TUHH
Hamburg
University of
Technology

Module Manual

Master of Science (M.Sc.)

Renewable Energies

Cohort: Winter Term 2021

Updated: 27th January 2023

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Program description

Content

In recent decades energy consumption and the associated man-made repercussions on the environment have steadily increased and the (perceived) security of supplies has decreased. This trend can be expected to continue. Increased use of renewable energies - these being hydroelectric, wind and solar power, biomass and geothermal energy - in the electricity, heating and fuel market can make a major contribution toward facing these challenges.

On completing this master’s program in Renewable Energies, graduates are able to explain and assess the possibilities of and limits to the provision of energy for the heating, electricity and fuel market by the renewable energy sources sun, geothermal heat and planetary gravitation and movement. These explanations are primarily from the technical but also from the economic and ecological viewpoint. Graduates can provide an overview of the physical and chemical characteristics of renewable energy sources, have understood the fundamental technical principles of their use and can assess the resulting technical and technological requirements of the requisite conversion plant technology. They can also assess the plant and system technology and the economic and ecological basics of the individual options for renewable energy supply. Graduates have an overview of aspects for integration of plants and systems based on renewable energies into the existing energy system - both in Germany and in non-European countries. Furthermore they can discuss issues of energy storage and the development of renewable energy projects with experts. This specialized knowledge and related skills also enable graduates to take up a position on current energy industry issues on a sound and ideology-free basis. As a result of this master’s program they are qualified to advise interested parties in a professional capacity or to formulate independently problems and objectives for new application - or research-oriented tasks.

A further in-depth specialization, as a part of the master’s program, in the renewable energy system biomass, solar or wind power is possible. Thus, the program provides a comprehensive knowledge on practically all options of renewable energy supply, it’s utilization in the energy system - taking existing structures into account - and on selected associated technical, economic and ecological aspects.

Career prospects

The successful completion of the Master's program "Renewable Energies" enables graduates to hold leading positions in the engineering labor market. Typical fields of activities can be found in energy suppliers, energy consultants, project developers, as well as technical authorities in the renewable energy industry. Furthermore, there is the possibility of engaging in activities as a research assistant with the aim of doctoral degree.

Learning target

Graduates of the Master's program "Renewable Energies" will be able to transfer their acquired knowledge of their engineering and scientific study into practice and to broaden it independently if necessary. They can analyse problems using scientific methods to find an engineering solution, even if the problems are "open" or incomplete defined. They are able to work independently in power engineering and in related disciplines. They can apply, critically analyse and further develop new practices and procedures to solve technical and conceptual issues. Graduates are also qualified to develop projects in the field of "Renewable Energies" with an emphasis on:

- Wind energy
- Photovoltaics,
- Hydropower,
- Ocean energy,
- Biomass and
- Geothermal

and to define and schedule these with respect to necessary clarifications and available information.

Program structure

The technical contents of the master are structured as follows:

- Modules of the core skills:
  - technical fundamentals of usage of renewable energy sources,
  - project evaluation, economy and sustainability,
  - electrical power engineering,
  - non- technical supplementary courses,
- modules of specialization:
  - bioenergy systems,
  - solar energy systems,
  - wind energy systems,
- Master's thesis.

The choice of one specialization is compulsory. Within one specialization courses have to be selected from a catalog of elective courses.

Despite of individual freedom in the choice of courses within the specialization, courses in the core qualification are compulsory for all students. With these courses a balance of formal and practical course content in theory and application of the learning outcomes is ensured.

Non-technical supplementary courses and courses in operation and management provide more flexibilty in the individual design of the curriculum and ensure a linkage between technical and business knowledge. These courses can be chosen from the general catalog of the TUHH.

The master thesis with a share of 25% describe the remaining part of the curriculum.

Note: Within the specialization "Solar Energy Systems", students have been given the opportunity to study abroad at the "University of Jordan" in Amman, Jordan. Within this foreign stay, additional modules in the field of "solar energy systems" can be choosen. The earned credits are recognized at TUHH by agreement.

Core Qualification

Within the core qualification of the Master "Renewable energies" the students gain knowledge about the possibilities and limitations of energy supply from the various renewable energy sources for the heat, electricity and fuel market.
Basis for this aim are on one hand the courses of consecutive Bachelor courses and on the other hand continuing and applied courses in the field of electrical engineering, thermodynamics and fluid mechanics.
Continuing to these courses the different principles for the use of renewable energies and the resulting requirements on the corresponding conversion plant technology are presented, primarily from a technical perspective. Nonetheless, this knowledge is linked to economic and environmental context, to understand and to evaluate the integration of renewable energy applications in energy systems - both in Germany, Europe and countries outside Europe. Furthermore, energy storage opportunities are discussed in this context.
Within the module "Projects and their Assessment", non-technical aspects of the implementation of projects especially in the field of renewable energies are considered, to provide background information in the legal and economic energy implementation of renewable energy applications.

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: Yes; Bonus: 10 %; Form: Group discussion; Description:
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

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 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 L2993: Current issues in behavioral economics

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. Timo Heinrich
Language	EN
Cycle	SoSe
Content	The goal of the seminar is to discuss current issues in behavioral and to shed light on their relationship to economic theory and our own behavior. Students will first read a current popular science book (in English) as well as the relevant scientific literature. Then the individual topics will be presented and critically discussed during the seminar. Furthermore, students will develop individual research questions.
Literature	Wird noch bekanntgegeben.

Course L2664: Behavioral Decision Theory

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. Timo Heinrich
Language	EN
Cycle	WiSe
Content	• The lecture introduces the behavioral approach to individual decisions in economics. • We will critically review experimental studies of economic behavior in decisions under uncertainty, intertemporal decisions and formation of beliefs.
Literature	• Angner: A Course in Behavioral Economics, McMillan, 3rd edition, 2020. • Eeckhoudt/Gollier/Schlesinger: Economic and Financial Decisions under Risk, Princeton University Press, 2005. • Außerdem werden relevante Forschungspapiere im Lauf der Vorlesung vorgestellt. • Additionally, relevant research papers will be introduced during the course of the module.

Course L2599: Behavioral Game Theory	
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. Timo Heinrich
Language	EN
Cycle	WiSe
Content	• The lecture introduces the behavioral approach to strategic interactions in economics. • We will critically review experimental studies of economic behavior in markets, bargaining, auctions and public choice.
Literature	• Es gibt kein Lehrbuch auf das sich die Vorlesung stützt. Die relevanten Forschungspapiere werden im Lauf der Vorlesung vorgestellt. • There is no text book for this lecture. The relevant research papers will be introduced during the course of the module.

Course L2860: Behavioral Online Experiments	
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	5-seitige Ausarbeitung & 20-minütige Teampräsentation
Lecturer	Dr. Christina Strobel
Language	EN
Cycle	SoSe
Content	The course offers an introduction to the methods and techniques of online experiments used in experimental Economics, Psychology, and Business Administration. The course is targeted at participants with no or limited experience. It pursues the agenda of providing the practical, theoretical and tool knowledge to find a research question, deduce hypotheses and design and run an experiment. Hence, the focus will be on general methodological, design and process issues. The course is not surveying the existing experimental evidence but rather pinpoints towards selected well knowns experiments. We will follow a learning-by-doing approach. We will have a short introduction to data evaluation using non-parametric statistics as well as to relevant software tools (oTree). At the end of this course you will have gained not only the know-how needed to develop and implement an experimental research design online but you have also gained the basic skills required to gather, analyze and interpret experimental data.
Literature	Webster, M., & Sell, J. (Eds.). (2014). Laboratory experiments in the social sciences. Elsevier.

Course L2546: Building Business Data Products	
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	folgt
Lecturer	Prof. Christoph Ihl, Joschka Schwarz
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2544: Business Data Science Basics	
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	folgt
Lecturer	Prof. Christoph Ihl, Joschka Schwarz
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2545: Business Decisions with Machine Learning	
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	folgt
Lecturer	Prof. Christoph Ihl, Joschka Schwarz
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2722: Digitalization and the impact on people	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung (laut FPrO)
Examination duration and scale	Ausarbeitung, 5 Seiten
Lecturer	Robert Damköhler, Laura Noack
Language	DE
Cycle	SoSe
Content	
Literature	

Course L1703: Emotional Design / User Centered Product Development	
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	Teamarbeit und abschließender Vortrag
Lecturer	Jörg Heuser
Language	DE
Cycle	SoSe
Content	Lecture • Objective and subjective perception for the evaluation of product characteristics • Effects of material, color, shape and structure to the acceptance of a product • Aesthetic function of a product • Case studies, lack of acceptance of a product and possible reason Seminar • Identification of non-technical product functions • Identification of subjective influences for the product development Project Work • Topics will be developed in cooperation with the students. Project works will be presented in teams, presented and evaluated Exemplary Project: Holistic product evaluation, product optimization
Literature	Wird in der Veranstaltung angegeben

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	Dr. Alexander Kuhlicke, Marvin Hamm, Stephan Meier
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2600: Green Economy - Entrepreneurship, Innovation & Technology Management	
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	Ausarbeitung und Gruppenpräsentation
Lecturer	Prof. Michael Prange
Language	EN
Cycle	WiSe/SoSe
Content	Topics: • Green Economy • Business models • Business strategy • Green Technologies • Green Innovation • Business planning • Business development • Green Entrepreneurship Based on examples and case studies primarily in the field of Green Economy, students learn the basics of Entrepreneurship, Innovation and Technology Management and will be able to develop business models, to evaluate start-up projects and to describe strategic innovation processes.
Literature	Präsentationsfolien, Beispiele und Fallstudien aus der Lehrveranstaltung. Presentation slides, examples, and case studies from the lecture.

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 L2717: Configuration 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 min
Lecturer	York Schnatmeier
Language	DE
Cycle	WiSe/SoSe
Content	Configuration management in complex projects and plans with high development shares, long runtimes and the use of high technology. Configuration management (KM) is thus becoming increasingly important, especially in public, national and international tenders/projects, as well as in the aerospace and shipbuilding industries, among others. It is a tool of project management. The essential terms and processes of KM are explained. The common basis is the DIN ISO 10007. KM is classified and delimited to the essential other processes of project management such as systems engineering, scheduling, quality management, risk management, controlling, contract management, etc.. The necessary structures in the products to be developed and manufactured and within the project organization itself are shown. KM supports the interface between the Project Management Office (PMO) and the executing departments, as well as the subcontractors involved. A key discipline of KM is change control, starting from the identification of the need for change to its implementation in planning, design, manufacturing and product. Special attention is given to the involvement of the client, often the public sector client. The classical project phases, acquisition, realization, commissioning and utilization require commonalities as well as different requirements for the respective KM. The content taught is intended to enable students to work purposefully on new projects from the outset, to drive existing projects forward and to use KM in the process. **Basics I** Concepts of configuration management Goals & definitions, historical development 3x3 of project management, why processes are so important, Different project phases Complex projects and project management **Basics II** Description of the configuration with physical and functional features/properties

	Different project phases Project organization (AG, AN, ARGE and consortia, UAN) DIN ISO 10007 Complex projects and project management **Delimitations and interfaces to other processes** Systems Engineering and the V-Model, scheduling, quality management, risk management, controlling, Construction contract and contract management **Structures in projects** Product structure, functional, physical and logistic structures, document structure, work breakdown structure Organization and Responsibility Matrix **KM Identification** a. Formation of configuration units and product structure b. Criteria for the formation of baselines c. Baselines, Master Record Index d. Scheduled subscription lists **KM Change Control + Change Management** a. Change demand and change effort b. Changes with and without customer and subcontractor involvement c. Vertical and horizontal object dependencies d. Change process e. Common point of disposal **KM auditing** a. Audits and audit levels b. Audits with and without customer and subcontractor participation c. Audits and the V-Model d. Presentation of project progress based on completed audits e. Audits and the quality management f. Planning of audits **KM Accounting** a. Accounting task & use of data b. Interface to construction status management c. Interface to existing databases the product lifecycle management PLM **KM Planning** a. Determination for the acquisition phase b. Specifications for the realization phase during the acquisition phase c. The KM plan for the realization phase **KM Organization and Tools** a. Disposal point / Configuration Control Board **Summary** KM as an interface between project management and order processing. KM as a success factor in product development and a tool for technical control
Literature	DIN ISO 10007

