Elective Compulsory

Course L0548: Marine Geotechnics

Typ	Lecture
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	• Geotechnical investigation an description of the seabed • Foundations of Offshore-Constructions • cCliff erosion • Sea dikes • Port structures • Flood protection structures
Literature	• EAK (2002): Empfehlungen für Küstenschutzbauwerke • EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke • Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London • Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst & Sohn, Berlin

Course L0549: Marine Geotechnics

Typ	Recitation Section (large)
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0375: Numerical Methods in Geotechnics	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	SoSe
Content	Topics: • numerical simulations • numerical algorithms • finite element method • application of finite element method in geomechanics • constitutive models for soils • contact models for soil structure interaction • selected applications
Literature	• Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden, Springer Verlag, Berlin • Bathe Klaus-Jürgen (2002): Finite-Elemente-Methoden. Springer Verlag, Berlin

Module M1132: Maritime Transport

Courses

Title	Typ	Hrs/wk	CP
Maritime Transport (L0063)	Lecture	2	3
Maritime Transport (L0064)	Recitation Section (small)	2	3

Module Responsible	Prof. Carlos Jahn
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to... • present the actors involved in the maritime transport chain with regard to their typical tasks; • name common cargo types in shipping and classify cargo to the corresponding categories; • explain operating forms in maritime shipping, transport options and management in transport networks; • weigh the advantages and disadvantages of the various modes of hinterland transport and apply them in practice; • present relevant factors for the location planning of ports and seaport terminals and discuss them in a problem-oriented way; • estimate the potential of digitisation in maritime shipping.
Skills	The students are able to... • determine the mode of transport, actors and functions of the actors in the maritime supply chain; • identify possible cost drivers in a transport chain and recommend appropriate proposals for cost reduction; • record, map and systematically analyse material and information flows of a maritime logistics chain, identify possible problems and recommend solutions; • perform risk assessments of human disruptions to the supply chain; • analyse accidents in the field of maritime logistics and evaluating their relevance in everyday life; • deal with current research topics in the field of maritime logistics in a differentiated way; • apply different process modelling methods in a hitherto unknown field of activity and to work out the respective advantages.
Personal Competence	
Social Competence	The students are able to... • discuss and organise extensive work packages in groups; • document and present the elaborated results.
Autonomy	The students are capable to... • research and select technical literature, including standards and guidelines; • submit own shares in an extensive written elaboration in small groups in due time.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	Compulsory: No; Bonus: 15 %; Form: Subject theoretical and practical work; Description: Teilnahme an einem Planspiel und anschließende schriftliche Ausarbeitung
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0063: Maritime Transport	
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	SoSe
Content	The general tasks of maritime logistics include the planning, design, implementation and control of material and information flows in the logistics chain ship - port - hinterland. This includes technology assessment, selection, dimensioning and implementation as well as the operation of technologies. The aim of the course is to provide students with knowledge of maritime transport and the actors involved in the maritime transport chain. Typical problem areas and tasks will be dealt with, taking into account the economic development. Thus, classical problems as well as current developments and trends in the field of maritime logistics are considered. In the lecture, the components of the maritime logistics chain and the actors involved will be examined and risk assessments of human disturbances on the supply chain will be developed. In addition, students learn to estimate the potential of digitisation in maritime shipping, especially with regard to the monitoring of ships. Further content of the lecture is the different modes of transport in the hinterland, which students can evaluate after completion of the course regarding their advantages and disadvantages.
Literature	• Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005. • Schönknecht, Axel. Maritime Containerlogistik: Leistungsvergleich von Containerschiffen in intermodalen Transportketten. Berlin Heidelberg: Springer-Verlag, 2009. • Stopford, Martin. Maritime Economics Routledge, 2009

Course L0064: Maritime Transport	
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	SoSe
Content	The exercise lesson bases on the haptic management game MARITIME. MARITIME focuses on providing knowledge about structures and processes in a maritime transport network. Furthermore, the management game systematically provides process management methodology and also promotes personal skills of the participants.
Literature	• Stopford, Martin. Maritime Economics Routledge, 2009 • Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005. • Schönknecht, Axel. Maritime Containerlogistik: Leistungsvergleich von Containerschiffen in intermodalen Transportketten. Berlin Heidelberg: Springer-Verlag, 2009.

Module M1133: Port Logistics

Courses

Title	Typ	Hrs/wk	CP
Port Logistics (L0686)	Lecture	2	3
Port Logistics (L1473)	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	Th After completing the module, students can... • reflect on the development of seaports (in terms of the functions of the ports and the corresponding terminals, as well as the relevant operator models) and place them in their historical context; • explain and evaluate different types of seaport terminals and their specific characteristics (cargo, transhipment technologies, logistic functional areas); • analyze common planning tasks (e.g. berth planning, stowage planning, yard planning) at seaport terminals and develop suitable approaches (in terms of methods and tools) to solve these planning tasks; • identify future developments and trends regarding the planning and control of innovative seaport terminals and discuss them in a problem-oriented manner.
Skills	After completing the module, students will be able to... • recognize functional areas in ports and seaport terminals; • define and evaluate suitable operating systems for container terminals; • perform static calculations with regard to given boundary conditions, e.g. required capacity (parking spaces, equipment requirements, quay wall length, port access) on selected terminal types; • reliably estimate which boundary conditions influence common logistics indicators in the static planning of selected terminal types and to what extent.
Personal Competence	
Social Competence	After completing the module, students can... • transfer the acquired knowledge to further questions of port logistics; • discuss and successfully organize extensive task packages in small groups; • in small groups, document work results in writing in an understandable form and present them to an appropriate extent.
Autonomy	After completing the module, the students are able to... • research and select specialist literature, including standards, guidelines and journal papers, and to develop the contents independently; • submit own parts in an extensive written elaboration in small groups in due time and to present them jointly within a fixed time frame.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	Compulsory: No; Bonus: 15 %; Form: Written elaboration; Description:
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0686: Port Logistics	
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	SoSe
Content	Port Logistics deals with the planning, control, execution and monitoring of material flows and the associated information flows in the port system and its interfaces to numerous actors inside and outside the port area. The extraordinary role of maritime transport in international trade requires very efficient ports. These must meet numerous requirements in terms of economy, speed, safety and the environment. Against this background, the lecture Port Logistics deals with the planning, control, execution and monitoring of material flows and the associated information flows in the port system and its interfaces to numerous actors inside and outside the port area. The aim of the lecture Port Logistics is to convey an understanding of structures and processes in ports. The focus will be on different types of terminals, their characteristical layouts and the technical equipment used as well as the ongoing digitization and interaction of the players involved. In addition, renowned guest speakers from science and practice will be regularly invited to discuss some lecture-relevant topics from alternative perspectives. The following contents will be conveyed in the lectures: • Instruction of structures and processes in the port • Planning, control, implementation and monitoring of material and information flows in the port • Fundamentals of different terminals, characteristical layouts and the technical equipment used • Handling of current issues in port logistics
Literature	• Alderton, Patrick (2013). Port Management and Operations. • Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium. • Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005. • Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen. • Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele. • Jahn, Carlos; Saxe, Sebastian (Hg.). Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag, 2017. • Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft • Lun, Y.H.V. and Lai, K.-H. and Cheng, T.C.E. (2010). Shipping and Logistics Management. • Woitschützke, Claus-Peter (2013). Verkehrsgeografie.

Course L1473: Port Logistics	
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	SoSe
Content	The content of the exercise is the independent preparation of a scientific paper plus an accompanying presentation on a current topic of port logistics. The paper deals with current topics of port logistics. For example, the future challenges in sustainability and productivity of ports, the digital transformation of terminals and ports or the introduction of new regulations by the International Maritime Organization regarding the verified gross weight of containers. Due to the international orientation of the event, the paper is to be prepared in English.
Literature	• Alderton, Patrick (2013). Port Management and Operations. • Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium. • Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. (2005) Berlin Heidelberg: Springer-Verlag. • Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen. • Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele. • Jahn, Carlos; Saxe, Sebastian (Hg.) (2017) Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag. • Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft • Lun, Y.H.V. and Lai, K.-H. and Cheng, T.C.E. (2010). Shipping and Logistics Management. • Woitschützke, Claus-Peter (2013). Verkehrsgeografie.

Module M1021: Marine Diesel Engine Plants

Courses

Title	Typ	Hrs/wk	CP
Marine Diesel Engine Plants (L0637)	Lecture	3	4
Marine Diesel Engine Plants (L0638)	Recitation Section (large)	1	2

Module Responsible	Prof. Christopher Friedrich Wirz
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can • explain different types four / two-stroke engines and assign types to given engines, • name definitions and characteristics, as well as • elaborate on special features of the heavy oil operation, lubrication and cooling.
Skills	Students can • evaluate the interaction of ship, engine and propeller, • use relationships between gas exchange, flushing, air demand, charge injection and combustion for the design of systems, • design waste heat recovery, starting systems, controls, automation, foundation and design machinery spaces , and • apply evaluation methods for excited motor noise and vibration.
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	The widespread scope of gained knowledge enables the students to handle situations in their future profession independently and confidently.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	20 min
Assignment for the Following Curricula	Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L0637: Marine Diesel Engine Plants	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	SoSe
Content	• Historischer Überblick • Bauarten von Vier- und Zweitaktmotoren als Schiffsmotoren • Vergleichsprozesse, Definitionen, Kenndaten • Zusammenwirken von Schiff, Motor und Propeller • Ausgeführte Schiffsdieselmotoren • Gaswechsel, Spülverfahren, Luftbedarf • Aufladung von Schiffsdieselmotoren • Einspritzung und Verbrennung • Schwerölbetrieb • Schmierung • Kühlung • Wärmebilanz • Abwärmenutzung • Anlassen und Umsteuern • Regelung, Automatisierung, Überwachung • Motorerregte Geräusche und Schwingungen • Fundamentierung • Gestaltung von Maschinenräumen
Literature	• D. Woodyard: Pounder’s Marine Diesel Engines • H. Meyer-Peter, F. Bernhardt: Handbuch der Schiffsbetriebstechnik • K. Kuiken: Diesel Engines • Mollenhauer, Tschöke: Handbuch Dieselmotoren • Projektierungsunterlagen der Motorenhersteller

Course L0638: Marine Diesel Engine Plants	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Christopher Friedrich Wirz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1175: Special Topics of Ship Propulsionand Hydrodynamics of High Speed Water Vehicles

Courses

Title	Typ	Hrs/wk	CP
Hydrodynamics of High Speed Water Vehicles (L1593)	Lecture	3	3
Special Topics of Ship Propulsion (L1589)	Lecture	3	3

Module Responsible	Prof. Moustafa Abdel-Maksoud
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge on ship resistance, ship propulsion and propeller theory
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Understand present research questions in the field of ship propulsion • Explain the present state of the art for the topics considered • Apply given methodology to approach given problems • Evaluate the limits of the present ship propulsion systems • Identify possibilities to extend present methods and technologies • Evaluate the feasibility of further developments
Skills	Students are able to • select and apply suitable computing and simulation methods to determine the hydrodynamic characteristics of ship propulsion systems • model the behavior of ship propulsion systems under different operation conditions by using simplified methods • evaluate critically the investigation results of experimental or numerical investigations
Personal Competence	
Social Competence	Students are able to • solve problems in heterogeneous groups and to document the corresponding results • share new knowledge with group members
Autonomy	Students are able to assess their knowledge by means of exercises and case studies
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	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1593: Hydrodynamics of High Speed Water Vehicles

Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE/EN
Cycle	SoSe
Content	1. Resistance components of different high speed water vehicles 2. Propulsion units of high speed vehicles 3. Waves resistance in shallow and deep water 4. Surface effect ships (SES) 5. Hydrofoil supported vehicles 6. Semi-displacement vehicles 7. Planning vehicles 8. Slamming 9. Manoeuvrability
Literature	Faltinsen,O. M., Hydrodynamics of High-Speed Marine Vehicles, Cambridge University Press, UK, 2006

Course L1589: Special Topics of Ship Propulsion	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE/EN
Cycle	SoSe
Content	1. Propeller Geometry 2. Cavitation 3. Model Tests, Propeller-Hull Interaction 4. Pressure Fluctuation / Vibration 5. Potential Theory 6. Propeller Design 7. Controllable Pitch Propellers 8. Ducted Propellers 9. Podded Drives 10. Water Jet Propulsion 11. Voith-Schneider-Propulsors
Literature	• Breslin, J., P., Andersen, P., Hydrodynamics of Ship Propellers, Cambridge Ocean Technology, Series 3, Cambridge University Press, 1996. • Lewis, V. E., ed., Principles of Naval Architecture, Volume II Resistance, Propulsion and Vibration, SNAME, 1988. • N. N., International Confrrence Waterjet 4, RINA London, 2004 • N. N., 1st International Conference on Technological Advances in Podded Propulsion, Newcastle, 2004

Module M1182: Technical Elective Course for TMBMS (according to Subject Specific Regulations)

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	see FSPO
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	see FSPO
Skills	see FSPO
Personal Competence	
Social Competence	see FSPO
Autonomy	see FSPO
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the Following Curricula	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Module M1233: Numerical Methods in Ship Design

Courses

Title	Typ	Hrs/wk	CP
Numerical Methods in Ship Design (L1271)	Lecture	2	4
Numerical Methods in Ship Design (L1709)	Project-/problem-based Learning	2	2

Module Responsible	Prof. Stefan Krüger
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge* *Skills* **Personal Competence** *Social Competence* *Autonomy*	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	45 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1271: Numerical Methods in Ship Design

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	SoSe
Content	The lecture starts with the definition of the early design phase and the importance of first principle approaches. The reasons for process reengineering when such kinds of methods are introduced is demonstrated. Several numerical modelling techniques are introduced and discussed for the following design relevant topics: - Hullform representation, fairing and interpolation - Hullform design by modifying parent hulls - Modelling of subdivison - Volumetric and stability calculations - Mass distributions and longitudinal strength - Hullform Design by CFD- techniques - Propulsor and Rudder Design by CFD Techniques
Literature	Skript zur Vorlesung.

Course L1709: Numerical Methods in Ship Design

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1146: Ship Vibration

Courses

Title	Typ	Hrs/wk	CP
Ship Vibration (L1528)	Lecture	2	3
Ship Vibration (L1529)	Recitation Section (small)	2	3

Module Responsible	Dr. Rüdiger Ulrich Franz von Bock und Polach
Admission Requirements	None
Recommended Previous Knowledge	Mechanis I - III Structural Analysis of Ships I Fundamentals of Ship Structural Design
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can reproduce the acceptance criteria for vibrations on ships; they can explain the methods for the calculation of natural frequencies and forced vibrations of sructural components and the entire hull girder; they understand the effect of exciting forces of the propeller and main engine and methods for their determination
Skills	Students are capable to apply methods for the calculation of natural frequencies and exciting forces and resulting vibrations of ship structures including their assessment; they can model structures for the vibration analysis
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	Students are able to detect vibration-prone components on ships, to model the structure, to select suitable calculation methods and to assess the results
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	3 hours
Assignment for the Following Curricula	Energy Systems: Specialisation Marine Engineering: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Ship and Offshore Technology: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1528: Ship Vibration

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	EN
Cycle	WiSe
Content	1. Introduction; assessment of vibrations 2. Basic equations 3. Beams with discrete / distributed masses 4. Complex beam systems 5. Vibration of plates and Grillages 6. Deformation method / practical hints / measurements 7. Hydrodynamic masses 8. Spectral method 9. Hydrodynamic masses acc. to Lewis 10. Damping 11. Shaft systems 12. Propeller excitation 13. Engines
Literature	Siehe Vorlesungsskript

Course L1529: Ship Vibration	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	EN
Cycle	WiSe
Content	1. Introduction; assessment of vibrations 2. Basic equations 3. Beams with discrete / distributed masses 4. Complex beam systems 5. Vibration of plates and Grillages 6. Deformation method / practical hints / measurements 7. Hydrodynamic masses 8. Spectral method 9. Hydrodynamic masses acc. to Lewis 10. Damping 11. Shaft systems 12. Propeller excitation 13. Engines
Literature	Siehe Vorlesungsskript

Module M1268: Linear and Nonlinear Waves

Courses

Title	Typ	Hrs/wk	CP
Linear and Nonlinear Waves (L1737)	Project-/problem-based Learning	4	6

Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	Good Knowledge in Mathematics, Mechanics and Dynamics.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to reflect existing terms and concepts in Wave Mechanics and to develop and research new terms and concepts.
Skills	Students are able to apply existing methods and procesures of Wave Mechanics and to develop novel methods and procedures.
Personal Competence	
Social Competence	Students can reach working results also in groups.
Autonomy	Students are able to approach given research tasks individually and to identify and follow up novel research tasks by themselves.
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	2 Hours
Assignment for the Following Curricula	Mechatronics: Specialisation System Design: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1737: Linear and Nonlinear Waves

Typ	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann, Dr. Antonio Papangelo
Language	DE/EN
Cycle	WiSe
Content	Introduction into the Dynamics of Linear and Nonlinear Waves.
Literature	G.B. Witham, Linear and Nonlinear Waves. Wiley 1999. C.C. Mei, Theory and Applications of Ocean Surface Waves. World Scientific 2004.

Module M1148: Selected topics in Naval Architecture and Ocean Engineering

Courses

Title	Typ	Hrs/wk	CP
Outfitting and Operation of Special Purpose Offshore Ships (L1896)	Lecture	2	3
Design of Underwater Vessels (L0670)	Lecture	2	3
Lattice-Boltzmann methods for the simulation of free surface flows (L2066)	Lecture	2	3
Modeling and Simulation of Maritime Systems (L2013)	Project-/problem-based Learning	2	3
Offshore Wind Parks (L0072)	Lecture	2	3
Ship Acoustics (L1605)	Lecture	2	3
Ship Dynamics (L0352)	Lecture	2	3
Selected Topics of Experimental and Theoretical Fluiddynamics (L0240)	Lecture	2	3
Technical Elements and Fluid Mechanics of Sailing Ships (L0873)	Lecture	2	3
Technology of Naval Surface Vessels (L0765)	Lecture	2	3

Module Responsible	Prof. Sören Ehlers
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 find their way through selected special areas within naval architecture and ocean engineering • Students are able to explain basic models and procedures in selected special areas. • Students are able to interrelate scientific and technical knowledge.
Skills	Students are able to apply basic methods in selected areas of ship and ocean engineering.
Personal Competence	
Social Competence	The students are able to communicate and cooperate in a professional environment in the shipbuilding and component supply industry.
Autonomy	Students can chose independently, in which fields they want to deepen their knowledge and skills through the election of courses.
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1896: Outfitting and Operation of Special Purpose Offshore Ships	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Hendrik Vorhölter
Language	DE
Cycle	SoSe
Content	The lecture is separated into two parts. In the first part some basic skills necessary for the design of offshore vessels and their equipment will be repeated and where necessary deepened. In particular, the specialties which are common for the ma-jority of offshore vessels will be addressed: rules and regulations, determination of operational limits as well as mooring and dynamic positioning. In the second part of the lecture single types of special offshore vessels and their equipment and outfitting will be addressed. For each type the specific requirements on design and operation will be discussed. Furthermore, the students shall be en-gaged with the preparation of short presentation about the specific ship types as incentive for the respective unit. In particular, it is planned to discuss the following ship types in the lecture: - Anchor handling and plattform supply vessels - Cable -and pile lay vessels - Jack-up vessels - Heavy lift and offshore construction vessels - Dredgers and rock dumping vessels - Diving support vessels
Literature	Chakrabarti, S. (2005): Handbook of Offshore Engineering. Elsevier. Amsterdam, London Volker Patzold (2008): Der Nassabbau. Springer. Berlin Milwee, W. (1996): Modern Marine Salvage. Md Cornell Maritime Press. Centreville. DNVGL-ST-N001 „Marine Operations and Marin Warranty“ IMCA M 103 “The Design and Operation of Dynamically Positioned Vessels” 2007-12 IMCA M 182 “The Safe Operation of Dynamically Positioned Offshore Supply Vessels” 2006-03 IMCA M 187 “Lifting Operations” 2007-10 IMCA SEL 185 “Transfer of Personnel to and from Offshore Vessels” 2010-03

Course L0670: Design of Underwater Vessels	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Peter Hauschildt
Language	DE
Cycle	SoSe
Content	The lectures will give an overview about the design of underwater vessels. The Topics are: 1.) Special requirements on the design of modern, konventional submarines 2.) Design history 3.) Generals description of submarines 4.) Civil submersibles 5.) Diving, trim, stability 6.) Rudders and Propulsion systems 7.) Air Independent propulsion 8.) Signatures 9.) Hydrodynamics and CFD 10.) Weapon- and combatmangementsystems 11.) Safety and rescue 12.) Fatigue and shock 13.) Ships technical systems 14.) Electricals Systems and automation 15.) Logisics 16.) Accomodation Some of the lectures will be Hheld in form of a excursion to ThyssenKrupp Marine Systems in Kiel
Literature	Gabler, Ubootsbau

Course L2066: Lattice-Boltzmann methods for the simulation of free surface flows	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christian Friedrich Janßen
Language	DE/EN
Cycle	WiSe
Content	This lecture addresses Lattice Boltzmann Methods for the simulation of free surface flows. After an introduction to the basic concepts of kinetic methods (LGCAs, LBM, ….), recent LBM extensions for the simulation of free-surface flows are discussed. Parallel to the lecture, selected maritime free-surface flow problems are to be solved numerically.
Literature	Krüger et al., “The Lattice Boltzmann Method - Principles and Practice”, Springer Zhou, “Lattice Boltzmann Methods for Shallow Water Flows”, Springer Janßen, “Kinetic approaches for the simulation of non-linear free surface flow problems in civil and environmental engineering”, PhD thesis, TU Braunschweig, 2010.