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, Janna Ehrlich
Language	DE
Cycle	WiSe
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 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 L2350: Operational 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	• Leadership & its Environment - Führung & Führungsumfeld • Motivation • Lead Yourself - Selbstführung • Leadership Theories & Styles - Führungstheorien und -stile • Team Leadership - Team & Führung • Lead Change - Wandel herbeiführen • Operational Change - Veränderung im Unternehmen umsetzen • Develop Leadership - Führungsworkshop
Literature	Czikszentmihalyi, Mihalyi (2014): Flow im Beruf oder Das Geheimnis des Glücks am Arbeitsplatz, Klett-Cotta, 1. Auflage Drucker, Peter F. (1999): Manage Oneself, Harvard Business School, On Managing Yourself, S.13-32 Dweck, Carol (2017): Selbstbild - Wie unser Denken Erfolge oder Niederlagen bewirkt, Piper-Verlag (engl. Original: Mindset - The new psychology of success) Goleman, Daniel (2000): Leadership that gets results, Harvard Business School, On Managing People, S.1-14 Laloux, Frederic (2015): Reinventing Organizations, Verlag Franz Vahlen McKee, Annie (2014): A focus on leaders, Pearson Education Ltd., 2. Auflage Northouse, Peter G. (2019): Leadership - Theory & Practise, Sage Publications, 8. Auflage Robbins, Stephen P., Coulter, Mary, Fischer, Ingo (2014): Management - Grundlagen der Unternehmensführung, , Pearson Deutschland GmbH, 12. Auflage (engl. Original: Management, 2007, Pearson Prentice Hall, 9. Auflage)

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	• PMBOK-Guide 7th Edition (A Guide to the Project Management Body of Knowledge) • GPM Kompetenzbasiertes Projektmanagement (PM4) • Kerzner (2003): Projektmanagement • Litke (2004): Projektmanagement • Patzak / Rattay (2004): Projektmanagement • 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 L1133: Law for Engineers	
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	Markus A. Meyer-Chory
Language	DE
Cycle	WiSe
Content	• Refreshment: Basics of Law • Legal relevance of Engineers cases and actions: Contract Law, Liabilities - also for products, labor law, patent law, companies law
Literature	**Notwendiger Gesetzestext (in Klausur erlaubt):** **Bürgerliches Gesetzbuch 72. Auflage , 2013 , dtv Beck-Texte 5001, ISBN 978-3-406-65707-8** **Empfohlene Gesetzestexte:Arbeitsgesetze 83. Auflage, 2013 dtv Beck-Texte 5006 ISBN 978-3-406-65689-7** **Handelsgesetzbuch 54. Auflage, 2013** dtv Beck Texte 5002 ISBN 978-3-406-65083-3 **Gesellschaftsrecht, 13. Auflage , 2013** dtv Beck Texte 5585 ISBN 978-3-406-64502-0 **Wettbewerbsrecht, Markenrecht und Kartellrecht , 33. Auflage, 2013** dtv Beck Texte ISBN 978-3-406-65212-7 **Empfohlene Literatur:** **Vock, Willi,** Recht der Ingenieure, 1. Auflage 2012, Boorberg Verlag , ISBN-10:3-415-04535-8 --- EAN:9783415045354 **Meurer** Rechtshandbuch für Architekten und Ingenieure 1...Auflage -- erscheint Anfg 2014 Werner Verlag ISBN 978-3-8041-4342-5 **Eisenberg / Gildeggen / Reuter / Willburger** Produkthaftung 2. Auflage - erscheint Anfg 2014 Oldenbourg Verlag - ISBN 978-3-486-71324-4 **ENDERS/HETGER,** Grundzüge der betrieblichen Rechtsfragen, 4. Auflage, 2008 Richard Boorberg Verlag - ISBN 978-3-415-04005-2 **Müssig, Peter,** Wirtschaftsprivatrecht, 15. Auflage, 2012 , C.F. Müller UTB - ISBN 978-3-81149476-3 **Schade, Friedrich,** Wirtschaftsprivatrecht, 2. Auflage 2009, Kohlhammer - ISBN 978-3-17-021087-5

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 L2982: Startup Engineering	
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	30 Minuten
Lecturer	Prof. Christoph Ihl, Oliver Mork
Language	EN
Cycle	SoSe
Content	
Literature	

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	WiSe/SoSe
Content	
Literature	

Course L2295: Strategic Planning with Simulation Games	
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 L2857: Sustainable Supply Chain Management	
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 Ausarbeitung + Gruppenpräsentation
Lecturer	Dr. Stephanie Schrage
Language	DE
Cycle	WiSe
Content	Global supply chains are networks of buyers and suppliers that often span continents. Mostly, they are not linear chains but rather complex networks of many independent companies. Governments and civil society organizations such as environmental and human rights advocates put increasing pressure on companies operating in global supply chains and demand better sustainability standards. These demands evolve around examples like avoiding hazardous chemicals in textile supply chains, ensuring sustainable fishing or securing human rights in the toys industry. Corporations take different measures from the area of sustainable supply chain management in order to meet these demands. It is the goal of this class to understand and explain these measures. Students will hold group presentations and write a short term paper. Possible topics of the groups: Challenges and opportunities of hydrogen supply chains in the automotive industry - Challenges and opportunities of battery supply chains - Challenges and opportunities for Sustainable Supply Chain Management in the cocoa industry - Challenges and opportunities for Sustainable Supply Chain Management in the area of textile recycling - Challenges and opportunities for sustainable fishing - Blockchain technology as a solution for Sustainable Supply Chain Management - Auditing standard SA8000 as a solution for Sustainable Supply Chain Management
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 L2669: Negotiation Management	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	Vorbereitung, Durchführung und Selbstreflektion zu einer simulierten Verhandlungssituation. Die fiktive Verhandlung hat einen Umfang von 4 ½ Präsenzstunden und erfordert ausführliche Vor- und Nachbereitung im Umfang von ca. 3 x 2 Stunden. Zum Abschluss ist ein Reflektionsbericht einzureichen. Weitere Prüfungsleistungen werden im Rahmen von Lernfortschrittsabfragen entlang der Vorlesung erbracht.

Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	WiSe
Content	**General description of course content and course goals** We negotiaate everday in privat and professional contexts. Leading negotiations successfully has a significant impact on future careers. Yet, we tend to have limited knowledge about the theory and empirical evidence regarding successful negotiating. Many people approach negotiations in a rather intuitive and unplanned way which often results in sub-optimal negotiation outcomes. The purpose of this interactive and problem-based course is to theortically understand the strategies and process of negotiation as practiced in a variety of business-related settings (e.g. negotiations about working conditions, negotiations with customers and suppliers). The course will highlight the components of an effective negotiation (strategy, perparation, execution, evaluation) and offer the students the opportunity to analyze their own behavior in negotiations in order to improve. The course structure is experiential and problem-based, combining lectures, class discussion, mini-cases and small erxercises, and more comprehensive negotiation practices in longer sessions. Through participation in negotiation exercises, students will have the opportunity to practice their communication and persuasion skills and to experiment with a variety of negotiating strategies and tactics. Students will apply the lessons learned to ongoing, real-world negotiations. **Content:** The students will find answers to the following fundamental questions of negotiation strategies in theory and practice: • How do negotiations influence everyday life and business processes? • What are key features of negotiations? • What are different forms of negotiations? What kinds of negotiation can be distinguished? • Which theoretical approaches to a theory of negotiation can be distinguished? • How can game theory be applied to negotiation? • What makes an effective negotiator? • Which factors should be considered when planning negotiations? • What steps must be followed to reach a deal? • Are there specific negotiation tactics? • What are the typical barriers to an agreement and how to deal with them? • What are possible cognitive (mental) errors and how to correct them? **Knowledge** Students know... • the theory basics of negotiations (e.g. game theory, behavioral theories) • the types and the pros and cons of diffrent negotiation strategies • the process of negotiation, inlcuding goal formulation, preparation/planning, execution and evaluation • about some key issues impacting negotiations (e.g. team building and roles, barriers to reaching a deal, cognitive biases, multi-phase negotiations) **Skills** Students are capable of... • simultaneously considering multiple factors in negotiation situations and taking reasoned actions when preparing and conducting negotiations. • Analyzing and handling the key challenges of uncertainty, risk, intercultural differences, and time pressure in realistic negotiation situations. • assessing the typical barriers to an agreement (e.g. lack of trust), dealing with hardball tactics (e.g. good cop, bad cop; lowball, highball; intimidation), and avoiding cognitive traps (e.g. unchecked emotions, overconfidence). • reflecting on their decision-making in uncertain negotiation situations and derive actions for future decisions. **Social Competence** Students can... • provide appropriate feedback and handle feedback on their own performance constructively. • constructively interact with their team members in role playing in negotiations sessions • develop joint solutions in mixed teams and present them to others in real-world negotiation situatio **Self-Reliance** Students are able to... ◦ assess possible consequences of their own negotiation behavior ◦ define own positions and tasks in the negotiation preparation process. ◦ justify and make elaborated decisions in authentic negotiation situations.

Literature	R.J. Lewicki / B. Barry / D.M. Saunders: Negotiation. Sixth Edition, McGraw-Hill, Boston, 2010. H. Raiffa: Negotiation analysis. Belknap Press of Harvard Univ. Press, Cambridge, Mass, 2007. R. Fisher / W. Ury: Getting to yes. Third edition. Penguin, New York, 2011. M. Voeth / U. Herbst: Verhandlungsmanagement: Planung, Steuerung und Analyse. Schäffer-Poeschel, Stuttgart, 2009.

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 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. Weischenberg, S. (2010): Das Jahrhundert des Journalismus ist vorbei. Rekonstruktionen und Prognosen zur Formation gesellschaftlicher Selbstbeobachtung. In: Bartelt-Kircher, Gabriele u.a.: Krise der Printmedien - eine Krise des Journalismus? Berlin und New York: de Gruyter Saur, S. 32-60. Eine ausführliche Literaturliste wird am Anfang des Seminars verteilt.

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 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 L2890: D: Responsible project management in engineering (for dual study program)	
Typ	Seminar
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	digitalen Lern- und Entwicklungsberichtes (E-Portfolio)
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	• Theories and methods of project management • Innovation management • Agile project management • Fundamentals of classic and agile methods • Hybrid use of classic and agile methods • Roles, perspectives and stakeholders throughout the project • Initiating and coordinating complex engineering projects • Principles of moderation, team management, team leadership, conflict management • Communication structures: in-house, cross-company • Public information policy • Promoting commitment and empowerment • Sharing experience with specialists and managers from the engineering sector • Documenting and reflecting on learning experiences
Literature	Seminarapparat

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 L2891: E: Responsible change and transformation management in engineering (for dual study program)	
Typ	Seminar
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	Anfertigung eines digitalen Lern- und Entwicklungsberichtes
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	• Basic concepts, opportunities and limits of organisational change • Models and methods of organisational design and development • Strategic orientation and change, and their short-, medium- and long-term consequences for individuals, organisations and society as a whole • Roles, perspectives and stakeholders in change processes • Initiating and coordinating change measures in engineering • Phase models of organisational change (Lewin, Kotter, etc.) • Change-oriented information policy and dealing with resistance and uncertainty • Promoting commitment and empowerment • Successfully handling change and transformation: personally, as an employee, as a manager (personal, professional, organisational) • Company-level and globally (systemic) • Sharing experience with specialists and managers from the engineering sector • Documenting and reflecting on learning experiences
Literature	Seminarapparat

Course L2479: Introduction to technology journalism: How research, development and solutions reach the public	
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	15 Minuten je 3er Team
Lecturer	Prof. Margarete Jarchow, Matthias Kowalski
Language	DE
Cycle	WiSe/SoSe
Content	The seminar imparts basic journalistic knowledge and skills to convey technical content to a broad public. Technical topics are increasingly being taken up and discussed not only in specialist and special interest magazines, but also in the public media such as daily newspapers, television, radio and on the Internet. The participants of the seminar receive skills that can enable them to actively contribute to such discussions. Technology journalism is a comparatively young branch of professional journalism and includes reporting on topics from the areas of construction and housing, energy and the environment, transport and transportation, trade and industrial production, trade and services, as well as information and communication. The topics of climate and sustainability have recently been added. From these areas, journalistic topics for the final presentations are conceived, researched and implemented in small teams. The seminar uses digital and analog communication channels in technology journalism. The handling of often very complex subjects and their understandable presentation is trained, the reporting is analyzed, the research is conceived, and typical forms of presentation and linguistic peculiarities are learned. The relationship to science, research and public relations also plays a role here. The seminar is rounded off by an overview of legal and ethical framework conditions.
Literature	Newman, Nic: Journalism, Media & Technology - Trends and predictions 2019, Reuters Institute/ University of Oxford Digital News Publications http://www.digitalnewsreport.org/publications/2019/journalism-media-technology-trends-predictions-2019/#executive-summary; Schümchen, Andreas: Technikjournalismus (Riehe Praktischer Journalismus), 328 S., UVK-Verlag 2008

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 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 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	DE
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.