Course L2013: Modeling and Simulation of Maritime Systems	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christian Friedrich Janßen
Language	DE/EN
Cycle	SoSe
Content	In the scope of this lecture, students learn to model and solve selected maritime problems with the help of numerical programs and scripts. First, basic concepts of computational modeling are explained, from the physical modeling and discretization to the implementation and actual numerical solution of the problem. Then, available tools for the implementation and solution process are discussed, including high-level compiled and interpreted programming languages and computer algebra systems (e.g., Python; Matlab, Maple). In the second half of the class, selected maritime problems will be discussed and subsequently solved numerically by the students.
Literature	“Introduction to Computational Modeling Using C and Open-Source Tools” (J.M. Garrido, Chapman and Hall); “Introduction to Computational Models with Python” (J.M. Garrido, Chapman and Hall); “Programming Fundamentals” (MATLAB Handbook, MathWorks);

Course L0072: Offshore Wind Parks	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Alexander Mitzlaff
Language	DE
Cycle	WiSe
Content	• Nonlinear Waves: Stability, pattern formation, solitary states • Bottom Boundary layers: wave boundary layers, scour, stability of marine slopes • Ice-structure interaction • Wave and tidal current energy conversion
Literature	• Chakrabarti, S., Handbook of Offshore Engineering, vol. I&II, Elsevier 2005. • Mc Cormick, M.E., Ocean Wave Energy Conversion, Dover 2007. • Infeld, E., Rowlands, G., Nonlinear Waves, Solitons and Chaos, Cambridge 2000. • Johnson, R.S., A Modern Introduction to the Mathematical Theory of Water Waves, Cambridge 1997. • Lykousis, V. et al., Submarine Mass Movements and Their Consequences, Springer 2007. • Nielsen, P., Coastal Bottom Boundary Layers and Sediment Transport, World Scientific 2005. • Research Articles.

Course L1605: Ship Acoustics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Dietrich Wittekind
Language	DE
Cycle	SoSe
Content	
Literature	

Course L0352: Ship Dynamics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 min
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE
Cycle	SoSe
Content	Maneuverability of ships • Equations of motion • Hydrodynamic forces and moments • Linear equations and their solutions • Full-scale trials for evaluating the maneuvering performance • Regulations for maneuverability • Rudder Seakeeping • Representation of harmonic processes • Motions of a rigid ship in regular waves • Flow forces on ship cross sections • Strip method • Consequences induced by ship motion in regular waves • Behavior of ships in a stationary sea state • Long-term distribution of seaway influences
Literature	• Abdel-Maksoud, M., Schiffsdynamik, Vorlesungsskript, Institut für Fluiddynamik und Schiffstheorie, Technische Universität Hamburg-Harburg, 2014 • Abdel-Maksoud, M., Ship Dynamics, Lecture notes, Institute for Fluid Dynamic and Ship Theory, Hamburg University of Technology, 2014 • Bertram, V., Practical Ship Design Hydrodynamics, Butterworth-Heinemann, Linacre House - Jordan Hill, Oxford, United Kingdom, 2000 • Bhattacharyya, R., Dynamics of Marine Vehicles, John Wiley & Sons, Canada,1978 • Brix, J. (ed.), Manoeuvring Technical Manual, Seehafen-Verlag, Hamburg, 1993 • Claus, G., Lehmann, E., Östergaard, C). Offshore Structures, I+II, Springer-Verlag. Berlin Heidelberg, Deutschland, 1992 • Faltinsen, O. M., Sea Loads on Ships and Offshore Structures, Cambridge University Press, United Kingdom, 1990 • Handbuch der Werften, Deutschland, 1986 • Jensen, J. J., Load and Global Response of Ships, Elsevier Science, Oxford, United Kingdom, 2001 • Lewis, Edward V. (ed.), Principles of Naval Architecture - Motion in Waves and Controllability, Society of Naval Architects and Marine Engineers, Jersey City, NJ, 1989 • Lewandowski, E. M., The Dynamics of Marine Craft: Maneuvering and Seakeeping, World Scientific, USA, 2004 • Lloyd, A., Ship Behaviour in Rough Weather, Gosport, Chichester, Sussex, United Kingdom, 1998

Course L0240: Selected Topics of Experimental and Theoretical Fluiddynamics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	WiSe
Content	Will be announced at the beginning of the lecture. Exemplary topics are 1. methods and procedures from experimental fluid mechanics 2. rational Approaches towards flow physics modelling 3. selected topics of theoretical computation fluid dynamics 4. turbulent flows
Literature	Wird in der Veranstaltung bekannt gegeben. To be announced during the lecture.

Course L0873: Technical Elements and Fluid Mechanics of Sailing Ships	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Thomas Rung, Peter Schenzle
Language	DE/EN
Cycle	WiSe
Content	Principles of Sailing Mechanics: - Sailing: Propulsion from relative motion - Lifting foils: Sails, wings, rudders, fins, keels - Wind climate: global, seasonal, meteorological, local - Aerodynamics of sails and sailing rigs - Hydrodynamics of Hulls and fins Technical Elements of Sailing: - Traditional and modern sail types - Modern and unconventional wind propulsors - Hull forms and keel-rudder-configurations - Sailing performance Prediction (VPP) - Auxiliary wind propulsion (motor-sailing) Configuration of Sailing Ships: - Balancing hull and sailing rig - Sailing-boats and -yachts - Traditional Tall Sailing Ships - Modern Wind-Ships
Literature	- Vorlesungs-Manuskript mit Literatur-Liste: Verteilt zur Vorlesung - B. Wagner: Fahrtgeschwindigkeitsberechnung für Segelschiffe, IfS-Rep. 132, 1967 - B. Wagner: Sailing Ship Research at the Hamburg University, IfS-Script 2249, 1976 - A.R. Claughton et al.: Sailing Yacht Design 1&2, University of Southampton, 1998 - L. Larsson, R.E. Eliasson: Principles of Yacht Design, Adlard Coles Nautical, London, 2000 - K. Hochkirch: Entwicklung einer Messyacht, Diss. TU Berlin, 2000

Course L0765: Technology of Naval Surface Vessels	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Martin Schöttelndreyer
Language	DE
Cycle	WiSe
Content	• Operational scenarios, tasks, capabilities, requirements • Product and process models, rules and regulations • Survivability: threats, signatures, counter measures • Design characteristics • Energy and propulsion systems • Command and combat systems • Vulnerability: residual strength, residual functionality
Literature	Th. Christensen, H.-D. Ehrenberg, H. Götte, J. Wessel: Entwurf von Fregatten und Korvetten, in: H. Keil (Hrsg.), Handbuch der Werften, Bd. XXV, Schiffahrts-Verlag "Hansa" C. Schroedter & Co., Hamburg (2000) 16th International Ship and Offshore Structures Congress: Committee V.5 - Naval Ship Design (2006) P. G. Gates: Surface Warships - An Introduction to Design Principles, Brassey’s Defence Publishers, London (1987)

Module M1232: Arctic Technology

Courses

Title	Typ	Hrs/wk	CP
Ice Engineering (L1607)	Lecture	2	2
Ice Engineering (L1615)	Recitation Section (small)	1	2
Ship structural design for arctic conditions (L1575)	Project-/problem-based Learning	2	2

Module Responsible	Prof. Sören Ehlers
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The challenges and requirements due to ice can be explained. Ice loads can be explained and ice strengthening can be understood.
Skills	The challenges and requirements due to ice can be assessed and the accuracy of these assessment can be evaluated. Calculation models to assess ice loads can be used and a structure can be designed accordingly.
Personal Competence	
Social Competence	Students are capable to present their structural design and discuss their decisions constructively in a group.
Autonomy	Independent and individual assignment tasks can be carried out and presented whereby the capabilities to both, present and defend, the skills and findings will be achieved.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1607: Ice Engineering	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Walter Kuehnlein
Language	DE/EN
Cycle	WiSe
Content	1. Ice, Ice Properties, Ice Failure Modes and Challenges and Requirements due to Ice ◦ Introduction, what is/means ice engineering ◦ Description of different kinds of ice, main ice properties and different ice failure modes ◦ Why is ice so different compared to open water ◦ Presentation of design challenges and requirements for structures and systems in ice covered waters 2. Ice Load Determination and Ice Model Testing ◦ Overview of different empirical equations for simple determination of ice loads ◦ Discussion and interpretation of the different equations and results ◦ Introduction to ice model tests ◦ What are the requirements for ice model tests, what parameters have to be scaled ◦ What can be simulated and how to use the results of such ice model tests 3. Computational Modelling of Ice-Structure Interaction Processes ◦ Dynamic fracture and continuum mechanics for modelling ice-structure interaction processes ◦ Alternative numerical crack propagation modelling methods. Examples of cohesive element models for real life structures. ◦ Discussion of contribution of ice properties, hydrodynamics and rubble. 4. Ice Design Philosophies and Perspectives ◦ What has to be considered when designing structures or systems for ice covered waters ◦ What are the main differences compared to open water design ◦ Ice Management ◦ What are the main ice design philosophies and why is an integrated concept so important for ice **Learning Objectives** The course will provide an introduction into ice engineering. Different kinds of ice and their different failure modes including numerical methods for ice load simulations are presented. Main design issues including design philosophies for structures and systems for ice covered waters are introduced. The course shall enable the attendees to understand the fundamental challenges due to ice covered waters and help them to understand ice engineering reports and presentations.
Literature	• Proceedings OMAE • Proceedings POAC • Proceedings ATC

Course L1615: Ice Engineering	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Walter Kuehnlein
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1575: Ship structural design for arctic conditions	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sören Ehlers, Dr. Rüdiger Ulrich Franz von Bock und Polach
Language	DE/EN
Cycle	WiSe
Content	The structural design under ice loads will be carried out for an individual case
Literature	FSICR, IACS PC and assorted publications

Module M1165: Ship Safety

Courses

Title	Typ	Hrs/wk	CP
Ship Safety (L1267)	Lecture	2	4
Ship Safety (L1268)	Recitation Section (large)	2	2

Module Responsible	Prof. Stefan Krüger
Admission Requirements	None
Recommended Previous Knowledge	Ship Design, Hydrostatics, Statistical Processes
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The student shall lean to integrate safety aspects into the ship design process. This includes the undertsnding and application of existing rules as well as the understanding of the sfatey concept and level which is targeted by a rule. Further, methods of demonstrating equivalent safety levels are introduced.
Skills	he lectures starts with an overview about general safety concepts for technical systems. The maritime safety organizations are introduced, their responses and duties. Then, the gerenal difference between prescriptive and performance based rules is tackled. Foer different examples in ship design, the influence of the rules on the deign is illustrated . Further, limitations of saftey rules with respect to the physical background are shown. Concepts of demonstrating equivalent levels of safety by direct calculations are discussed. The following fields will be treated. - Freeboard, water- and weathertight subdivisions, openings - all aspects of intact stability, including special problems such as grain code - damage stability for passenger vessels including Stockholm agreement - damage stbility fopr cargo vessels - on board stability, inclining experiment and stability booklet - Relevant manoevering information
Personal Competence	
Social Competence	The student learns to take responsibilty for the safety of his designn.
Autonomy	Responsible certification of technical designs.
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 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1267: Ship Safety

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	The lectures starts with an overview about general safety concepts for technical systems. The maritime safety organizations are introduced, their responses and duties. Then, the gerenal difference between prescriptive and performance based rules is tackled. Foer different examples in ship design, the influence of the rules on the deign is illustrated . Further, limitations of saftey rules with respect to the physical background are shown. Concepts of demonstrating equivalent levels of safety by direct calculations are discussed. The following fields will be treated. - Freeboard, water- and weathertight subdivisions, openings - all aspects of intact stability, including special problems such as grain code - damage stability for passenger vessels including Stockholm agreement - damage stbility fopr cargo vessels - on board stability, inclining experiment and stability booklet - Relevant manoevering information
Literature	SOLAS, LOAD LINES, CODE ON INTACT STABILITY. Alle IMO, London.