Mummendey, H. D. (1981). Methoden und Probleme der Kontrolle sozialer Erwünschtheit (Social

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

Rohde, J. & Block, M. (2018). Welche Herausforderungen und Bewältigungsstrategien berichten

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

Jenny Alice Rohde & Nadine Stahlberg. In: die hochschulehre (2019).

Schneider, M. & Preckel, F. (2017). Variables associated with achievement in higher education: A

systematic review of meta-analyse. Psychological Bulletin, 143(6), 565-600.

Skylar Powell, K. & Yalcin, S. (2010). Managerial training effectiveness: A meta-analysis 1952-2002.

Personnel Review, 39(2), 227-241.

27 Welches Lehrverhalten zeigen geschulte Tutor/innen

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

Stes, A., Min-Leliveld, M., Gijbels, D. & Van Petegem, P. (2010). The impact of instructional development

in higher education: The state-of-the-art of the research. Educational Research Review,

5(1), 25-49.

Stroebe, W. (2016). Why Good Teaching Evaluations May Reward Bad Teaching: On Grade Inflation

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

11(6), 800-816.

Technische Universität Hamburg (2018). Kennzahlen 2017. Hamburg: Technische Universität Hamburg.

[https://www.tuhh.de/tuhh/uni/informationen/kennzahlen.html]

Thumser-Dauth, K. (2008). Und was bringt das? Evaluation hochschuldidaktischer Weiterbildung.

In B. Berendt, H.-P. Voss & J. Wildt (Hrsg.), Neues Handbuch Hochschullehre. Lehren und Lernen

effizient gestalten. Kap. L 1.11 Hochschuldidaktische Aus- und Weiterbildung. Veranstaltungskonzepte

und -modelle. Berlin: Raabe. S. 1-10.

Wibbecke, G. (2015): Evaluation einer hochschuldidaktischen Weiterbildung an der Medizinischen

Fakultät Heidelberg. Dissertation. Ruprecht-Karls-Universität Heidelberg.

Willige, J., Woisch, A., Grützmacher, J. & Naumann, H. (2015a). Randauszählung Studienqualitätsmonitor

2014, Technische Universität Hamburg-Harburg, Online-Befragung Studierender im

Sommersemester 2014, DZHW - Deutsches Zentrum für Hochschul- und Wissenschaftsforschung.

Willige, J., Woisch, A., Grützmacher, J. & Naumann, H. (2015b). Randauszählung Studienqualitätsmonitor

2015, Technische Universität Hamburg-Harburg, Online-Befragung Studierender im

Sommersemester 2015, DZHW - Deutsches Zentrum für Hochschul- und Wissenschaftsforschung.

Winkler, M. (2018). Tutorielle Lehransätze im Vergleich. Die KOMPASS Begleitforschung. Vortrag

gehalten am 12.03.2018 auf dem Netzwerktreffen Tutorienarbeit an Hochschulen in Würzburg.

Zech, F. (1977). Grundkurs Mathematikdidaktik: theoretische und praktische Anleitungen für das

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 L2851: Join Mini Challenges of the ECIU University	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	90 Stunden Arbeitsaufwand
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe/SoSe
Content	Join multidisciplinary and international teams at the ECIU University and solve mini challenges linked to the SDG11 - Sustainable cities and communities, provided by business and societal partners across Europe. Participation in mini challenges will allow you to make a real impact in the community, city, or region by solving real-time local, national, and global challenges with a new way of learning - the challenge-based learning. General procedure of a challenge: 1. The mini challenge is provided by a city, region or business stakeholder and is entered on the ECIU University Challenge platform (**challenges.eciu.org**). 2. You register to the mini challenge you find relevant on the platform. 3. An international and interdisciplinary team is formed from registered participants from all ECIU partner universities and a team facilitator from the host university is assigned. 4. You work with the team on the mini challenge, engage, investigate, and propose non-technical solutions using the challenge-based learning methodology (https://eciu.tuhh.de/challenge-based-learning/). 5. During the process, you can select relevant micro-modules from ECIU member universities that help you gain additional knowledge or skills that are relevant to solve the mini challenge. 6. Finally, teams deliver their outputs - which may include services, products, research questions, start-ups and spin-offs. By working in multi-disciplinary and/or international teams, you will build up inter-cultural competences and increase your network of expertise by developing problem-solving and team-work skills. TUHH is major part of the ECIU University leading institution related to the Challenge-based learning. All ECIU challenges will constantly be updated at the challenge platform: challenges.eciu.org **“Mini challenges”** are challenges in the ECIU University that are supposed to be done within 1-4 weeks. Focus is to define your actual challenge, find suitable solution(s) and to implement them. https://eciu.tuhh.de/cbl-in-more-detail/ This course is aimed at Master students from member universities of the ECIU network (www.eciu.org). The course requires an independent approach to work, the willingness to learn independently about new non-technical topics and research methods, and the motivation to learn and actively participate in an international/disciplinary team.
Literature	ECIU UNIVERSITY 2030, CONNECTS U FOR LIFE https://www.eciu.org/news/eciu-university-2030-connects-u-for-life TOWARDS A EUROPEAN MICRO-CREDENTIALS INITIATIVE https://www.eciu.org/news/towards-a-european-micro-credentials-initiative

Course L2852: Join Nano Challenges of the ECIU University	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	30 Stunden Arbeitsaufwand
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe/SoSe
Content	Join multidisciplinary and international teams at the ECIU University and solve nano challenges linked to the SDG11 - Sustainable cities and communities, provided by business and societal partners across Europe. Participation in nano challenges will allow you to make a real impact in the community, city, or region by solving real-time local, national, and global challenges with a new way of learning - the challenge-based learning. General procedure of a challenge: 1. The nano challenge is provided by a city, region or business stakeholder and is entered on the ECIU University Challenge platform (**challenges.eciu.org**). 2. You register to the nano challenge you find relevant on the platform. 3. An international and interdisciplinary team is formed from registered participants from all ECIU partner universities and a team facilitator from the host university is assigned. 4. You work with the team on the nano challenge, engage, investigate, and propose non-technical solutions using the challenge-based learning methodology (https://eciu.tuhh.de/challenge-based-learning/). 5. During the process, you can select relevant micro-modules from ECIU member universities that help you gain additional knowledge or skills that are relevant to solve the nano challenge. 6. Finally, teams deliver their outputs - which may include services, products, research questions, start-ups and spin-offs. By working in multi-disciplinary and/or international teams, you will build up inter-cultural competences and increase your network of expertise by developing problem-solving and team-work skills. TUHH is major part of the ECIU University leading institution related to the Challenge-based learning. All ECIU challenges will constantly be updated at the challenge platform: challenges.eciu.org **“Nano challenges”** are the smallest unit of challenges in the ECIU University and are supposed to be done within 1-2 days. Focus is to define your actual challenge, find suitable solution(s) and create ideas for further steps. https://eciu.tuhh.de/cbl-in-more-detail/ This course is aimed at Master students from member universities of the ECIU network (www.eciu.org). The course requires an independent approach to work, the willingness to learn independently about new non-technical topics and research methods, and the motivation to learn and actively participate in an international/disciplinary team.
Literature	ECIU UNIVERSITY 2030, CONNECTS U FOR LIFE https://www.eciu.org/news/eciu-university-2030-connects-u-for-life TOWARDS A EUROPEAN MICRO-CREDENTIALS INITIATIVE https://www.eciu.org/news/towards-a-european-micro-credentials-initiative

Course L2853: Join Standard Challenges of the ECIU University	
Typ	Project-/problem-based Learning
Hrs/wk	6
CP	6
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	180 Stunden Arbeitsaufwand
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe/SoSe
Content	Join multidisciplinary and international teams at the ECIU University and solve standard challenges linked to the SDG11 - Sustainable cities and communities, provided by business and societal partners across Europe. Participation in standard challenges will allow you to make a real impact in the community, city, or region by solving real-time local, national, and global challenges with a new way of learning - the challenge-based learning. General procedure of a challenge: 1. The standard challenge is provided by a city, region or business stakeholder and is entered on the ECIU University Challenge platform (**challenges.eciu.org**). 2. You register to the standard challenge you find relevant on the platform. 3. An international and interdisciplinary team is formed from registered participants from all ECIU partner universities and a team facilitator from the host university is assigned. 4. You work with the team on the standard challenge, engage, investigate, and propose non-technical solutions using the challenge-based learning methodology (https://eciu.tuhh.de/challenge-based-learning/). 5. During the process, you can select relevant micro-modules from ECIU member universities that help you gain additional knowledge or skills that are relevant to solve the standard challenge. 6. Finally, teams deliver their outputs - which may include services, products, research questions, start-ups and spin-offs. By working in multi-disciplinary and/or international teams, you will build up inter-cultural competences and increase your network of expertise by developing problem-solving and team-work skills. TUHH is major part of the ECIU University leading institution related to the Challenge-based learning. All ECIU challenges will constantly be updated at the challenge platform: challenges.eciu.org **“Standard challenges”** are challenges in the ECIU University that are supposed to be done within 3-6 months. Focus is to define your actual challenge, find suitable solution(s) and to implement as well as evaluate and publish them. https://eciu.tuhh.de/cbl-in-more-detail/ This course is aimed at Master students from member universities of the ECIU network (www.eciu.org). The course requires an independent approach to work, the willingness to learn independently about new non-technical topics and research methods, and the motivation to learn and actively participate in an international/disciplinary team.
Literature	ECIU UNIVERSITY 2030, CONNECTS U FOR LIFE https://www.eciu.org/news/eciu-university-2030-connects-u-for-life TOWARDS A EUROPEAN MICRO-CREDENTIALS INITIATIVE https://www.eciu.org/news/towards-a-european-micro-credentials-initiative

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 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 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	**The group project: TUHH goes Circular addresses environmental challenges and studies non-technical aspects that support the circular economy and environmental initiatives. Topics are to be chosen matching the general scope of environmental challenges, i.e. the challenges of rising resource consumption and waste production. In a practical group task, students will gain experience in the research, design and execution of a sustainability action plan. Important aspects of action plan should be supported by scientific evidence and improved upon based on constructive feedback. In addition, students will be introduced to the importance of high-quality science communication for ecologically and socially sustainable development.**
Literature	Wird im Seminar bekannt gegeben Will be announced in lecture.

Course L3052: Becoming resilient: Connecting Narratives between Nature and Culture	
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	45 Minuten Referat mit schriftlicher Ausarbeitung (Handout)
Lecturer	Jacobus Bracker
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Course L2649: Brave New World? Technology, Society and Digitalitization in Cinematic Dystopias	
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	45 Minuten
Lecturer	Dr. Marlis Bussacker
Language	DE
Cycle	WiSe/SoSe
Content	Desolate landscapes, destruction, violence - these are usually our first associations when we think of dystopias. But it is not that obvious. At first we often see an almost utopian-looking world without disease, without hunger, without poverty, in which many of our current problems have been solved. But the idyll is illusory and has its price. What does this price look like? The seminar will focus on films in which technical progress and the development of artificial intelligence have opened up almost unlimited possibilities for people - to improve their living conditions, but also to gain complete control over them. Who carries out this control? Is an individual life still possible? What about democratic structures? Do these films show us our future? How much freedom do we want to give up for a life that seems safe and carefree at first sight? And: Why are there no more social utopias? These questions, among others, will be focused in the discussion.
Literature	Wird im Seminar bekannt gegeben.