Course L1268: Ship Safety	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Krüger
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1178: Manoeuvrability and Shallow Water Ship Hydrodynamics

Courses

Title	Typ	Hrs/wk	CP
Manoeuvrability of Ships (L1597)	Lecture	2	3
Shallow Water Ship Hydrodynamics (L1598)	Lecture	2	3

Module Responsible	Prof. Moustafa Abdel-Maksoud
Admission Requirements	None
Recommended Previous Knowledge	B.Sc. Schiffbau
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students lern the motion equation and how to describe hydrodynamic forces. They'll will be able to develop methods for analysis of manoeuvring behaviour of ships and explaining the Nomoto equation. The students will know the common model tests as well as their assets and drawbacks. Furthermore, the students lern the basics of assessment and prognosis of ship manoeuvrabilit. Basics of characteristics of flows around ships in shallow water regarding ship propulsion and manoeuvrability will be aquired.
Skills	
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory

Course L1597: Manoeuvrability of Ships

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud
Language	DE/EN
Cycle	WiSe
Content	• coordinates & degrees of freedom • governing equations of motion • hydrodynamic forces & moments • ruder forces • navigation based on linearised eq.of motion(exemplary solutions, yaw stability) • manoeuvering test (constraint & unconstraint motion) • slender body approximation **Learning Outcomes** Introduction into basic concepts for the assessment and prognosis ship manoeuvrabilit. Ability to develop methods for analysis of manoeuvring behaviour of ships.
Literature	• Crane, C. L. H., Eda, A. L., Principles of Naval Architecture, Chapter 9, Controllability, SNAME, New York, 1989 • Brix, J., Manoeuvring Technical Manual, Seehafen Verlag GmbH, Hamburg 1993 • Söding, H., Manövrieren , Vorlesungsmanuskript, Institut für Fluiddynamik und Schiffstheorie, TUHH, Hamburg, 1995

Course L1598: Shallow Water Ship Hydrodynamics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Moustafa Abdel-Maksoud, Dr. Norbert Stuntz
Language	DE/EN
Cycle	WiSe
Content	• Special Aspects of Shallow Water Hydrodynamics, Vertical and Horizontal Constraints, Irregularities in Channel Bed • Fundamental Equations of Shallow Water Hydrodynamics • Approximation of Shallow Water Waves, Boussinesq's Approximation • Ship Waves in Deep Water and under critical, non-critical and supercritical Velocities • Solitary Wves, Critical Speed Range, Extinction of Waves • Aspects of Ship motions in Canals with limited water depth
Literature	• PNA (1988): Principle of Naval Architecture, Vol. II, ISBN 0-939773-01-5 • Schneekluth (1988): Hydromechanik zum Schiffsentwurf • Jiang, T. (2001): Ship Waves in Shallow Water, Fortschritt-Berichte VDI, Series 12, No 466, ISBN 3-18-346612-0

Specialization Materials Science

The focus of the specialization „materials technology“ is the acquisition of in-depth knowledge and skills in materials technology. One main focus is on the creation of modern material models. Modules in the electives are the material modeling and Multi-scale modeling phenomena and methods in materials science, polymer processing, as well as plastics and composites. In addition, subjects in the Technical Supplement Course for TMBMS (according FSPO) are freely selectable.

Module M1342: Polymers

Courses

Title	Typ	Hrs/wk	CP
Structure and Properties of Polymers (L0389)	Lecture	2	3
Processing and design with polymers (L1892)	Lecture	2	3

Module Responsible	Dr. Hans Wittich
Admission Requirements	None
Recommended Previous Knowledge	Basics: chemistry / physics / material science
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can use the knowledge of plastics and define the necessary testing and analysis. They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, including to explain neighboring contexts (e.g. sustainability, environmental protection).
Skills	Students are capable of - using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials. - selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.
Personal Competence	
Social Competence	Students can - arrive at funded work results in heterogenius groups and document them. - provide appropriate feedback and handle feedback on their own performance constructively.
Autonomy	Students are able to - assess their own strengths and weaknesses. - assess their own state of learning in specific terms and to define further work steps on this basis. - assess possible consequences of their professional activity.
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 min
Assignment for the Following Curricula	Materials Science: Specialisation Engineering Materials: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L0389: Structure and Properties of Polymers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Hans Wittich
Language	DE
Cycle	WiSe
Content	- Structure and properties of polymers - Structure of macromolecules Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weihght distribution - Morphology amorph, crystalline, blends - Properties Elasticity, plasticity, viscoelacity - Thermal properties - Electrical properties - Theoretical modelling - Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag

Course L1892: Processing and design with polymers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Dr. Hans Wittich
Language	DE/EN
Cycle	WiSe
Content	Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining Designing with Polymers: Materials Selection; Structural Design; Dimensioning
Literature	Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag Crawford: Plastics engineering, Pergamon Press Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag Konstruieren mit Kunststoffen, Gunter Erhard , Hanser Verlag

Module M1182: Technical Elective Course for TMBMS (according to Subject Specific Regulations)

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	see FSPO
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	see FSPO
Skills	see FSPO
Personal Competence	
Social Competence	see FSPO
Autonomy	see FSPO
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the Following Curricula	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Numerics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Module M1170: Phenomena and Methods in Materials Science

Courses

Title	Typ	Hrs/wk	CP
Experimental Methods for the Characterization of Materials (L1580)	Lecture	2	3
Phase equilibria and transformations (L1579)	Lecture	2	3

Module Responsible	Prof. Patrick Huber
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in Materials Science, e.g. Werkstoffwissenschaft I/II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.
Personal Competence	
Social Competence	The students are able to present solutions to specialists and to develop ideas further.
Autonomy	The students are able to ... • assess their own strengths and weaknesses. • gather new necessary expertise by their own.
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	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L1580: Experimental Methods for the Characterization of Materials

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber
Language	DE
Cycle	SoSe
Content	• Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) • Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) • Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Course L1579: Phase equilibria and transformations	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	SoSe
Content	Fundamentals of statistical physics, formal structure of phenomenological thermodynamics, simple atomistic models and free-energy functions of solid solutions and compounds. Corrections due to nonlocal interaction (elasticity, gradient terms). Phase equilibria and alloy phase diagrams as consequence thereof. Simple atomistic considerations for interaction energies in metallic solid solutions. Diffusion in real systems. Kinetics of phase transformations for real-life boundary conditions. Partitioning, stability and morphology at solidification fronts. Order of phase transformations; glass transition. Phase transitions in nano- and microscale systems.
Literature	Wird im Rahmen der Lehrveranstaltung bekannt gegeben.

Module M1226: Mechanical Properties

Courses

Title	Typ	Hrs/wk	CP
Mechanical Behaviour of Brittle Materials (L1661)	Lecture	2	3
Dislocation Theory of Plasticity (L1662)	Lecture	2	3

Module Responsible	Dr. Erica Lilleodden
Admission Requirements	None
Recommended Previous Knowledge	Basics in Materials Science I/II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain basic principles of crystallography, statics (free body diagrams, tractions) and thermodynamics (energy minimization, energy barriers, entropy)
Skills	Students are capable of using standardized calculation methods: tensor calculations, derivatives, integrals, tensor transformations
Personal Competence	
Social Competence	Students can provide appropriate feedback and handle feedback on their own performance constructively.
Autonomy	Students are able to - assess their own strengths and weaknesses - assess their own state of learning in specific terms and to define further work steps on this basis guided by teachers. - work independently based on lectures and notes to solve problems, and to ask for help or clarifications when needed
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	Materials Science: Core Qualification: Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1661: Mechanical Behaviour of Brittle Materials	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Gerold Schneider
Language	DE/EN
Cycle	SoSe
Content	**Theoretical Strength** Of a perfect crystalline material, theoretical critical shear stress **Real strength of brittle materials** Energy release reate, stress intensity factor, fracture criterion **Scattering of strength of brittle materials** Defect distribution, strength distribution, Weibull distribution **Heterogeneous materials I** Internal stresses, micro cracks, weight function, **Heterogeneous materials II** Toughening mechanisms: crack bridging, fibres **Heterogeneous materials III** Toughening mechanisms. Process zone **Testing methods to determine the fracture toughness of brittle materials** **R-curve, stable/unstable crack growth, fractography** **Thermal shock** **Subcritical crack growth)** v-K-curve, life time prediction **Kriechen** **Mechanical properties of biological materials** **Examples of use for a mechanically reliable design of ceramic components**
Literature	D R H Jones, Michael F. Ashby, Engineering Materials 1, An Introduction to Properties, Applications and Design, Elesevier D.J. Green, An introduction to the mechanical properties of ceramics", Cambridge University Press, 1998 B.R. Lawn, Fracture of Brittle Solids", Cambridge University Press, 1993 D. Munz, T. Fett, Ceramics, Springer, 2001 D.W. Richerson, Modern Ceramic Engineering, Marcel Decker, New York, 1992

Course L1662: Dislocation Theory of Plasticity	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Erica Lilleodden
Language	DE/EN
Cycle	SoSe
Content	This class will cover the principles of dislocation theory from a physical metallurgy perspective, providing a fundamental understanding of the relations between the strength and of crystalline solids and distributions of defects. We will review the concept of dislocations, defining terminology used, and providing an overview of important concepts (e.g. linear elasticity, stress-strain relations, and stress transformations) for theory development. We will develop the theory of dislocation plasticity through derived stress-strain fields, associated self-energies, and the induced forces on dislocations due to internal and externally applied stresses. Dislocation structure will be discussed, including core models, stacking faults, and dislocation arrays (including grain boundary descriptions). Mechanisms of dislocation multiplication and strengthening will be covered along with general principles of creep and strain rate sensitivity. Final topics will include non-FCC dislocations, emphasizing the differences in structure and corresponding implications on dislocation mobility and macroscopic mechanical behavior; and dislocations in finite volumes.
Literature	Vorlesungsskript Aktuelle Publikationen Bücher: Introduction to Dislocations, by D. Hull and D.J. Bacon Theory of Dislocations, by J.P. Hirth and J. Lothe Physical Metallurgy, by Peter Hassen

Module M1343: Fibre-polymer-composites

Courses

Title	Typ	Hrs/wk	CP
Structure and properties of fibre-polymer-composites (L1894)	Lecture	2	3
Design with fibre-polymer-composites (L1893)	Lecture	2	3

Module Responsible	Prof. Bodo Fiedler
Admission Requirements	None
Recommended Previous Knowledge	Basics: chemistry / physics / materials science
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the necessary testing and analysis. They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain neighboring contexts (e.g. sustainability, environmental protection).
Skills	Students are capable of • using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials. • approximate sizing using the network theory of the structural elements implement and evaluate. • selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.
Personal Competence	
Social Competence	Students can • arrive at funded work results in heterogenius groups and document them. • provide appropriate feedback and handle feedback on their own performance constructively.
Autonomy	Students are able to - assess their own strengths and weaknesses. - assess their own state of learning in specific terms and to define further work steps on this basis. - assess possible consequences of their professional activity.
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 min
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Specialisation Engineering Materials: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1894: Structure and properties of fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	- Microstructure and properties of the matrix and reinforcing materials and their interaction - Development of composite materials - Mechanical and physical properties - Mechanics of Composite Materials - Laminate theory - Test methods - Non destructive testing - Failure mechanisms - Theoretical models for the prediction of properties - Application
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press Mallick: Fibre-Reinforced Composites, Marcel Deckker, New York

Course L1893: Design with fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	Designing with Composites: Laminate Theory; Failure Criteria; Design of Pipes and Shafts; Sandwich Structures; Notches; Joining Techniques; Compression Loading; Examples
Literature	Konstruieren mit Kunststoffen, Gunter Erhard , Hanser Verlag

Module M1239: Experimental Micro- and Nanomechanics

Courses

Title	Typ	Hrs/wk	CP
Experimental Micro- and Nanomechanics (L1673)	Lecture	2	4
Experimental Micro- and Nanomechanics (L1674)	Recitation Section (small)	1	2

Module Responsible	Dr. Erica Lilleodden
Admission Requirements	None
Recommended Previous Knowledge	Basics in Materials Science I/II, Mechanical Properties, Phenomena and Methods in Materials Science
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to describe the principles of mechanical behavior (e.g., stress, strain, modulus, strength, hardening, failure, fracture). Students can explain the principles of characterization methods used for investigating microstructure (e.g., scanning electron microscopy, x-ray diffraction) They can describe the fundamental relations between microstructure and mechanical properties.
Skills	Students are capable of using standardized calculation methods to calculate and evaluate mechanical properties (modulus, strength) of different materials under varying loading states (e.g., uniaxial stress or plane strain).
Personal Competence	
Social Competence	Students can provide appropriate feedback and handle feedback on their own performance constructively.
Autonomy	Students are able to - assess their own strengths and weaknesses - assess their own state of learning in specific terms and to define further work steps on this basis guided by teachers. - to be able to work independently based on lectures and notes to solve problems, and to ask for help or clarifications when needed
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 min
Assignment for the Following Curricula	Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1673: Experimental Micro- and Nanomechanics	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Dr. Erica Lilleodden
Language	DE/EN
Cycle	SoSe

Content	This class will cover the principles of mechanical testing at the micron and nanometer scales. A focus will be made on metallic materials, though issues related to ceramics and polymeric materials will also be discussed. Modern methods will be explored, along with the scientific questions investigated by such methods.
	• Principles of micromechanics
	  ◦ Motivations for small-scale testing
	  ◦ Sample preparation methods for small-scale testing
	  ◦ General experimental artifacts and quantification of measurement resolution
	• Complementary structural analysis methods
	  ◦ Electron back scattered diffraction
	  ◦ Transmission electron microscopy
	  ◦ Micro-Laue diffraction
	• Nanoindentation-based testing
	  ◦ Principles of contact mechanics
	  ◦ Berkovich indentation
	  ▪ Loading geometry
	  ▪ Governing equations for analysis of stress & strain
	  ▪ Case study:
	  ▪ Indentation size effects
	  ◦ Microcompression
	  ▪ Loading geometry
	  ▪ Governing equations for analysis of stress & strain
	  ▪ Case study:
	  ▪ Size effects in yield strength and hardening
	  ◦ Microbeam-bending
	  ▪ Loading geometry
	  ▪ Governing equations for analysis of stress & strain
	  ▪ Case study:
	  ▪ Fracture strength & toughness
	•

Literature	Vorlesungsskript Aktuelle Publikationen

Course L1674: Experimental Micro- and Nanomechanics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Erica Lilleodden
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1237: Methods in Theoretical Materials Science

Courses

Title	Typ	Hrs/wk	CP
Methods in Theoretical Materials Science (L1677)	Lecture	2	4
Methods in Theoretical Materials Science (L1678)	Recitation Section (small)	1	2

Module Responsible	Prof. Stefan Fritz Müller
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of advanced mathematics like analysis, linear algebra, differential equations and complex functions, e.g., Mathematics I-IV Knowledge of physics, particularly solid state physics, e.g., Materials Physics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The master students will be able to... ...explain how different modeling methods work. ...assess the field of application of individual methodological approaches. ...evaluate the strengths and weaknesses of different methods. The students are thereby able to assess which method is best suited to solve a scientific problem and what accuracy can be expected from the simulation results.
Skills	After completing the module, the students are able to... ...select the most suitable modeling method as a function of various parameters such as length scale, time scale, temperature, material type, etc..
Personal Competence	
Social Competence	The students are able to discuss competently and adapted to the target group with experts from various fields including physics and materials science, for example at conferences or exhibitions. Further, this promotes their abilities to work in interdisciplinary groups.
Autonomy	The students are able to ... ...assess their own strengths and weaknesses. ...acquire the knowledge they need on their own.
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	
Assignment for the Following Curricula	Materials Science: Specialisation Modeling: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1677: Methods in Theoretical Materials Science	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Stefan Fritz Müller
Language	DE/EN
Cycle	SoSe
Content	1. Introduction 1.1 Classification of Modelling Approaches and the Solid State 2. Quantum Mechanical Approaches 2.1 Electronic states : Atoms, Molecules, Solids 2.2 Density Functional Theory 2.3 Spin-Dynamics 3. Thermodynamic Approaches 3.1 Thermodynamic Potentials 3.2 Alloys 3.3 Cluster Expansion 3.4 Monte-Carlo-Methods
Literature	Solid State Physics, Ashcroft/Mermin, Saunders College Computational Physics, Thijsen, Cambridge Computational Materials Science, Ohno et al.. Springer Materials Science and Engineering: An Introduction, Callister/Rethwisch, Edition 9, Wiley

Course L1678: Methods in Theoretical Materials Science	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Stefan Fritz Müller
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1238: Quantum Mechanics of Solids

Courses

Title	Typ	Hrs/wk	CP
Quantum Mechanics of Solids (L1675)	Lecture	2	4
Quantum Mechanics of Solids (L1676)	Recitation Section (small)	1	2

Module Responsible	Prof. Stefan Fritz Müller
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of advanced mathematics like analysis, linear algebra, differential equations and complex functions, e.g., Mathematics I-IV Knowledge of mechanics and physics, particularly solid state physics, e.g., Materials Physics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The master students will be able to explain... ...the basics of quantum mechanics. ... the importance of quantum physics for the description of materials properties. ... correlations between on quantum mechanics based phenomena between individual atoms and macroscopic properties of materials. The master students will then be able to connect essential materials properties in engineering with materials properties on the atomistic scale in order to understand these connections.
Skills	After attending this lecture the students can ... ...perform materials design on a quantum mechanical basis.
Personal Competence	
Social Competence	The students are able to discuss competently quantum-mechanics-based subjects with experts from fields such as physics and materials science.
Autonomy	The students are able to independently develop solutions to quantum mechanical problems. They can also acquire the knowledge they need to deal with more complex questions with a quantum mechanical background from the literature.
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	
Assignment for the Following Curricula	Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1675: Quantum Mechanics of Solids	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Stefan Fritz Müller
Language	DE/EN
Cycle	SoSe
Content	1. Introduction 1.1 Relevance of Quantum Mechanics 1.2 Classification of Solids 2. Foundations of Quantum Mechanics 2.1 Reminder : Elements of Classical Mechanics 2.2 Motivation for Quantum Mechanics 2.3 Particle-Wave Duality 2.4 Formalism 3. Elementary QM Problems 3.1 Onedimensional Problems of a Particle in a Potential 3.2 Two-Level System 3.3 Harmonic Oscillator 3.4 Electrons in a Magnetic Field 3.5 Hydrogen Atom 4. Quantum Effects in Condensed Matter 4.1 Preliminary 4.2 Electronic Levels 4.3 Magnetism 4.4 Superconductivity 4.5 Quantum Hall Effect
Literature	Physik für Ingenieure, Hering/Martin/Stohrer, Springer Atom- und Quantenphysik, Haken/Wolf, Springer Grundkurs Theoretische Physik 5|1, Nolting, Springer Electronic Structure of Materials, Sutton, Oxford Materials Science and Engineering: An Introduction, Callister/Rethwisch, Edition 9, Wiley

Course L1676: Quantum Mechanics of Solids	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Stefan Fritz Müller
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1152: Modeling Across The Scales

Courses

Title	Typ	Hrs/wk	CP
Modeling Across The Scales (L1537)	Lecture	2	3
Modeling Across The Scales - Excercise (L1538)	Recitation Section (small)	2	3

Module Responsible	Prof. Christian Cyron
Admission Requirements	None
Recommended Previous Knowledge	Basics of linear and nonlinear continuum mechanics as taught, e.g., in the modules Mechanics II and Continuum Mechanics (forces and moments, stress, linear and nonlinear strain, free-body principle, linear and nonlinear constitutive laws, strain energy).
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can describe different deformation mechanisms on different scales and can name the appropriate kind of modeling concept suited for its description.
Skills	The students are able to predict first estimates of the effective material behavior based on the material's microstructure. They are able to correlate and describe the damage behavior of materials based on their micromechanical behavior. In particular, they are able to apply their knowledge to different problems of material science and evaluate and implement material models into a finite element code.
Personal Competence	
Social Competence	The students are able to develop solutions, to present them to specialists and to develop ideas further.
Autonomy	The students are able to assess their own strengths and weaknesses. They can independently and on their own identify and solve problems in the area of scale-bridging modeling and acquire the knowledge required to this end.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	45 min
Assignment for the Following Curricula	Materials Science: Specialisation Modeling: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L1537: Modeling Across The Scales

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	• modeling of deformation mechanisms in materials at different scales (e.g., molecular dynamics, crystal plasticity, phenomenological models, ...) • relationship between microstructure and macroscopic mechanical material behavior • Eshelby problem • effective material properties, concept of RVE • homogenisation methods, coupling of scales (micro-meso-macro) • micromechanical concepts for the description of damage and failure behavior
Literature	D. Gross, T. Seelig, Bruchmechanik: Mit einer Einführung in die Mikromechanik, Springer T. Zohdi, P. Wriggers: An Introduction to Computational Micromechanics D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch G. Gottstein., Physical Foundations of Materials Science, Springer

Course L1538: Modeling Across The Scales - Excercise	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	• modeling of deformation mechanisms in materials at different scales (e.g., molecular dynamics, crystal plasticity, phenomenological models, ...) • relationship between microstructure and macroscopic mechanical material behavior • Eshelby problem • effective material properties, concept of RVE • homogenisation methods, coupling of scales (micro-meso-macro) • micromechanical concepts for the description of damage and failure behavior
Literature	D. Gross, T. Seelig, Bruchmechanik: Mit einer Einführung in die Mikromechanik, Springer T. Zohdi, P. Wriggers: An Introduction to Computational Micromechanics D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch G. Gottstein., Physical Foundations of Materials Science, Springer

Module M1199: Advanced Functional Materials

Courses

Title	Typ	Hrs/wk	CP
Advanced Functional Materials (L1625)	Seminar	2	6

Module Responsible	Prof. Patrick Huber
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in Materials Science, e.g. Materials Science I/II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.
Skills	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.
Personal Competence	
Social Competence	The students are able to present solutions to specialists and to develop ideas further.
Autonomy	The students are able to ... • assess their own strengths and weaknesses. • gather new necessary expertise by their own.
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Credit points	6
Course achievement	None
Examination	Presentation
Examination duration and scale	30 min
Assignment for the Following Curricula	Materials Science: Core Qualification: Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L1625: Advanced Functional Materials

Typ	Seminar
Hrs/wk	2
CP	6
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber, Prof. Stefan Fritz Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller, Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	1. Porous Solids - Preparation, Characterization and Functionalities 2. Fluidics with nanoporous membranes 3. Thermoplastic elastomers 4. Optimization of polymer properties by nanoparticles 5. Fiber composites in automotive 6. Modeling of materials based on quantum mechanics 7. Biomaterials
Literature	Aktuelle Publikationen aus der Fachliteratur werden während der Veranstaltung bekanntgegeben.