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/EN
Cycle	WiSe/SoSe
Content	This seminar is intended to enable and promote social engagement for refugees and migrants and the social learning that goes along with it. The term "social commitment for refugees" means active cooperation and participation in projects, initiatives or organizations that aim at supporting refugees/migrants in Germany. The recognition of activities within the framework of projects, initiatives or organizations with anti-democratic objectives is excluded. The goal is "social learning within the framework of social commitment": On the one hand, this includes the acquisition or deepening of competencies on the part of the students through their commitment in the above-mentioned area; on the other hand, it includes the support/promotion/learning of the refugees/migrants through the competencies of the students. In this course, students independently look for social projects in the above-mentioned sense and commit themselves for at least 50 hours. Previous social commitment in the above-mentioned area can be taken into account. In this course, students engage in social projects for at least 50h. Previous social commitment in this field can be taken into account. In addition, participants will have the opportunity to exchange information with other students from the Social Learning seminars on their voluntary activities. The participants will be closely accompanied and advised by the course instructor, especially in the search and selection of a suitable activity. Compulsory 20h of present teaching including consultation enable the students to reflect on the learning situation on site as well as their own competences in a reflection work / written elaboration Obligatory 10 h of presence teaching including consulting time enable students to reflect the learning situation on site and their own competence in a structured and successful way, either accompanying or following their involvement in a reflection work / written elaboration to be able to identify and evaluate their own learning process. In addition, the participants are given the opportunity to specifically exchange information with other students from the Master's programs about their social activities.
Literature	Wird im Seminar bekannt gegeben. Will be announced in lecture.

Course L2485: Social Learning: Social Engagement for Sustainability - M.Sc.	
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 + mündliche Präsentation
Lecturer	Tatjana Grimm
Language	DE
Cycle	WiSe/SoSe
Content	This seminar is intended promote social engagement in the field of ecological, economic and social sustainability and the accompanying social learning. "Social Engagement for Sustainability" means active cooperation and participation in projects, initiatives or organisations which aim to preserve or improve living conditions and environment for present and future generations, e.g. conservation of resources, nature protection or strengthening fair trade. Activities in projects, initiatives or organisations with anti-democratic objectives and in political parties are not accepted. In this course, students are volunteering in social projects for at least 32 hours. Previous social engagement in this field can be considered. In addition, participants are given the opportunity to exchange information with other students from the Social Learning seminars on their voluntary service. The participants will be closely accompanied and advised by the instructor, especially during the search and selection of a suitable activity. Obligatory 28 hours of presence teaching including counselling time enable students to critically reflect on their commitment. The focus is on the effects in society.
Literature	-

Course L2480: Social Learning: Social commitment to preservation of historical cultural assets - MSc	
Typ	Seminar
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	10 Seiten + mündliche Präsentation
Lecturer	Tatjana Grimm
Language	DE
Cycle	WiSe/SoSe
Content	This seminar is intended to promote social engagement in the field of natural- and technical history and the associated social learning. "Social commitment to preservation of historical cultural assets" means the active participation in projects, initiatives or organizations whose aim is to preserve natural-, social- and technological historical cultural assets. Possible contacts are natural history- and technology museums as well as monument protection foundations, which look after historic buildings, ships and port facilities or underground buildings. Activities in projects, initiatives or organisations with anti-democratic objectives and in political parties are not accepted. In this course, students engage in social projects for at least 42h. Previous social commitment in this field can be taken into account. In addition, participants will have the opportunity to exchange information with other students from the Social Learning seminars on their voluntary activities. The participants will be closely accompanied and advised by the course instructor, especially in the search and selection of a suitable activity. Compulsory 18h of present teaching including consultation enable the students to reflect on the learning situation on site as well as their own competences in a reflection work / written elaboration.
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 L1885: Urban Life - City and Technology	
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 Handout
Lecturer	Dr. Anke Rees
Language	DE
Cycle	WiSe/SoSe
Content	More than half world's population live in cities. The UN estimates that by 2030 the figure will rise to 5 billion people. Cities are booming and „Urbanity" is en vogue. But what is „Urbanity"? The specifics take on a tangible form when looking at the connections between people, buildings, materials, history and current affairs. This assemblage interlaces - at times invisibly - with technology. This seminar intensifies the view of properties, characteristics and qualities of cities. Various methods and perspectives of urban research from Social Science, Geography, Material Culture Studies, Art History and Cultural Anthropology will be presented.
Literature	Wird im Seminar bekannt gegeben.

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 L3051: Scientific writing for student theses, conference articles and journal papers	
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	Präsentation und schriftliche Ausarbeitung
Lecturer	Dr. Robinson Peric
Language	EN
Cycle	WiSe
Content	
Literature	

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. Sigrid Vierck
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 different levels: 1. searching, 2. presenting with words, slides and pictures and 3. practical appliance. The course 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	**Ascheron,** Klaus: Die Kunst des wissenschaftlichen Präsentierens und Publizierens. Ein Praxisleitfaden für junge Wissenschaftler. München 2007. Der Autor, Naturwissenschaftler, erklärt aufgrund seiner langjährigen und internationalen Erfahrung worauf es beim wissenschaftlichen Präsentieren (und Schreiben) ankommt. Aus seinem ganzheitlichen Ansatz heraus gibt er klare und hilfreiche Tipps für ein erfolgreiches und korrektes Darstellen im wissenschaftlichen Kontext. **Eufinger,** Günther: Dokumente perfekt gestalten. München 2007. Der Autor geht in dem kompakten Band auf die Schlüsselkompetenzen für erfolgreiches Präsentieren ein, die er aufgrund langjähriger praktischer Erfahrungen definiert. Darunter wird die Power-Point-Präsentation eingehend behandelt, wobei das in den weiteren Kapiteln dargestellte Basiswissen auch für PPP anzuwenden ist. **Feuerbacher**, Bernd: Professionell Präsentieren in den Natur- und Ingenieurwissenschaften. Weinheim 2009. Ansprechender, klar strukturierter Band, der auf die Unterschiede zwischen mündlichem Vortrag und schriftlichen Ausdruck eingeht sowie zusätzlich den Schwerpunkt auf die Power-Point-Präsentation legt. Wie im Titel angegeben zwar mit Betonung der Natur- und Ingenieurwissenschaften, aber in der Beschreibung rhetorischen Auftretens allgemeingültig formuliert. **Hug**, Theo (Hrsg.): Wie kommt Wissenschaft zu Wissen, Band 1: Einführung in das wissenschaftliche Arbeiten. Hohengehren 2001. Weitreichende Einführung, die bereits in den späteren Praxisbereich übergreift. Intensive Behandlung der internetbezogenen Arbeit. **Kremer**, Bruno P.: Vom Referat bis zur Abschlussarbeit. Naturwissenschaftliche Texte perfekt produzieren, präsentieren und publizieren. 5. Aufl. 2018. Berlin, Heidelberg (Imprint: Springer Spektrum). Der Autor schreibt mit langjähriger Erfahrung. Der Band, wie im Titel formuliert auf die Naturwissenschaften zugeschnitten, informiert umfassend, ist sehr gut gegliedert und verständlich geschrieben, sozusagen eine Werkstattanleitung, praxisnah und ermunternd. **Prexl**, Lydia: Mit digitalen Quellen arbeiten: richtig zitieren aus Datenbanken, E-Books, YouTube & Co. 3., aktualisierte und überarbeitete Auflage, Paderborn, Stuttgart 2019 (UTB) https://elibrary.utb.de/doi/book/10.36198/9783838550725 (Lizenzpflichtig) Die Autorin schildert in kleinen Schritten das wissenschaftliche Arbeiten mit Betonung des digitalen Anteils wie E-Books, E-Journals, Social-Media-Einträgen, Datenbanken und anderen elektronische Quellen. Vor allem bei der Frage nach der Verwendbarkeit und Zitierfähigkeit gibt dieser Ratgeber Lösungen ebenso wie zur Vermeidung von Plagiaten, sowie der bibliographischen Angabe, auch bei Unvollständigkeit. **Pöhm**, Matthias: Präsentieren Sie noch oder faszinieren Sie schon? Der Irrtum PowerPoint. 6. Aufl. Heidelberg 2009. Als Coach und Moderator bietet der Autor Tipps zur erfolgreichen Präsentation, die - wie er provokant im Titel formuliert - ohne PowerPoint auskommen soll, denn er setzt auf die Emotion als Kommunikationsmittel. Damit wird deutlich, dass er sich mehr im verkaufsorientierten als im wissenschaftlichen Bereich ansiedelt. **Pukas**, Dietrich: Lernmanagement. Einführung in Lern- und Arbeitstechniken. 3. aktual. Aufl. Rinteln 2008. Übersichtliches und umfassendes Kompendium zu den zahlreichen Fragen des Lernens und wissenschaftlichen Arbeitens. Zunächst wirtschaftswissenschaftlich orientiert, was auch durch die Struktur sowie die Tabellen und Diagramme deutlich wird, hat der Band durchaus allgemeine Gültigkeit. Darüber hinaus werden praxisorientierte Hinweise gegeben. **Reynolds**, Garr: Zen oder die Kunst der Präsentation. München u.a. 2010. Der Autor kommt aus dem Designbereich und bietet somit Stilmittel zur Gestaltung der PPP an. Wie im Titel angedeutet sind für ihn die Mittel der Konzentration auf das Wesentliche, der Ruhe und Einfachheit von entscheidender Bedeutung. **Rost**, Friedrich: Lern- und Arbeitstechniken für das Studium. 8., überarb. u. aktual. Aufl. Wiesbaden 2018. Ausführliche Vermittlung von Arbeitstechniken der Stoffermittlung, der Stoffverarbeitung, der Stoffsammlung, des informativen Schreibens, des Sprechens und Redens mit Berücksichtigung der computergestützten Arbeit und einem Anhang zu Ausdruck und

	Grammatik der deutschen Sprache. **Sesink**, Werner: Einführung in das wissenschaftliche Arbeiten: inklusive E-Learning, Web-Recherche, digitale Präsentation u.a. 9., vollständ. überarb. u. aktual. Aufl. München 2014. Arbeitshilfe mit Betonung auf der Computer-Verwendung. Erklärung des wissenschaftlichen Arbeitens und der Vorarbeiten wie Literatursuche und persönlicher Materialsammlung. Beschreibung des Abfassens einer schriftlichen Arbeit, auch Protokoll, Thesenpapier und Klausur. Ausführliche Behandlung der computergestützten Arbeit, vor allem auch des Textformatierens und der Textverarbeitung in der Studienpraxis. **Spoun**, Sascha und Dominik B. **Domnik**: Erfolgreich studieren. Ein Handbuch für Wirtschafts- und Sozialwissenschaftler. München u.a. 2005. Pearson-Studium. Handlicher Band, der Selbstorganisation als Erfolg versprechende Grundlage für das Studium sowie Techniken des Recherchierens, Lesens und Darstellens beschreibt. Durch die Konzentration auf das Wesentliche wird der Intensität und Kürze des Bachelor- und Masterstudiums Rechnung getragen und ein Leitfaden für die Bewältigung des workloads gegeben. **Theisen**, Manuel R.: Wissenschaftliches Arbeiten. Technik, Methodik, Form. 17., aktual. u. bearb. Aufl. München 2017. Zielgerichtete Beschreibung des Arbeitsprozesses von der Planung bis zum Druck und der Präsentation. Alle Stufen werden ausführlich, detailliert und in sinnvoller Reihenfolge beschrieben, wobei einzelne Kapitel auch für sich genommen werden können. Klar, übersichtlich, grundlegend. Der Autor ist in der Betriebswirtschaftslehre beheimatet. **Wolpert**, Lewis: Unglaubliche Wissenschaft. Frankfurt a. M. 2004. Der Autor, Naturwissenschaftler, vermittelt aufgrund seiner lebenslang gewonnenen Erfahrung den Weg zur wissenschaftlichen Erkenntnis durch Aufzeigen der grundlegenden Frageprinzipien und des wissenschaftlichen, sprich nachvollziehbaren und beweisfähigen Denkens. Der Band ist in der Reihe „Die Andere Bibliothek“ erschienen, mit der Herausgeber Hans Magnus Enzensberger ein Kompendium der Welt- und Wissensliteratur eigener Prägung schafft. Der Band regt zum unkonventionellen Denken an.