Module M1198: Materials Physics and Atomistic Materials Modeling

Courses

Title	Typ	Hrs/wk	CP
Materials Physics (L1624)	Lecture	2	2
Quantum Mechanics and Atomistic Materials Modeling (L1672)	Lecture	2	2
Exercises in Materials Physics and Modeling (L2002)	Recitation Section (small)	2	2

Module Responsible	Prof. Patrick Huber
Admission Requirements	None
Recommended Previous Knowledge	Advanced mathematics, physics and chemistry for students in engineering or natural sciences
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to - explain the fundamentals of condensed matter physics - describe the fundamentals of the microscopic structure and mechanics, thermodynamics and optics of materials systems. - to understand concept and realization of advanced methods in atomistic modeling as well as to estimate their potential and limitations.
Skills	After attending this lecture the students • can perform calculations regarding the thermodynamics, mechanics, electrical and optical properties of condensed matter systems • are able to transfer their knowledge to related technological and scientific fields, e.g. materials design problems. • can select appropriate model descriptions for specific materials science problems and are able to further develop simple models.
Personal Competence	
Social Competence	The students are able to present solutions to specialists and to develop ideas further.
Autonomy	Students are able to assess their knowldege continuously on their own by exemplified practice. The students are able to assess their own strengths and weaknesses and define tasks independently.
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	Materials Science: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory

Course L1624: Materials Physics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber
Language	DE
Cycle	WiSe
Content	
Literature	Für den **Elektromagnetismus:** • Bergmann-Schäfer: „Lehrbuch der Experimentalphysik“, Band 2: „Elektromagnetismus“, de Gruyter Für die **Atomphysik:** • Haken, Wolf: „Atom- und Quantenphysik“, Springer Für die **Materialphysik und Elastizität:** • Hornbogen, Warlimont: „Metallkunde“, Springer

Course L1672: Quantum Mechanics and Atomistic Materials Modeling	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Robert Meißner
Language	DE
Cycle	WiSe
Content	- Why atomistic materials modeling - Newton's equations of motion and numerical approaches - Ergodicity - Atomic models - Basics of quantum mechanics - Atomic & molecular many-electron systems - Hartree-Fock and Density-Functional Theory - Monte-Carlo Methods - Molecular Dynamics Simulations - Phase Field Simulations
Literature	Begleitliteratur zur Vorlesung (sortiert nach Relevanz): 1. Daan Frenkel & Berend Smit „Understanding Molecular Simulations“ 2. Mark E. Tuckerman „Statistical Mechanics: Theory and Molecular Simulations“ 3. Andrew R. Leach „Molecular Modelling: Principles and Applications“ Zur Vorbereitung auf den quantenmechanischen Teil der Klausur empfiehlt sich folgende Literatur 1. Regine Freudenstein & Wilhelm Kulisch "Wiley Schnellkurs Quantenmechanik"

Course L2002: Exercises in Materials Physics and Modeling	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Robert Meißner, Prof. Patrick Huber
Language	DE
Cycle	WiSe
Content	
Literature	- Daan Frenkel & Berend Smit: Understanding Molecular Simulation from Algorithms to Applications - Rudolf Gross und Achim Marx: Festkörperphysik - Neil Ashcroft and David Mermin: Solid State Physics

Module M1151: Material Modeling

Courses

Title	Typ	Hrs/wk	CP
Material Modeling (L1535)	Lecture	2	3
Material Modeling (L1536)	Recitation Section (small)	2	3

Module Responsible	Prof. Christian Cyron
Admission Requirements	None
Recommended Previous Knowledge	Basics of linear and nonlinear continuum mechanics as taught, e.g., in the modules Mechanics II and Continuum Mechanics (forces and moments, stress, linear and nonlinear strain, free-body principle, linear and nonlinear constitutive laws, strain energy)
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can explain the fundamentals of multidimensional consitutive material laws
Skills	The students can implement their own material laws in finite element codes. In particular, the students can apply their knowledge to various problems of material science and evaluate the corresponding material models.
Personal Competence	
Social Competence	The students are able to develop solutions, to present them to specialists and to develop ideas further.
Autonomy	The students are able to assess their own strengths and weaknesses. They can independently and on their own identify and solve problems in the area of materials modeling and acquire the knowledge required to this end.
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	45 min
Assignment for the Following Curricula	Materials Science: Specialisation Modeling: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory

Course L1535: Material Modeling

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	One of the most important questions when modeling mechanical systems in practice is how to model the behavior of the materials of their different components. In addition to simple isotropic elasticity in particular the following phenomena play key roles - anisotropy (material behavior depending on direction, e.g., in fiber-reinforced materials) - plasticity (permanent deformation due to one-time overload, e.g., in metal forming) - viscoelasticity (absorption of energy, e.g., in dampers) - creep (slow deformation under permanent load, e.g., in pipes) This lecture briefly introduces the theoretical foundations and mathematical modeling of the above phenomena. It is complemented by exercises where simple examples problems are solved by calculations and where the implementation of the content of the lecture in computer simulations is explained. It will also briefly discussed how important material parameters can be determined from experimental data.
Literature	

Course L1536: Material Modeling	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Specialization Product Development and Production

At the center of the specialization „product development and production“ is the acquisition of knowledge and skills for developing, designing and manufacturing of mechanical engineering products. This includes product planning, systematic and methodical development of solution concepts, the design and construction of products with special emphasis on component stress and cost considerations, to the derivation and creation of manufacturing documentation and the implementation in production.

Module M0815: Product Planning

Courses

Title	Typ	Hrs/wk	CP
Product Planning (L0851)	Project-/problem-based Learning	3	3
Product Planning Seminar (L0853)	Project-/problem-based Learning	2	3

Module Responsible	Prof. Cornelius Herstatt
Admission Requirements	None
Recommended Previous Knowledge	Good basic-knowledge of Business Administration
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	

Knowledge	Students will gain insights into:
	• Product Planning
	  ◦ Process
	  ◦ Methods
	• Design thinking
	  ◦ Process
	  ◦ Methods
	  ◦ User integration

Skills	Students will gain deep insights into:
	• Product Planning
	  ◦ Process-related aspects
	  ◦ Organisational-related aspects
	  ◦ Human-Ressource related aspects
	  ◦ Working-tools, methods and instruments
	  ◦

Personal Competence	
Social Competence	• Interact within a team • Raise awareness for globabl issues
Autonomy	• Gain access to knowledge sources • Interpret complex cases • Develop presentation skills
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	Compulsory: Yes; Bonus: 20 %; Form: Subject theoretical and practical work; Description:
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	Global Innovation Management: Core Qualification: Compulsory Global Technology and Innovation Management & Entrepreneurship: Core Qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0851: Product Planning	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Product Planning Process This integrated lecture is designed to understand major issues, activities and tools in the context of systematic product planning, a key activity for managing the front-end of innovation, i.e.: • Systematic scanning of markets for innovation opportunities • Understanding strengths/weakness and specific core competences of a firm as platforms for innovation • Exploring relevant sources for innovation (customers, suppliers, Lead Users, etc.) • Developing ideas for radical innovation, relying on the creativeness of employees, using techniques to stimulate creativity and creating a stimulating environment • Transferring ideas for innovation into feasible concepts which have a high market attractively Voluntary presentations in the third hour (articles / case studies) - Guest lectures by researchers - Lecture on Sustainability with frequent reference to current research - Permanent reference to current research Examination: In addition to the written exam at the end of the module, students have to attend the PBL-exercises and prepare presentations in groups in order to pass the module. Additionally, students have the opportunity to present research papers on a voluntary base. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010

Course L0853: Product Planning Seminar	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Seminar is integrative part of the Module Product Planning (for content see lecture) and can not be choosen independantly
Literature	see/siehe Vorlesung Produktplanung/Product Planning

Module M0867: Production Planning & Control and Digital Enterprise

Courses

Title	Typ	Hrs/wk	CP
The Digital Enterprise (L0932)	Lecture	2	2
Production Planning and Control (L0929)	Lecture	2	2
Production Planning and Control (L0930)	Recitation Section (small)	1	1
Exercise: The Digital Enterprise (L0933)	Recitation Section (small)	1	1

Module Responsible	Prof. Hermann Lödding
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals of Production and Quality Management
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain the contents of the module in detail and take a critical position to them.
Skills	Students are capable of choosing and applying models and methods from the module to industrial problems.
Personal Competence	
Social Competence	Students can develop joint solutions in mixed teams and present them to others.
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 Minuten
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L0932: The Digital Enterprise

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered. Content: • Business Process Management and Data Modelling, Simulation • Knowledge and Competence Management • Process Management (PPC, Workflow Management) • Computer Aided Planning (CAP) and NC-Programming • Virtual Reality (VR) and Augmented Reality (AR) • Computer Aided Quality Management (CAQ) • Industry 4.0
Literature	Scheer, A.-W.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002 Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag. Berlin 3. Auflage 2006 Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004 Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007 Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006

Course L0929: Production Planning and Control	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	• Models of Production and Inventory Management • Production Programme Planning and Lot Sizing • Order and Capacity Scheduling • Selected Strategies of PPC • Manufacturing Control • Production Controlling • Supply Chain Management
Literature	• Vorlesungsskript • Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 • Nyhuis, P.; Wiendahl, H.-P.: Logistische Kennlinien, Springer 2002

Course L0930: Production Planning and Control	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0933: Exercise: The Digital Enterprise	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	Siehe korrespondierende Vorlesung See interlocking course

Module M1182: Technical Elective Course for TMBMS (according to Subject Specific Regulations)

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Prof. Robert Seifried
Admission Requirements	None
Recommended Previous Knowledge	see FSPO
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	see FSPO
Skills	see FSPO
Personal Competence	
Social Competence	see FSPO
Autonomy	see FSPO
Workload in Hours	Depends on choice of courses
Credit points	6
Assignment for the Following Curricula	Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Numerics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory

Module M1024: Methods of Integrated Product Development

Courses

Title	Typ	Hrs/wk	CP
Integrated Product Development II (L1254)	Lecture	3	3
Integrated Product Development II (L1255)	Project-/problem-based Learning	2	3

Module Responsible	Prof. Dieter Krause
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of Integrated product development and applying CAE systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After passing the module students are able to: • explain technical terms of design methodology, • describe essential elements of construction management, • describe current problems and the current state of research of integrated product development.
Skills	After passing the module students are able to: • select and apply proper construction methods for non-standardized solutions of problems as well as adapt new boundary conditions, • solve product development problems with the assistance of a workshop based approach, • choose and execute appropriate moderation techniques.
Personal Competence	
Social Competence	After passing the module students are able to: • prepare and lead team meetings and moderation processes, • work in teams on complex tasks, • represent problems and solutions and advance ideas.
Autonomy	After passing the module students are able to: • give a structured feedback and accept a critical feedback, • implement the accepted feedback autonomous.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 Minuten
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory

Course L1254: Integrated Product Development II	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	**Lecture** The lecture extends and enhances the learned content of the module “Integrated Product Development and lightweight design” and is based on the knowledge and skills acquired there. Topics of the course include in particular: • Methods of product development, • Presentation techniques, • Industrial Design, • Design for variety • Modularization methods, • Design catalogs, • Adapted QFD matrix, • Systematic material selection, • Assembly oriented design, Construction management • CE mark, declaration of conformity including risk assessment, • Patents, patent rights, patent monitoring • Project management (cost, time, quality) and escalation principles, • Development management for mechatronics, • Technical Supply Chain Management. **Exercise (PBL)** In the exercise the content presented in the lecture “Integrated Product Development II” and methods of product development and design management will be enhanced. Students learn an independently moderated and workshop based approach through industry related practice examples to solve complex and currently existing issues in product development. They will learn the ability to apply important methods of product development and design management autonomous and acquire further expertise in the field of integrated product development. Besides personal skills, such as teamwork, guiding discussions and representing work results will be acquired through the workshop based structure of the event under its own planning and management.
Literature	• Andreasen, M.M., Design for Assembly, Berlin, Springer 1985. • Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007. • Beckmann, H.: Supply Chain Management, Berlin, Springer 2004. • Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer, Weinheim, Beltz 2007. • Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006. • Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000. • Simpson, T.W., Siddique, Z., Jiao, R.J.: Product Platform and Product Family Design. Methods and Applications, New York, Springer 2013.