Module M1294: Bioenergy

Courses

Title	Typ	Hrs/wk	CP
Biofuels Process Technology (L0061)	Lecture	1	1
Biofuels Process Technology (L0062)	Recitation Section (small)	1	1
World Market for Commodities from Agriculture and Forestry (L1769)	Lecture	1	1
Thermal Biomass Utilization (L1767)	Lecture	2	2
Thermal Biomass Utilization (L2386)	Practical Course	1	1

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	Students are able to reproduce an in-depth outline of energy production from biomass, aerobic and anaerobic waste treatment processes, the gained products and the treatment of produced emissions.
Skills	Students can apply the learned theoretical knowledge of biomass-based energy systems to explain relationships for different tasks, like dimesioning and design of biomass power plants. In this context, students are also able to solve computational tasks for combustion, gasification and biogas, biodiesel and bioethanol use.
Personal Competence	
Social Competence	Students can participate in discussions to design and evaluate energy systems using biomass as an energy source.
Autonomy	Students can independently exploit sources with respect to the emphasis of the lectures. They can choose and aquire the for the particular task useful knowledge. Furthermore, they can solve computational tasks of biomass-based energy systems independently with the assistance of the lecture. Regarding to this they can 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	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Energy and Bioprocess Technology: Elective Compulsory 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 Renewable Energies: Core Qualification: Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory

Course L0061: Biofuels Process Technology	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Oliver Lüdtke
Language	DE
Cycle	WiSe

Content	• General introduction
	• What are biofuels?
	• Markets & trends
	• Legal framework
	• Greenhouse gas savings
	• Generations of biofuels
	  ◦ first-generation bioethanol
	  ▪ raw materials
	  ▪ fermentation distillation
	  ◦ biobutanol / ETBE
	  ◦ second-generation bioethanol
	  ▪ bioethanol from straw
	  ◦ first-generation biodiesel
	  ▪ raw materials
	  ▪ Production Process
	  ▪ Biodiesel & Natural Resources
	  ◦ HVO / HEFA
	  ◦ second-generation biodiesel
	  ▪ Biodiesel from Algae
	• Biogas as fuel
	  ◦ the first biogas generation
	  ▪ raw materials
	  ▪ fermentation
	  ▪ purification to biomethane
	  ◦ Biogas second generation and gasification processes
	• Methanol / DME from wood and Tall oil ©

Literature	• Skriptum zur Vorlesung • Drapcho, Nhuan, Walker; Biofuels Engineering Process Technology • Harwardt; Systematic design of separations for processing of biorenewables • Kaltschmitt; Hartmann; Energie aus Biomasse: Grundlagen, Techniken und Verfahren • Mousdale; Biofuels - Biotechnology, Chemistry and Sustainable Development • VDI Wärmeatlas

Course L0062: Biofuels Process Technology	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Oliver Lüdtke
Language	DE
Cycle	WiSe

Content	• Life Cycle Assessment
	  ◦ Good example for the evaluation of CO2 savings potential by alternative fuels - Choice of system boundaries and databases
	• Bioethanol production
	  ◦ Application task in the basics of thermal separation processes (rectification, extraction) will be discussed. The focus is on a column design, including heat demand, number of stages, reflux ratio ...
	• Biodiesel production
	  ◦ Procedural options for solid / liquid separation, including basic equations for estimating power, energy demand, selectivity and throughput
	• Biomethane production
	  ◦ Chemical reactions that are relevant in the production of biofuels, including equilibria, activation energies, shift reactions

Literature	Skriptum zur Vorlesung

Course L1769: World Market for Commodities from Agriculture and Forestry	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Michael Köhl, Bernhard Chilla
Language	DE
Cycle	WiSe
Content	1) Markets for Agricultural Commodities What are the major markets and how are markets functioning Recent trends in world production and consumption. World trade is growing fast. Logistics. Bottlenecks. The major countries with surplus production Growing net import requirements, primarily of China, India and many other countries. Tariff and non-tariff market barriers. Government interferences. 2) Closer Analysis of Individual Markets Thomas Mielke will analyze in more detail the global vegetable oil markets, primarily palm oil, soya oil, rapeseed oil, sunflower oil. Also the raw material (the oilseed) as well as the by-product (oilmeal) will be included. The major producers and consumers. Vegetable oils and oilmeals are extracted from the oilseed. The importance of vegetable oils and animal fats will be highlighted, primarily in the food industry in Europe and worldwide. But in the past 15 years there have also been rapidly rising global requirements of oils & fats for non-food purposes, primarily as a feedstock for biodiesel but also in the chemical industry. Importance of oilmeals as an animal feed for the production of livestock and aquaculture Oilseed area, yields per hectare as well as production of oilseeds. Analysis of the major oilseeds worldwide. The focus will be on soybeans, rapeseed, sunflowerseed, groundnuts and cottonseed. Regional differences in productivity. The winners and losers in global agricultural production. 3) Forecasts: Future Global Demand & Production of Vegetable Oils Big challenges in the years ahead: Lack of arable land for the production of oilseeds, grains and other crops. Competition with livestock. Lack of water. What are possible solutions? Need for better education & management, more mechanization, better seed varieties and better inputs to raise yields. The importance of prices and changes in relative prices to solve market imbalances (shortage situations as well as surplus situations). How does it work? Time lags. Rapidly rising population, primarily the number of people considered “middle class” in the years ahead. Higher disposable income will trigger changing diets in favour of vegetable oils and livestock products. Urbanization. Today, food consumption per caput is partly still very low in many developing countries, primarily in Africa, some regions of Asia and in Central America. What changes are to be expected? The myth and the realities of palm oil in the world of today and tomorrow. Labour issues curb production growth: Some examples: 1) Shortage of labour in oil palm plantations in Malaysia. 2) Structural reforms overdue for the agriculture in India, China and other countries to become more productive and successful, thus improving the standard of living of smallholders.
Literature	Lecture material

Course L1767: Thermal Biomass Utilization	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	WiSe

Content	Goal of this course is it to discuss the physical, chemical, and biological as well as the technical, economic, and environmental basics of all options to provide energy from biomass from a German and international point of view. Additionally different system approaches to use biomass for energy, aspects to integrate bioenergy within the energy system, technical and economic development potentials, and the current and expected future use within the energy system are presented.
	
	The course is structured as follows:
	
	• Biomass as an energy carrier within the energy system; use of biomass in Germany and world-wide, overview on the content of the course
	• Photosynthesis, composition of organic matter, plant production, energy crops, residues, organic waste
	• Biomass provision chains for woody and herbaceous biomass, harvesting and provision, transport, storage, drying
	• Thermo-chemical conversion of solid biofuels
	  ◦ Basics of thermo-chemical conversion
	  ◦ Direct thermo-chemical conversion through combustion: combustion technologies for small and large scale units, electricity generation technologies, flue gas treatment technologies, ashes and their use
	  ◦ Gasification: Gasification technologies, producer gas cleaning technologies, options to use the cleaned producer gas for the provision of heat, electricity and/or fuels
	  ◦ Fast and slow pyrolysis: Technologies for the provision of bio-oil and/or for the provision of charcoal, oil cleaning technologies, options to use the pyrolysis oil and charcoal as an energy carrier as well as a raw material
	• Physical-chemical conversion of biomass containing oils and/or fats: Basics, oil seeds and oil fruits, vegetable oil production, production of a biofuel with standardized characteristics (trans-esterification, hydrogenation, co-processing in existing refineries), options to use this fuel, options to use the residues (i.e. meal, glycerine)
	• Bio-chemical conversion of biomass
	  ◦ Basics of bio-chemical conversion
	  ◦ Biogas: Process technologies for plants using agricultural feedstock, sewage sludge (sewage gas), organic waste fraction (landfill gas), technologies for the provision of bio methane, use of the digested slurry
	  ◦ Ethanol production: Process technologies for feedstock containing sugar, starch or celluloses, use of ethanol as a fuel, use of the stillage

Literature	**Kaltschmitt, M.; Hartmann, H. (Hrsg.): Energie aus Biomasse; Springer, Berlin, Heidelberg, 2009, 2. Auflage**

Course L2386: Thermal Biomass Utilization	
Typ	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt, Dr. Isabel Höfer
Language	DE
Cycle	WiSe
Content	The experiments of the practical lab course illustrate the different aspects of heat generation from biogenic solid fuels. First, different biomasses (e.g. wood, straw or agricultural residues) will be investigated; the focus will be on the calorific value of the biomass. Furthermore, the used biomass will be pelletized, the pellet properties analysed and a combustion test carried out on a pellet combustion system. The gaseous and solid pollutant emissions, especially the particulate matter emissions, are measured and the composition of the particulate matter is investigated in a further experiment. Another focus of the practical course is the consideration of options for the reduction of particulate matter emissions from biomass combustion. In the practical course, a method for particulate matter reduction will be developed and tested. All experiments will be evaluated and the results presented. Within the practical lab course the students discuss different technical-scientific tasks, both subject-specifically and interdisciplinary. They discuss various approaches to solving the problem and advise on the theoretical or practical implementation.
Literature	- Kaltschmitt, Martin; Hartmann, Hans; Hofbauer, Hermann: Energie aus Biomasse: Grundlagen, Techniken und Verfahren. 3. Auflage. Berlin Heidelberg: Springer Science & Business Media, 2016. -ISBN 978-3-662-47437-2 - Versuchsskript

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 (small)	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 General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Renewable Energy: Elective Compulsory Data Science: Core Qualification: Elective Compulsory Electrical Engineering: Core Qualification: 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 Green Technologies: Energy, Water, Climate: Specialisation Energy Systems: Elective Compulsory Computational Science and Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Renewable Energies: Core Qualification: 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 (small)
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 M1303: Energy Projects - Development and Assessment

Courses

Title	Typ	Hrs/wk	CP
Development of Renewable Energy Projects (L0003)	Lecture	2	2
Renewable Energy Projects in Emerged Markets (L0014)	Project Seminar	2	2
Economics of an Energy Provision from Renewables (L0005)	Lecture	1	1
Economics of an Energy Provision from Renewables (L0006)	Project Seminar	1	1

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Environmental Assessment
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	By ending this module, students can describe the planning and development of projects using renewable energy sources. Furthermore they are able to explain the special emphasis on the economic and legal aspects in this context. The learning content of the different topics of the module are use-oriented; thus students can apply them i.a. in professional fields of consultation or supervision of energy projects.
Skills	By ending the module the students can apply the learned theoretical foundations of the development of renewable energy projects to exemplary energy projects and can explain technically and conceptually the resulting correlations with respect to legal and economic requirements. As a basis for the design of renewable energy systems they can calculate the demand for thermal and/or electrical energy at operating and regional level. Regarding to this calculation they can choose and dimension possible energy systems. To assess sustainability aspects of renewable energy projects, the students can choose and discuss the right methodology according to the particular task. Through active discussions of various topics within the seminars and exercises 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.
Personal Competence	
Social Competence	Students will be able to edit scientific tasks in the context of the economic analysis of renewable energy projects in a group with a high number of participants and can organize the processing time within the group. They can perform subject-specific and interdisciplinary discussions. Consequently, they can asses the knowledge of their fellow students and are able to deal with feedback on their own performance. Students can present their group results in front of others.
Autonomy	Regarding to the contents of the lectures and to solve the tasks for the economical analysis of renewable energy projects the students are able to exploit sources and acquire the particular knowledge about the subject area independently and self-organized. Based on this expertise they are able to use indenpendently calculation methods for these tasks. Regarding to these calculations, guided by the lecturers, the students can recognize self-organized theri personal level of knowledge.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	2 hours written exam + Written assay from project seminar
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Energy and Bioprocess Technology: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory

Course L0003: Development of Renewable Energy Projects	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	WiSe
Content	• Development of renewable energy projects from the analysis of the local situation to the final energy project: what steps have to be completed in order to implement a successful regenerative energy project and what factors must be considered • Survey of energy demand; methods to collect the demand for thermal and/or electrical energy at operational and regional level until the point of a development of an energy master plan • Technology of renewable energy: how to combine the various options for using renewable energy with different supply situation in the most reasonable way? How can under certain conditions ideal combinations look like? • Feasibility study, requirements and content of a feasibility study • Legal framework for plant construction; representation of authorization rights, including the entire formal procedure for the different approval procedures in the context of the BImSch legislation; further legal requirements (including laws pertaining to construction, water and waterways, noise, etc. • Company structures; which company structure is the most appropriate for the various applications? What are the pros and cons? • Risk management: how the risks of renewable energy projects can be best determined? How the minimizing of risk can be ensured? • Insurance: which kinds of insurance exit? Why do you need insurance? What requirements must be met in order to obtain certain types of insurance for certain renewable energy projects for the construction and operational phase? • Acceptance: how the acceptance of an application for the use of renewable energy can be assessed and improved? How the acceptance can be measured? • Organization of realization of a project: how the construction phase of a renewable energy system is organized after the end of the planning period? • Acceptance: Which are the acceptance steps until the regular continuous operation (VOB acceptance, safety acceptance, approval by authority) • Examples: good and less good examples of project development
Literature	• Script zur Vorlesung mit Literaturhinweisen

Course L0014: Renewable Energy Projects in Emerged Markets	
Typ	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Andreas Wiese
Language	DE
Cycle	WiSe

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 L0005: Economics of an Energy Provision from Renewables	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Andreas Wiese
Language	DE
Cycle	WiSe

Content	• Introduction: definitions; importance of cost and profitability statements for projects in the "Renewable Energies"; prices and costs; efficiency of energy systems versus profitability of individual project
	• Cost estimates and cost calculations
	  ◦ Definitions
	  ◦ Cost calculation
	  ◦ Cost estimation
	  ◦ Calculation of costs for the provision of work and power
	  ◦ Cost summaries for renewable energy technologies
	  ◦ Energy Storage: cost overviews; impact on the cost of renewable energy projects
	• Efficiency calculation
	  ◦ Definitions
	  ◦ Methods: static methods, dynamic methods (eg. LCOE (levelised cost of electricity))
	  ◦ Economic versus national economic approach
	  ◦ Power and work in cost accounting
	  ◦ Energy storage and its influence on the efficiency calculation
	• The due diligence process as an attendant of economic analysis
	• Consideration of uncertainty in projects for renewable energy
	  ◦ Definitions
	  ◦ Technical uncertainty
	  ◦ Cost uncertainties
	  ◦ Other uncertainties
	• Project financing
	  ◦ Definitions
	  ◦ Project -versus corporate finance
	  ◦ Funding models
	  ◦ Equity ratio , DSCR
	  ◦ Treatment of risks in project financing
	  ◦ Funding opportunities for renewable energy projects
	  ◦ Possible funding approaches
	  ◦ Legal requirements in Germany (EEG)
	  ◦ Emissions trading and carbon credits

Literature	Script der Vorlesung

Course L0006: Economics of an Energy Provision from Renewables	
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	WiSe
Content	Calculation of tasks to evaluate the economics of a renewable energy project, with the aim to deepen the complex knowledge of economic analysis and market analysis. Processing is carried out individually or in smaller groups. The following topics are covered: • Stat. and dyn. calculation of profitability • Cost estimate plus stat. and dyn. calculation of profitability • sensitivity analysis • joint production • Grid parity calculation Within the seminar, the various tasks are actively discussed and applied to various cases of application.
Literature	Skript der Vorlesung

Module M1309: Dimensioning and Assessment of Renewable Energy Systems

Courses

Title	Typ	Hrs/wk	CP
Environmental Technology and Energy Economics (L0137)	Project-/problem-based Learning	2	2
Electricity Generation from Renewable Sources of Energy (L0046)	Seminar	2	2
Heat Provision from Renewable Sources of Energy (L0045)	Seminar	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	The students can describe current issue and problems in the field of renewable energies. Furthermore, they can explain aspects in relation to the provision of heat or electricity through different renewable technologies, and explain and assess them in a technical, economical and environmental way.
Skills	Students are able to solve scientific problems in the context of heat and electricity supply using renewable energy systems by: • using module-comprehensive knowledge for different applications, • evaluating alternative input parameter regarding the solution of the task in the case of incomplete information (technical, economical and ecological parameter), • a systematic documentation of the work results in form of a written version, the presentation itself and the defense of contents.
Personal Competence	
Social Competence	Students can • respectfully work together as a team with around 2-3 members, • participate in subject-specific and interdisciplinary discussions in the area of dimensioning and analysis of potentials of heat and electricty supply using renewable energie, and can develop cooperated solutions, • defend their own work results in front of fellow students and • assess the performance of fellow students in comparison to their own performance. Furthermore, they can accept professional constructive criticism.
Autonomy	Students can independently tap knowledge regarding to the given task. They are capable, in consultation with supervisors, to assess their learning level and define further steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance with the potential social, economic and cultural impact.
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	per course: 20 minutes presentation + written report
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory

Course L0137: Environmental Technology and Energy Economics	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	WiSe
Content	• Preliminary discussion with the rules of the lecture • Issue of topics from the field of renewable energy technology in the form of a tender of engineering services to a group of students (depending on the number of participating students) • "Procurement" deal with aspects of the design, costing and environmental, economic and technical evaluation of various energy generation concepts (eg onshore wind power generation, commercial-scale photovoltaic power generation, biogas production, geothermal power and heat generation) under very special circumstances • Submission of a written solution of the task and distribution to the participants by the student / group of students • Presentation of the edited theme (20 min) with PPT presentation and subsequent discussion (20 minutes) • Attendance is mandatory for all seminars
Literature	Eigenständiges Literaturstudium in der Bibliothek und aus anderen Quellen.

Course L0046: Electricity Generation from Renewable Sources of Energy	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	WiSe
Content	• Preliminary discussion with the seminar rules • Distribution of the topics related to the subject of the seminar to individual students / groups of students (depending on the number of participating students) • Delivery of a five-page summary of the seminar topic and distribution to the participants by the student / group of students • Presentation of the processed topic (30 min) with PPT presentation and subsequent discussion (20 minutes) • Attendance is mandatory for all seminars
Literature	• Eigenständiges Literaturstudium in der Bibliothek und aus anderen Quellen.

Course L0045: Heat Provision from Renewable Sources of Energy	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	• Preliminary discussion with the seminar rules • Distribution of the topics related to the subject of the seminar to individual students / groups of students (depending on the number of participating students) • Delivery of a five-page summary of the seminar topic and distribution to the participants by the student / group of students • Presentation of the processed topic (30 min) with PPT presentation and subsequent discussion (20 minutes) • Attendance is mandatory for all seminars
Literature	Eigenständiges Literaturstudium in der Bibliothek und aus anderen Quellen.

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 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 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	Martin Schlecht, Prof. Alf Mews, Roman Fritsches-Baguhl, Paola Pignatelli
Language	DE
Cycle	SoSe
Content	Photovoltaics: 1. Introduction 2. Primary energies and consumption, available solar energy 3. Physics of the ideal solar cell 4. Light absorption, PN transition, characteristic sizes of the solar cell, efficiency 5. Physics of the real solar cell 6. Charge carrier recombination, characteristic curves, barrier layer recombination, equivalent circuit diagram 7. Increasing efficiency 8. Methods for increasing the quantum yield and reducing recombination 9. Hetero- and tandem structures 10. Heterojunction, Schottky, electrochemical, MIS and SIS cell, tandem cell 11. Concentrator cells 12. Concentrator optics and tracking systems, concentrator cells 13. Technology and properties: solar cell types, manufacturing, monocrystalline silicon and gallium arsenide, polycrystalline silicon and silicon thin film cells, thin film cells on carriers (amorphous silicon, CIS, electrochemical cells) 14. Modules 15. Switches Concentrating solar power plants: 1. Introduction 2. Point focused technologies 3. Line focused technologies 4. Design of CSP projects
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 M0513: System Aspects of Renewable Energies

Courses

Title	Typ	Hrs/wk	CP
Fuel Cells, Batteries, and Gas Storage: New Materials for Energy Production and Storage (L0021)	Lecture	2	2
Energy Trading (L0019)	Lecture	1	1
Energy Trading (L0020)	Recitation Section (small)	1	1
Deep Geothermal Energy (L0025)	Lecture	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Module: Technical Thermodynamics I Module: Technical Thermodynamics II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to describe the processes in energy trading and the design of energy markets and can critically evaluate them in relation to current subject specific problems. Furthermore, they are able to explain the basics of thermodynamics of electrochemical energy conversion in fuel cells and can establish and explain the relationship to different types of fuel cells and their respective structure. Students can compare this technology with other energy storage options. In addition, students can give an overview of the procedure and the energetic involvement of deep geothermal energy.
Skills	Students can apply the learned knowledge of storage systems for excessive energy to explain for various energy systems different approaches to ensure a secure energy supply. In particular, they can plan and calculate domestic, commercial and industrial heating equipment using energy storage systems in an energy-efficient way and can assess them in relation to complex power systems. In this context, students can assess the potential and limits of geothermal power plants and explain their operating mode. Furthermore, the students are able to explain the procedures and strategies for marketing of energy and apply it in the context of other modules on renewable energy projects. In this context they can unassistedly carry out analysis and evaluations of energie markets and energy trades.
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 , acquire the particular knowledge about the subject area and transform it to new questions.
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	Bioprocess Engineering: Specialisation A - General Bioprocess 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 International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory

Course L0021: Fuel Cells, Batteries, and Gas Storage: New Materials for Energy Production and Storage	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Fröba
Language	DE
Cycle	SoSe

Content	1. Introduction to electrochemical energy conversion
	2. Function and structure of electrolyte
	3. Low-temperature fuel cell
	  ◦ Types
	  ◦ Thermodynamics of the PEM fuel cell
	  ◦ Cooling and humidification strategy
	4. High-temperature fuel cell
	  ◦ The MCFC
	  ◦ The SOFC
	  ◦ Integration Strategies and partial reforming
	5. Fuels
	  ◦ Supply of fuel
	  ◦ Reforming of natural gas and biogas
	  ◦ Reforming of liquid hydrocarbons
	6. Energetic Integration and control of fuel cell systems

Literature	• Hamann, C.; Vielstich, W.: Elektrochemie 3. Aufl.; Weinheim: Wiley - VCH, 2003

Course L0019: Energy Trading	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Michael Sagorje, Dr. Sven Orlowski
Language	DE
Cycle	SoSe
Content	• Basic concepts and tradable products in energy markets • Primary energy markets • Electricity Markets • European Emissions Trading Scheme • Influence of renewable energy • Real options • Risk management Within the exercise the various tasks are actively discussed and applied to various cases of application.
Literature	

Course L0020: Energy Trading	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Michael Sagorje, Dr. Sven Orlowski
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0025: Deep Geothermal Energy	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Ben Norden
Language	DE
Cycle	SoSe
Content	1. Introduction to the deep geothermal use 2. Geological Basics I 3. Geological Basics II 4. Geology and thermal aspects 5. Rock Physical Aspects 6. Geochemical aspects 7. Exploration of deep geothermal reservoirs 8. Drilling technologies, piping and expansion 9. Borehole Geophysics 10. Underground system characterization and reservoir engineering 11. Microbiology and Upper-day system components 12. Adapted investment concepts, cost and environmental aspect
Literature	• Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012) • www.geo-energy.org • Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2012. • Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013. • Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001) • Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH & Co. KGaA; Auflage: 1. Auflage (19. April 2010)

Module M1308: Modelling and technical design of bio refinery processes

Courses

Title	Typ	Hrs/wk	CP
Biorefineries - Technical Design and Optimization (L1832)	Project-/problem-based Learning	3	3
CAPE in Energy Engineering (L0022)	Projection Course	3	3

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Bachelor degree in Process Engineering, Bioprocess Engineering or Energy- and Environmental Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The tudents can completely design a technical process including mass and energy balances, calculation and layout of different process devices, layout of measurement- and control systems as well as modeling of the overall process. Furthermore, they can describe the basics of the general procedure for the processing of modeling tasks, especially with ASPEN PLUS ® and ASPEN CUSTOM MODELER ®.
Skills	Students are able to simulate and solve scientific task in the context of renewable energy technologies by: • development of modul-comprehensive approaches for the dimensioning and design of production processes • evaluating alternatives input parameter to solve the particular task even with incomplete information, • a systematic documentation of the work results in form of a written version, the presentation itself and the defense of contents. They can use the ASPEN PLUS ® and ASPEN CUSTOM MODELER ® for modeling energy systems and to evaluate the simulation solutions. Through active discussions of various topics within the seminars and exercises 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.
Personal Competence	
Social Competence	Students can • respectfully work together as a team with around 2-3 members, • participate in subject-specific and interdisciplinary discussions in the area of dimensioning and design of production processes, and can develop cooperated solutions, • defend their own work results in front of fellow students and assess the performance of fellow students in comparison to their own performance. Furthermore, they can accept professional constructive criticism.
Autonomy	Students can independently tap knowledge regarding to the given task. They are capable, in consultation with supervisors, to assess their learning level and define further steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance with the potential social, economic and cultural impact.
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	Written report incl. presentation
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Energy and Bioprocess Technology: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory

Course L1832: Biorefineries - Technical Design and Optimization	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Oliver Lüdtke
Language	DE
Cycle	SoSe

Content	**I. Repetition of engineering basics**
	1. Shell and tube heat exchangers
	2. Steam generators and refrigerating machines
	3. Pumps and turbines
	4. Flow in piping networks
	5. Pumping and mixing of non-newtonian fluids
	6. Requirements to a detailed layout plan
	II. Calculation:
	1. Planning and design of a specific bio-refinery plant section, such as Ethanol distillation and fermentation. This is based on empirical valuse of a real, industrial plant.
	  ○ Mass and energy balances (Aspen)
	  ○ Equipment design (heat exchangers, pumps, pipes, tanks, etc.) (
	  ○ Isolation, wall thickness and material selection
	  ○ Energy demand (electrical, heat or cooling), design of steam boilers and appliances
	  ○ Selection of fittings, measuring instruments and safety equipment
	  ○ Definition of main control loops
	2. Hereby, the dependencies of transport phenomena between certain plant sections become evident and methods of calculation are introduced.
	3. In Detail Engineering , it is focused on aspects of plant engineering planning that are relevant for the subsequent construction of the plant.
	4. Depending of time requirement and group size a cost estimation and preparation of a complete R&I flow chart can be implemented as well.