Course L1255: Integrated Product Development II	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1143: Mechanical Design Methodology

Courses

Title	Typ	Hrs/wk	CP
Mechanical Design Methodology (L1523)	Lecture	3	4
Mechanical Design Methodology (L1524)	Recitation Section (small)	1	2

Module Responsible	Prof. Josef Schlattmann
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Science-based working on product design considering targeted application of specific product design techniques
Skills	Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1523: Mechanical Design Methodology

Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Josef Schlattmann
Language	DE
Cycle	SoSe
Content	• Systematic reflection and analysis of the mechanical design process • Process structuring in sections (task, functions, acting principles, design-elements and total construction) as well as levels (working-, controlling-, and deciding-levels) • Creativity (basics, methods, practical application in mechatronics) • Diverse methods applied as tools (function structure, GALFMOS, AEIOU method, GAMPFT, simulation tools, TRIZ) • Evaluation and selection (technical-economical evaluation, preference matrix) • Value analysis, cost-benefit analysis • Low-noise design of technical products • Project monitoring and leading (leading projects / employees, organisation in product development, creating ideas / responsibility and communication) • Aesthetic product design (industrial design, colouring, specific examples / exercises)
Literature	• Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, K.-H.: Konstruktionslehre: Grundlage erfolgreicher Produktentwicklung, Methoden und Anwendung, 7. Auflage, Springer Verlag, Berlin 2007 • VDI-Richtlinien: 2206; 2221ff

Course L1524: Mechanical Design Methodology	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Josef Schlattmann
Language	DE
Cycle	SoSe
Content	• Systematic reflection and analysis of the mechanical design process • Process structuring in sections (task, functions, acting principles, design-elements and total construction) as well as levels (working-, controlling-, and deciding-levels) • Creativity (basics, methods, practical application in mechatronics) • Diverse methods applied as tools (function structure, GALFMOS, AEIOU method, GAMPFT, simulation tools, TRIZ) • Evaluation and selection (technical-economical evaluation, preference matrix) • Value analysis, cost-benefit analysis • Low-noise design of technical products • Project monitoring and leading (leading projects / employees, organisation in product development, creating ideas / responsibility and communication) • Aesthetic product design (industrial design, colouring, specific examples / exercises)
Literature	• Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, K.-H.: Konstruktionslehre: Grundlage erfolgreicher Produktentwicklung, Methoden und Anwendung, 7. Auflage, Springer Verlag, Berlin 2007 • VDI-Richtlinien: 2206; 2221ff

Module M1281: Advanced Topics in Vibration

Courses

Title	Typ	Hrs/wk	CP
Advanced Topics in Vibration (L1743)	Project-/problem-based Learning	4	6

Module Responsible	Prof. Norbert Hoffmann
Admission Requirements	None
Recommended Previous Knowledge	Vibration Theory
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to reflect existing terms and concepts of Advanced Vibrations and to develop and research new terms and concepts.
Skills	Students are able to apply existing methods and procesures of Advanced Vibrations and to develop novel methods and procedures.
Personal Competence	
Social Competence	Students can reach working results also in groups.
Autonomy	Students are able to approach given research tasks individually and to identify and follow up novel research tasks by themselves.
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	2 Hours
Assignment for the Following Curricula	Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory

Course L1743: Advanced Topics in Vibration

Typ	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann, Merten Tiedemann, Sebastian Kruse
Language	DE/EN
Cycle	SoSe
Content	Research Topics in Vibrations.
Literature	Aktuelle Veröffentlichungen

Module M0805: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)

Courses

Title	Typ	Hrs/wk	CP
Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics) (L0516)	Lecture	2	3
Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics) (L0518)	Recitation Section (large)	2	3

Module Responsible	Prof. Otto von Estorff
Admission Requirements	None
Recommended Previous Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students possess an in-depth knowledge in acoustics regarding acoustic waves, noise protection, and psycho acoustics and are able to give an overview of the corresponding theoretical and methodical basis.
Skills	The students are capable to handle engineering problems in acoustics by theory-based application of the demanding methodologies and measurement procedures treated within the module.
Personal Competence	
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.
Autonomy	The students are able to independently solve challenging acoustical problems in the areas treated within the module. Possible conflicting issues and limitations can be identified and the results are critically scrutinized.
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	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory

Course L0516: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	SoSe
Content	- Introduction and Motivation - Acoustic quantities - Acoustic waves - Sound sources, sound radiation - Sound engergy and intensity - Sound propagation - Signal processing - Psycho acoustics - Noise - Measurements in acoustics
Literature	Cremer, L.; Heckl, M. (1996): Körperschall. Springer Verlag, Berlin Veit, I. (1988): Technische Akustik. Vogel-Buchverlag, Würzburg Veit, I. (1988): Flüssigkeitsschall. Vogel-Buchverlag, Würzburg

Course L0518: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1174: Automation Technology and Systems

Courses

Title	Typ	Hrs/wk	CP
Automation Technology and Systems (L2329)	Lecture	4	4
Automation Technology and Systems (L2331)	Project-/problem-based Learning	1	1
Automation Technology and Systems (L2330)	Recitation Section (small)	1	1

Module Responsible	Prof. Thorsten Schüppstuhl
Admission Requirements	None
Recommended Previous Knowledge	without major course assessment
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students • know the characteristic components of an automation systems and have good understanding of their interaction • know methods for a systematical analysis of automation tasks and are able to use them • have special competences in industrial robot based automation systems
Skills	Students are able to... • analyze complex Automation tasks • develop application based concepts and solutions • design subsystems and integrate into one system • investigate and evaluate safety of machinery • create simple programs for robots and programmable logic controllers • design of circuit for pneumatic applications
Personal Competence	
Social Competence	Students are able to ... - find solutions for automation and handling tasks in groups - develop solutions in a production environment with qualified personnel at technical level and represent decisions.
Autonomy	Students are able to ... • analyze automation tasks independently • generate programs for robots and programmable logic devices autonomously • develop solutions for practice oriented tasks of automation independently • design safety concepts for automation applications • assess consequences of their professional actions and responsibilities
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	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory

Course L2329: Automation Technology and Systems

Typ	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2331: Automation Technology and Systems	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L2330: Automation Technology and Systems	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1183: Laser systems and methods of manufacturing design and analysis

Courses

Title	Typ	Hrs/wk	CP
Laser Systems and Process Technologies (L1612)	Lecture	2	3
Methods for Analysing Production Processes (L0876)	Lecture	2	3

Module Responsible	Prof. Wolfgang Hintze
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge* *Skills* **Personal Competence** *Social Competence* *Autonomy*	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory

Course L1612: Laser Systems and Process Technologies

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	• Fundamentals of laser technology • Laser beam sources: CO2-, Nd:YAG-, Fiber- and Diodelasers • Laser system technology: beam forming, beam guidance systems, beam motion and beam control • Laser-based manufacturing technologies: generation, marking, cutting, joining, surface treatment • Quality assurance and economical aspects of laser material processing • Markets and Applications of laser technology • Student group exercises
Literature	• Hügel, H. , T. Graf: Laser in der Fertigung : Strahlquellen, Systeme, Fertigungsverfahren, 3. Aufl., Vieweg + Teubner Wiesbaden 2014. • Eichler, J., Eichler. H. J.: Laser: Bauformen, Strahlführung, Anwendungen, 7. Aufl., Springer-Verlag Berlin Heidelberg 2010. • Steen W. M.; Mazumder J.: Laser material processing, 4th Edition, Springer-Verlag London 2010. • J.C. Ion: Laser processing of engineering materials: principles, procedure and industrial applications, Elsevier Butterworth-Heinemann 2005. • Gebhardt, A.: Understanding additive manufacturing, München [u.a.] Hanser 2011

Course L0876: Methods for Analysing Production Processes	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	• Modelling and simulation of maching and forming processes • Numerical simulation of forces, temperatures, deformation in machining • Analysis of vibration problems in maching (chatter, modal analysis,..) • Knowledge based process planning • Design of experiments • Machinability of nonmetallic materials • Analysis of interaction between maching process and machine tool systems with regard to process stabiltity and quality • Simulation of maching processes by virtual reality methods
Literature	Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004) Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006) Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001) Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)

Module M0806: Technical Acoustics II (Room Acoustics, Computational Methods)

Courses

Title	Typ	Hrs/wk	CP
Technical Acoustics II (Room Acoustics, Computational Methods) (L0519)	Lecture	2	3
Technical Acoustics II (Room Acoustics, Computational Methods) (L0521)	Recitation Section (large)	2	3

Module Responsible	Prof. Otto von Estorff
Admission Requirements	None
Recommended Previous Knowledge	Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics) Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students possess an in-depth knowledge in acoustics regarding room acoustics and computational methods and are able to give an overview of the corresponding theoretical and methodical basis.
Skills	The students are capable to handle engineering problems in acoustics by theory-based application of the demanding computational methods and procedures treated within the module.
Personal Competence	
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.
Autonomy	The students are able to independently solve challenging acoustical problems in the areas treated within the module. Possible conflicting issues and limitations can be identified and the results are critically scrutinized.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	20-30 Minuten
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory

Course L0519: Technical Acoustics II (Room Acoustics, Computational Methods)

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	WiSe
Content	- Room acoustics - Sound absorber - Standard computations - Statistical Energy Approaches - Finite Element Methods - Boundary Element Methods - Geometrical acoustics - Special formulations - Practical applications - Hands-on Sessions: Programming of elements (Matlab)
Literature	Cremer, L.; Heckl, M. (1996): Körperschall. Springer Verlag, Berlin Veit, I. (1988): Technische Akustik. Vogel-Buchverlag, Würzburg Veit, I. (1988): Flüssigkeitsschall. Vogel-Buchverlag, Würzburg Gaul, L.; Fiedler, Ch. (1997): Methode der Randelemente in Statik und Dynamik. Vieweg, Braunschweig, Wiesbaden Bathe, K.-J. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