Literature	Perry, R.;Green, R.: Perry's Chemical Engineers' Handbook, 8 th Edition, McGraw Hill Professional, 2007 Sinnot, R. K.: Chemical Engineering Design, Elsevier, 2014

Course L0022: CAPE in Energy Engineering	
Typ	Projection Course
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe

Content	• CAPE = *Computer*-Aided-Project-Engineering
	• INTRODUCTION TO THE THEORY
	  ○ Classes of simulation programs
	  ○ Sequential modular approach
	  ○ Equation-oriented approach
	  ○ Simultaneous modular approach
	  ○ General procedure for the processing of modeling tasks
	  ○ Special procedure for solving models with repatriations
	• COMPUTER EXERCISES renewable energy projects WITH ASPEN PLUS ® AND ASPEN CUSTOM MODELER ®
	  ○ Scope, potential and limitations of Aspen Plus ® and Aspen Custom Modeler ®
	  ○ Use of integrated databases for material data
	  ○ Methods for estimating non-existent physical property data
	  ○ Use of model libraries and Process Synthesis
	  ○ Application of design specifications and sensitivity analyzes
	  ○ Solving optimization problems
	Within the seminar, the various tasks are actively discussed and applied to various cases of application.

Literature	• Aspen Plus® - Aspen Plus User Guide • William L. Luyben; Distillation Design and Control Using Aspen Simulation; ISBN-10: 0-471-77888-5

Module M0511: Electrical Energy from Solar Radiation and Wind Power

Courses

Title	Typ	Hrs/wk	CP
Sustainability Management (L0007)	Lecture	2	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. Isabel Höfer
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 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	2.5 hours written exam + written elaboration (incl. presentation) in sustainability management
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 International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: 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: 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 L0007: Sustainability Management	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl
Language	DE
Cycle	SoSe
Content	The lecture "Sustainability Management" gives an insight into the different aspects and dimensions of sustainability. First, essential terms and definitions, significant developments of the last years, and legal framework conditions are explained. The various aspects of sustainability are then presented and discussed in detail. The lecture mainly focuses on concepts for the implementation of the topic sustainability in companies: • What is "sustainability"? • Why is this concept an important topic for companies? • What opportunities and business risks are addressed or are associated with it? • How can the often mentioned three pillars of sustainability - economy, ecology, and social- be meaningfully integrated into corporate management despite their sometimes contradictory tendencies, and how a corresponding compromise can be found? • What concepts or frameworks exist for the implementation of sustainability management in companies? • Which sustainability labels exist for products or companies? What do they have in common, and where do they differ? Furthermore, the lecture is intended to provide insights into the concrete implementation of sustainability aspects into business practice. External lecturers from companies will be invited to report on how sustainability is integrated into their daily processes. In the course of an independently carried out group work, the students will analyze and discuss the implementation of sustainability aspects based on short case studies. By studying and comparing best practice examples, the students will learn about corporate decisions' effects and implications. It should become clear which risks or opportunities are associated if sustainability aspects are taken into account in management decisions.
Literature	Die folgenden Bücher bieten einen Überblick: Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.

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
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 M0742: Thermal Energy Systems

Courses

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

Module Responsible	Prof. Dr. Arne Speerforck
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	In lectures and exercises, the students can use many examples and experiments to discuss in small groups in a goal-oriented manner, develop a solution and present it. Within the exercises, the students can independently develop further questions and work out targeted solutions.
Autonomy	Students are able to define tasks independently, to develop the necessary knowledge themselves based on the knowledge they have received, and to use suitable means for implementation. In the exercises, the students discuss the methods taught in the lectures using complex tasks and critically analyze 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	60 min
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess 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 Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0023: Thermal Engergy Systems	
Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Dr. Arne Speerforck, 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 Engergy Systems	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Dr. Arne Speerforck
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Specialization Bioenergy Systems

In the specialization "Bioenergy systems" advanced knowledge for the energetic utilisation of biomass is provided. This implicates, inter alia, the processing and use of wood as an energy resource, but also an understanding about procedures and concepts which enable energy recovery from waste.

Module M1343: Structure and properties of fibre-polymer-composites

Courses

Title	Typ	Hrs/wk	CP
Structure and properties of fibre-polymer-composites (L1894)	Lecture	2	3
Structure and properties of fibre-polymer-composites (L2614)	Project-/problem-based Learning	2	2
Structure and properties of fibre-polymer-composites (L2613)	Recitation Section (large)	1	1

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 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Core Qualification: 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

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 L2614: Structure and properties of fibre-polymer-composites	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	
Literature	

Course L2613: Structure and properties of fibre-polymer-composites	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	
Literature	

Module M0518: Waste and Energy

Courses

Title	Typ	Hrs/wk	CP
Waste Recycling Technologies (L0047)	Lecture	2	2
Waste Recycling Technologies (L0048)	Recitation Section (small)	1	2
Waste to Energy (L0049)	Project-/problem-based Learning	2	2

Module Responsible	Prof. Kerstin Kuchta
Admission Requirements	None
Recommended Previous Knowledge	Basics of process engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to describe and explain in detail techniques, processes and concepts for treatment and energy recovery from wastes.
Skills	The students are able to select suitable processes for the treatment and energy recovery of wastes. They can evaluate the efforts and costs for processes and select economically feasible treatment Concepts. Students are able to evaluate alternatives even with incomplete information. Students are able to prepare systematic documentation of work results in form of reports, presentations and are able to defend their findings in a group.
Personal Competence	
Social Competence	Students can participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend their own work results in front of others and promote the scientific development of collegues. Furthermore, they can give and accept professional constructive criticism.
Autonomy	Students can independently tap knowledge of the subject area and transform it to new questions. They are capable, in consultation with supervisors, to assess their learning level and define further steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance with the potential social, economic and cultural impact.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	Compulsory: Yes; Bonus: 20 %; Form: Written elaboration; Description:
Examination	Presentation
Examination duration and scale	PowerPoint presentation (10-15 minutes)
Assignment for the Following Curricula	Environmental Engineering: Specialisation Waste and Energy: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Core Qualification: Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory

Course L0047: Waste Recycling Technologies	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	SoSe
Content	• Fundamentals on primary and secondary production of raw materials (steel, aluminum, phosphorous, copper, precious metals, rare metals) • Use and demand of metals and minerals in industry and society • collection systems and concepts • quota and efficiency • Advanced sorting technologies • mechanical pretreatment • advanced treatment • Chemical analysis of Critical Materials in post-consumer products • Analytical tools in Resource Management (Material Flow Analysis, Recycling Performance Indicators, Criticality Assessment, statistical analysis of uncertainties)
Literature	

Course L0048: Waste Recycling Technologies	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	SoSe
Content	• Fundamentals on primary and secondary production of raw materials (steel, aluminum, phosphorous, copper, precious metals, rare metals) • Use and demand of metals and minerals in industry and society • collection systems and concepts • quota and efficiency • Advanced sorting technologies • mechanical pretreatment • advanced treatment • Chemical analysis of Critical Materials in post-consumer products • Analytical tools in Resource Management (Material Flow Analysis, Recycling Performance Indicators, Criticality Assessment, statistical analysis of uncertainties)
Literature	

Course L0049: Waste to Energy	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Rüdiger Siechau
Language	EN
Cycle	SoSe

Content	• Project-based lecture
	• Introduction into the " Waste to Energy " consisting of:
	  ◦ Thermal Process (incinerator , RDF combustion)
	  ◦ Biological processes (Wet-/Dryfermentation)
	  ◦ technology , energy , emissions, approval , etc.
	• Group work
	  ◦ design of systems/plants for energy recovery from waste
	  ◦ The following points are to be processed :
	  ▪ Input: waste (fraction collection and transportation, current quantity , material flows , possible amount of development)
	  ▪ Plant (design, process diagram , technology, energy production)
	  ▪ Output (energy quantity / type , by-products)
	  ▪ Costs and revenues
	  ▪ Climate and resource protection (CO2 balance , substitution of primary raw materials / fossil fuels)
	  ▪ Location and approval (infrastructure , expiration authorization procedure)
	  ▪ Focus at the whole concept (advantages, disadvantages , risks and opportunities , discussion)
	• Grading: No Exam , but presentation of the results of the working group

Literature	**Literatur:** Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010 Powerpoint-Folien in Stud IP **Literature:** Introduction to Waste Management; Kranert Martin , Klaus Cord - Landwehr (Ed.), Vieweg + Teubner Verlag , 2010 PowerPoint slides in Stud IP

Module M0896: Bioprocess and Biosystems Engineering

Courses

Title	Typ	Hrs/wk	CP
Bioreactor Design and Operation (L1034)	Lecture	2	2
Bioreactors and Biosystems Engineering (L1037)	Project-/problem-based Learning	1	2
Biosystems Engineering (L1036)	Lecture	2	2

Module Responsible	Prof. An-Ping Zeng
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of bioprocess engineering and process engineering at bachelor level
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After completion of this module, participants will be able to: • differentiate between different kinds of bioreactors and describe their key features • identify and characterize the peripheral and control systems of bioreactors • depict integrated biosystems (bioprocesses including up- and downstream processing) • name different sterilization methods and evaluate those in terms of different applications • recall and define the advanced methods of modern systems-biological approaches • connect the multiple "omics"-methods and evaluate their application for biological questions • recall the fundamentals of modeling and simulation of biological networks and biotechnological processes and to discuss their methods • assess and apply methods and theories of genomics, transcriptomics, proteomics and metabolomics in order to quantify and optimize biological processes at molecular and process levels.
Skills	After completion of this module, participants will be able to: • describe different process control strategies for bioreactors and chose them after analysis of characteristics of a given bioprocess • plan and construct a bioreactor system including peripherals from lab to pilot plant scale • adapt a present bioreactor system to a new process and optimize it • develop concepts for integration of bioreactors into bioproduction processes • combine the different modeling methods into an overall modeling approach, to apply these methods to specific problems and to evaluate the achieved results critically • connect all process components of biotechnological processes for a holistic system view.
Personal Competence	
Social Competence	After completion of this module, participants will be able to debate technical questions in small teams to enhance the ability to take position to their own opinions and increase their capacity for teamwork. The students can reflect their specific knowledge orally and discuss it with other students and teachers.
Autonomy	After completion of this module, participants will be able to solve a technical problem in teams of approx. 8-12 persons independently including a presentation of the results. •
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	Compulsory: Yes; Bonus: 20 %; Form: Presentation; Description:
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Environmental Engineering: Specialisation Biotechnology: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Process Engineering: Core Qualification: Compulsory

Course L1034: Bioreactor Design and Operation	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. An-Ping Zeng, Dr. Johannes Möller
Language	EN
Cycle	SoSe
Content	**Design of bioreactors and peripheries:** • reactor types and geometry • materials and surface treatment • agitation system design • insertion of stirrer • sealings • fittings and valves • peripherals • materials • standardization • demonstration in laboratory and pilot plant **Sterile operation:** • theory of sterilisation processes • different sterilisation methods • sterilisation of reactor and probes • industrial sterile test, automated sterilisation • introduction of biological material • autoclaves • continuous sterilisation of fluids • deep bed filters, tangential flow filters • demonstration and practice in pilot plant **Instrumentation and control:** • temperature control and heat exchange • dissolved oxygen control and mass transfer • aeration and mixing • used gassing units and gassing strategies • control of agitation and power input • pH and reactor volume, foaming, membrane gassing **Bioreactor selection and scale-up:** • selection criteria • scale-up and scale-down • reactors for mammalian cell culture **Integrated biosystem:** • interactions and integration of microorganisms, bioreactor and downstream processing • Miniplant technologies **Team work with presentation:** • Operation mode of selected bioprocesses (e.g. fundamentals of batch, fed-batch and continuous cultivation)
Literature	• Storhas, Winfried, Bioreaktoren und periphere Einrichtungen, Braunschweig: Vieweg, 1994 • Chmiel, Horst, Bioprozeßtechnik; Springer 2011 • Krahe, Martin, Biochemical Engineering, Ullmann‘s Encyclopedia of Industrial Chemistry • Pauline M. Doran, Bioprocess Engineering Principles, Second Edition, Academic Press, 2013 • Other lecture materials to be distributed