Course L0521: Technical Acoustics II (Room Acoustics, Computational Methods)	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0739: Factory Planning & Production Logistics

Courses

Title	Typ	Hrs/wk	CP
Factory Planning (L1445)	Lecture	3	3
Production Logistics (L1446)	Lecture	2	3

Module Responsible	Prof. Jochen Kreutzfeldt
Admission Requirements	None
Recommended Previous Knowledge	Bachelor degree in logistics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students will acquire the following knowledge: 1. The students know the latest trends and developments in the planning of factories. 2. The students can explain basic procedures of factory planning and are able to deploy these procedures while considering different conditions. 3. The students know different methods of factory planning and are able to deal critically with these methods.
Skills	The students will acquire the following skills: 1. The students are able to analyze factories and other material flow systems with regard to new development and the need for change of these logistical systems. 2. The students are able to plan and redesign factories and other material handling systems. 3. The students are able to develop procedures for the implementation of new and revised material flow systems.
Personal Competence	
Social Competence	The students will acquire the following social skills: 1. The students are able to develop plans for the development of new and improvement of existing material flow systems within a group. 2. The developed planning proposal from the group work can be documented and presented together. 3. The students are able to derive suggestions for improvement from the feedback on the planning proposals and can even provide constructive criticism themselves.
Autonomy	The students will acquire the following independent competencies: 1. The students can plan and re-design material flow systems using existing planning procedures. 2. The students can evaluate independently the strengths and weaknesses of several techniques for factory planning and choose appropriate methods in a given context. 3. The students are able to carry out autonomously new plans and transformations of material flow systems.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory

Course L1445: Factory Planning	
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	WiSe
Content	The lecture gives an introduction into the planning of factories and material flows. The students will learn process models and methods to plan new factories and improve existing material flow systems. The course includes three basic topics: (1) Analysis of factory and material flow systems (2) Development and re-planning of factory and material flow systems (3) Implementation and realization of factory planning The students are introduced into several different methods and models per topic. Practical examples and planning exercises deepen the methods and explain the application of factory planning. The special requirements of factory planning in an international context are discussed. Specific requirements of Current trends and issues in the factory planning round off the lecture.
Literature	Bracht, Uwe; Wenzel, Sigrid; Geckler, Dieter (2018): Digitale Fabrik: Methoden und Praxisbeispiele. 2. Aufl.: Springer, Berlin. Helbing, Kurt W. (2010): Handbuch Fabrikprojektierung. Berlin, Heidelberg: Springer Berlin Heidelberg. Lotter, Bruno; Wiendahl, Hans-Peter (2012): Montage in der industriellen Produktion: Optimierte Abläufe, rationelle Automatisierung. 2. Aufl.: Springer, Berlin. Müller, Egon; Engelmann, Jörg; Löffler, Thomas; Jörg, Strauch (2009): Energieeffiziente Fabriken planen und betreiben. Berlin, Heidelberg: Springer Berlin Heidelberg. Schenk, Michael; Müller, Egon; Wirth, Siegfried (2014): Fabrikplanung und Fabrikbetrieb. Methoden für die wandlungsfähige, vernetzte und ressourceneffiziente Fabrik. 2. Aufl. Berlin [u.a.]: Springer Vieweg. Wiendahl, Hans-Peter; Reichardt, Jürgen; Nyhuis, Peter (2014): Handbuch Fabrikplanung: Konzept, Gestaltung und Umsetzung wandlungsfähiger Produktionsstätten. 2. Aufl. Carl Hanser Verlag.

Course L1446: Production Logistics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dipl.-Ing. Arnd Schirrmann
Language	DE
Cycle	WiSe
Content	• Introduction: situation, significance and main innovation focuses of logistics in a production company, aspects of procurement, production, distribution and disposal logistics, production and transport networks • Logistics as a production strategy: logistics-oriented method of working in a factory, throughput time, corporate strategy, structured networking, reducing complexity, integrated organization, integrated product and production logistics (IPPL) • Logistics-compatible production and process structuring; logistics-compatible product, material flow, information and organizational structures • Logistics-oriented production control: situation and development tendencies, logistics and cybernetics, market-oriented production planning, control, monitoring, PPS systems and production control, cybernetic production organization and control, production logistics control systems. • Production logistics planning: key performance indicators, developing a production logistics concept, computerized aids to planning production logistics, IPPL functions, economic efficiency of logistics projects • Production logistics controlling: production logistics and controlling, material flow-oriented cost transparency, cost controlling (process cost accounting, costs model in IPPL), process controlling (integrated production system, methods and tools, MEPOT.net method portal)
Literature	Pawellek, G.: Produktionslogistik: Planung - Steuerung - Controlling. Carl Hanser Verlag 2007

Module M0563: Robotics

Courses

Title	Typ	Hrs/wk	CP
Robotics: Modelling and Control (L0168)	Lecture	3	3
Robotics: Modelling and Control (L1305)	Recitation Section (large)	2	3

Module Responsible	Prof. Uwe Weltin
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals of electrical engineering Broad knowledge of mechanics Fundamentals of control theory
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to describe fundamental properties of robots and solution approaches for multiple problems in robotics.
Skills	Students are able to derive and solve equations of motion for various manipulators. Students can generate trajectories in various coordinate systems. Students can design linear and partially nonlinear controllers for robotic manipulators.
Personal Competence	
Social Competence	Students are able to work goal-oriented in small mixed groups.
Autonomy	Students are able to recognize and improve knowledge deficits independently. With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Course L0168: Robotics: Modelling and Control

Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Martin Gomse, Prof. Uwe Weltin
Language	EN
Cycle	WiSe
Content	Fundamental kinematics of rigid body systems Newton-Euler equations for manipulators Trajectory generation Linear and nonlinear control of robots
Literature	Craig, John J.: Introduction to Robotics Mechanics and Control, Third Edition, Prentice Hall. ISBN 0201-54361-3 Spong, Mark W.; Hutchinson, Seth; Vidyasagar, M. : Robot Modeling and Control. WILEY. ISBN 0-471-64990-2

Course L1305: Robotics: Modelling and Control	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Martin Gomse, Prof. Uwe Weltin
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1025: Fluidics

Courses

Title	Typ	Hrs/wk	CP
Fluidics (L1256)	Lecture	2	3
Fluidics (L1371)	Project-/problem-based Learning	1	2
Fluidics (L1257)	Recitation Section (large)	1	1

Module Responsible	Prof. Dieter Krause
Admission Requirements	None
Recommended Previous Knowledge	Good knowledge of mechanics (stereo statics, elastostatics, hydrostatics, kinematics and kinetics), fluid mechanics, and engineering design
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After passing the module students are able to • explain structures and functionalities of hydrostatic, pneumatic, and hydrodynamic components, • explain the interaction of hydraulic components in hydraulic systems, • explain open and closed loop control of hydraulic systems, • describe functioning and applications of hydrodynamic torque converters, brakes and clutches as well as centrifugal pumps and aggregates in plant technology
Skills	After passing the module students are able to • analyse and assess hydraulic and pneumatic components and systems, • design and dimension hydraulic systems for mechanical applications, • perform numerical simulations of hydraulic systems based on abstract problem definitions, • select and adapt pump characteristic curves for hydraulic systems • dimension hydrodynamic torque converters and brakes for mechanical aggregates.
Personal Competence	
Social Competence	After passing the module students are able to • discuss and present functional context in groups, • organise teamwork autonomously.
Autonomy	After passing the module students are able to • obtain necessary knowledge for the simulation.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6

Course achievement	Compulsory	Bonus	Form	Description
	Yes	None	Attestation	Simulation hydrostatischer Systeme

Examination	Written exam
Examination duration and scale	90
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory

Course L1256: Fluidics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	**Lecture** Hydrostatics • physical fundamentals • hydraulic fluids • hydrostatic machines • valves • components • hydrostatic transmissions • examples from industry Pneumatics • generation of compressed air • pneumatic motors • Examples of use Hydrodynamics • physical fundamentals • hydraulic continous-flow machines • hydrodynamic transmissions • interoperation of motor and transmission **Exercise** Hydrostatics • reading and design of hydraulic diagrams • dimensioning of hydrostatic traction and working drives • performance calculation Hydrodynamics • calculation / dimensioning of hydrodynamic torque converters • calculation / dimensioning of centrifugal pumps • creating and reading of characteristic curves of pumps and systems Field trip • field trip to a regional company from the hydraulic industry. **Exercise** Numerical simulation of hydrostatic systems • getting to know a numerical simulation environment for hydraulic systems • transformation of a task into a simulation model • simulation of common components • variation of simulation parameters • using simulations for system dimensioning and optimisation • (partly) self-organised teamwork
Literature	Bücher • Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011 • Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Pneumatik, Shaker Verlag, Aachen, 2006 • Matthies, H.J. Renius, K.Th.: Einführung in die Ölhydraulik, Teubner Verlag, 2006 • Beitz, W., Grote, K.-H.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage Skript zur Vorlesung

Course L1371: Fluidics	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1257: Fluidics	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Thesis

Master Thesis

Module M-002: Master Thesis

Courses			
Title	**Typ**	**Hrs/wk**	**CP**

Module Responsible	Professoren der TUHH
Admission Requirements	• According to General Regulations §21 (1): At least 60 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 use specialized knowledge (facts, theories, and methods) of their subject competently on specialized issues. • The students can explain in depth the relevant approaches and terminologies in one or more areas of their subject, describing current developments and taking up a critical position on them. • The students can place a research task in their subject area in its context and describe and critically assess the state of research.
Skills	The students are able: • To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in question. • To apply knowledge they have acquired and methods they have learnt in the course of their studies to complex and/or incompletely defined problems in a solution-oriented way. • To develop new scientific findings in their subject area and subject them to a critical assessment.
Personal Competence	
Social Competence	Students can • Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structured way. • Deal with issues competently in an expert discussion and answer them in a manner that is appropriate to the addressees while upholding their own assessments and viewpoints convincingly.
Autonomy	Students are able: • To structure a project of their own in work packages and to work them off accordingly. • To work their way in depth into a largely unknown subject and to access the information required for them to do so. • To apply the techniques of scientific work comprehensively in research of their own.
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0
Credit points	30
Course achievement	None
Examination	Thesis
Examination duration and scale	According to General Regulations
Assignment for the Following Curricula	Civil Engineering: Thesis: Compulsory Bioprocess Engineering: Thesis: Compulsory Chemical and Bioprocess Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory Energy and Environmental Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Global Innovation Management: Thesis: Compulsory Computational Science and Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory Materials Science: Thesis: Compulsory Mathematical Modelling in Engineering: Theory, Numerics, Applications: Thesis: Compulsory

	Mechanical Engineering and Management: Thesis: Compulsory Mechatronics: Thesis: Compulsory Biomedical Engineering: Thesis: Compulsory Microelectronics and Microsystems: Thesis: Compulsory Product Development, Materials and Production: Thesis: Compulsory Renewable Energies: Thesis: Compulsory Naval Architecture and Ocean Engineering: Thesis: Compulsory Ship and Offshore Technology: Thesis: Compulsory Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory Theoretical Mechanical Engineering: Thesis: Compulsory Process Engineering: Thesis: Compulsory Water and Environmental Engineering: Thesis: Compulsory Certification in Engineering & Advisory in Aviation: Thesis: Compulsory