Course L1037: Bioreactors and Biosystems Engineering	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. An-Ping Zeng, Dr. Johannes Möller
Language	EN
Cycle	SoSe
Content	**Introduction to Biosystems Engineering (Exercise)** **Experimental basis and methods for biosystems analysis** • Introduction to genomics, transcriptomics and proteomics • More detailed treatment of metabolomics • Determination of in-vivo kinetics • Techniques for rapid sampling • Quenching and extraction • Analytical methods for determination of metabolite concentrations **Analysis, modelling and simulation of biological networks** • Metabolic flux analysis • Introduction • Isotope labelling • Elementary flux modes • Mechanistic and structural network models • Regulatory networks • Systems analysis • Structural network analysis • Linear and non-linear dynamic systems • Sensitivity analysis (metabolic control analysis) **Modelling and simulation for bioprocess engineering** • Modelling of bioreactors • Dynamic behaviour of bioprocesses **Selected projects for biosystems engineering** • Miniaturisation of bioreaction systems • Miniplant technology for the integration of biosynthesis and downstream processin • Technical and economic overall assessment of bioproduction processes
Literature	E. Klipp et al. Systems Biology in Practice, Wiley-VCH, 2006 R. Dohrn: Miniplant-Technik, Wiley-VCH, 2006 G.N. Stephanopoulos et. al.: Metabolic Engineering, Academic Press, 1998 I.J. Dunn et. al.: Biological Reaction Engineering, Wiley-VCH, 2003 Lecture materials to be distributed

Course L1036: Biosystems Engineering	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. An-Ping Zeng
Language	EN
Cycle	SoSe
Content	**Introduction to Biosystems Engineering** **Experimental basis and methods for biosystems analysis** • Introduction to genomics, transcriptomics and proteomics • More detailed treatment of metabolomics • Determination of in-vivo kinetics • Techniques for rapid sampling • Quenching and extraction • Analytical methods for determination of metabolite concentrations **Analysis, modelling and simulation of biological networks** • Metabolic flux analysis • Introduction • Isotope labelling • Elementary flux modes • Mechanistic and structural network models • Regulatory networks • Systems analysis • Structural network analysis • Linear and non-linear dynamic systems • Sensitivity analysis (metabolic control analysis) **Modelling and simulation for bioprocess engineering** • Modelling of bioreactors • Dynamic behaviour of bioprocesses **Selected projects for biosystems engineering** • Miniaturisation of bioreaction systems • Miniplant technology for the integration of biosynthesis and downstream processin • Technical and economic overall assessment of bioproduction processes
Literature	E. Klipp et al. Systems Biology in Practice, Wiley-VCH, 2006 R. Dohrn: Miniplant-Technik, Wiley-VCH, 2006 G.N. Stephanopoulos et. al.: Metabolic Engineering, Academic Press, 1998 I.J. Dunn et. al.: Biological Reaction Engineering, Wiley-VCH, 2003 Lecture materials to be distributed

Module M0749: Waste Treatment and Solid Matter Process Technology

Courses

Title	Typ	Hrs/wk	CP
Solid Matter Process Technology for Biomass (L0052)	Lecture	2	2
Thermal Waste Treatment (L0320)	Lecture	2	2
Thermal Waste Treatment (L1177)	Recitation Section (large)	1	2

Module Responsible	Prof. Kerstin Kuchta
Admission Requirements	None
Recommended Previous Knowledge	Basics of • thermo dynamics • fluid dynamics • chemistry
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can name, describe current issue and problems in the field of thermal waste treatment and particle process engineering and contemplate them in the context of their field. The industrial application of unit operations as part of process engineering is explained by actual examples of waste incineration technologies and solid biomass processes. Compostion, particle sizes, transportation and dosing, drying and agglomeration of renewable resources and wastes are described as important unit operations when producing solid fuels and bioethanol, producing and refining edible oils, electricity , heat and mineral recyclables.
Skills	The students are able to select suitable processes for the treatment of wastes or raw material with respect to their characteristics and the process aims. They can evaluate the efforts and costs for processes and select economically feasible treatment concepts.
Personal Competence	
Social Competence	Students can • respectfully work together as a team and discuss technical tasks • participate in subject-specific and interdisciplinary discussions, • develop cooperated solutions • promote the scientific development and accept professional constructive criticism.
Autonomy	Students can independently tap knowledge of the subject area and transform it to new questions. They are capable, in consultation with supervisors, to assess their learning level and define further steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance with the potential social, economic and cultural impact.
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	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: 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 L0052: Solid Matter Process Technology for Biomass	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Werner Sitzmann
Language	DE
Cycle	SoSe
Content	The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC - products. Aspects of explosion protection and plant design complete the lecture.
Literature	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4 Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe, Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175

Course L0320: Thermal Waste Treatment	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	SoSe
Content	• Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals • basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition • Incineration techniques: grate firing, ash transfer, boiler • Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination • Ash treatment: Mass, quality, treatment concepts, recycling, disposal
Literature	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

Course L1177: Thermal Waste Treatment	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1709: Applied optimization in energy and process engineering

Courses

Title	Typ	Hrs/wk	CP
Applied optimization in energy and process engineering (L2693)	Integrated Lecture	2	3
Applied optimization in energy and process engineering (L2695)	Recitation Section (small)	2	3

Module Responsible	Prof. Mirko Skiborowski
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals in the field of mathematical modeling and numerical mathematics, as well as a basic understanding of process engineering processes. In particular the contents of the module Process and Plant Engineering II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The module provides a general introduction to the basics of applied mathematical optimization and deals with application areas on different scales from the identification of kinetic models, to the optimal design of unit operations and the optimization of entire (sub)processes, as well as production planning. In addition to the basic classification and formulation of optimization problems, different solution approaches are discussed and tested during the exercises. Besides deterministic gradient-based methods, metaheuristics such as evolutionary and genetic algorithms and their application are discussed as well. • Introduction to Applied Optimization • Formulation of optimization problems • Linear Optimization • Nonlinear Optimization • Mixed-integer (non)linear optimization • Multi-objective optimization • Global optimization
Skills	After successful participation in the module "Applied Optimization in Energy and Process Engineering", students are able to formulate the different types of optimization problems and to select appropriate solution methods in suitable software such as Matlab and GAMS and to develop improved solution strategies. Furthermore, students will be able to interpret and critically examine the results accordingly.
Personal Competence	
Social Competence	Students are capable of: •develop solutions in heterogeneous small groups
Autonomy	Students are capable of: •taping new knowledge on a special subject by literature research
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	35 min
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory

Course L2693: Applied optimization in energy and process engineering	
Typ	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mirko Skiborowski
Language	DE/EN
Cycle	SoSe
Content	The lecture offers a general introduction to the basics and possibilities of applied mathematical optimization and deals with application areas on different scales from kinetics identification, optimal design of unit operations to the optimization of entire (sub)processes, and production planning. In addition to the basic classification and formulation of optimization problems, different solution approaches are discussed. Besides deterministic gradient-based methods, metaheuristics such as evolutionary and genetic algorithms and their application are discussed as well. - Introduction to Applied Optimization - Formulation of optimization problems - Linear Optimization - Nonlinear Optimization - Mixed-integer (non)linear optimization - Multi-objective optimization - Global optimization
Literature	Weicker, K., Evolutionäre Algortihmen, Springer, 2015 Edgar, T. F., Himmelblau D. M., Lasdon, L. S., Optimization of Chemical Processes, McGraw Hill, 2001 Biegler, L. Nonlinear Programming - Concepts, Algorithms, and Applications to Chemical Processes, 2010 Kallrath, J. Gemischt-ganzzahlige Optimierung: Modellierung in der Praxis, Vieweg, 2002

Course L2695: Applied optimization in energy and process engineering	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mirko Skiborowski
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0902: Wastewater Treatment and Air Pollution Abatement

Courses

Title	Typ	Hrs/wk	CP
Biological Wastewater Treatment (L0517)	Lecture	2	3
Air Pollution Abatement (L0203)	Lecture	2	3

Module Responsible	Dr. Swantje Pietsch-Braune
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of biology and chemistry Basic knowledge of solids process engineering and separation technology
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completion of the module students are able to • name and explain biological processes for waste water treatment, • characterize waste water and sewage sludge, • discuss legal regulations in the area of emissions and air quality • explain the effects of air pollutants on the environment, • name and explan off gas tretament processes and to define their area of application
Skills	Students are able to • choose and design processs steps for the biological waste water treatment • combine processes for cleaning of off-gases depending on the pollutants contained in the gases
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	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Environmental Engineering: Specialisation Waste and Energy: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Water: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Compulsory Water and Environmental Engineering: Specialisation Cities: Compulsory

Course L0517: Biological Wastewater Treatment

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	DE/EN
Cycle	WiSe
Content	Charaterisation of Wastewater Metobolism of Microorganisms Kinetic of mirobiotic processes Calculation of bioreactor for wastewater treatment Concepts of Wastewater treatment Design of WWTP Excursion to a WWTP Biofilms Biofim Reactors Anaerobic Wastewater and sldge treatment resources oriented sanitation technology Future challenges of wastewater treatment

Literature	**Gujer, Willi** Siedlungswasserwirtschaft : mit 84 Tabellen ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv?id=2842122&prov=M&dok_var=1&dok_ext=htm Berlin [u.a.] : Springer, 2007 TUB_HH_Katalog **Henze, Mogens** Wastewater treatment : biological and chemical processes ISBN: 3540422285 (Pp.) Berlin [u.a.] : Springer, 2002 TUB_HH_Katalog **Imhoff, Karl** (Imhoff, Klaus R.;) Taschenbuch der Stadtentwässerung : mit 10 Tafeln ISBN: 3486263331 ((Gb.)) München [u.a.] : Oldenbourg, 1999 TUB_HH_Katalog **Lange, Jörg** (Otterpohl, Ralf; Steger-Hartmann, Thomas;) Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334 Donaueschingen-Pfohren : Mall-Beton-Verl., 2000 TUB_HH_Katalog **Mudrack, Klaus** (Kunst, Sabine;) Biologie der Abwasserreinigung : 18 Tabellen ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903 Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003 TUB_HH_Katalog **Tchobanoglous, George** (Metcalf & Eddy, Inc., ;) Wastewater engineering : treatment and reuse ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk)) Boston [u.a.] : McGraw-Hill, 2003 TUB_HH_Katalog **Henze, Mogens** Activated sludge models ASM1, ASM2, ASM2d and ASM3 ISBN: 1900222248 London : IWA Publ., 2002 TUB_HH_Katalog **Kunz, Peter** Umwelt-Bioverfahrenstechnik Vieweg, 1992 **Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt** (Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall, ;) Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe aus der Abwasserbehandlung, Kleinkläranlagen ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL: http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf Weimar : Universitätsverl, 2006 TUB_HH_Katalog **Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall** DWA-Regelwerk Hennef : DWA, 2004 TUB_HH_Katalog **Wiesmann, Udo** (Choi, In Su; Dombrowski, Eva-Maria;) Fundamentals of biological wastewater treatment ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm Weinheim : WILEY-VCH, 2007 TUB_HH_Katalog

Course L0203: Air Pollution Abatement	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Swantje Pietsch-Braune, Christian Eichler
Language	EN
Cycle	WiSe
Content	In the lecture methods for the reduction of emissions from industrial plants are treated. At the beginning a short survey of the different forms of air pollutants is given. In the second part physical principals for the removal of particulate and gaseous pollutants form flue gases are treated. Industrial applications of these principles are demonstrated with examples showing the removal of specific compounds, e.g. sulfur or mercury from flue gases of incinerators.
Literature	Handbook of air pollution prevention and control, Nicholas P. Cheremisinoff. - Amsterdam [u.a.] : Butterworth-Heinemann, 2002 Atmospheric pollution : history, science, and regulation, Mark Zachary Jacobson. - Cambridge [u.a.] : Cambridge Univ. Press, 2002 Air pollution control technology handbook, Karl B. Schnelle. - Boca Raton [u.a.] : CRC Press, c 2002 Air pollution, Jeremy Colls. - 2. ed. - London [u.a.] : Spon, 2002

Module M0900: Examples in Solid Process Engineering

Courses

Title	Typ	Hrs/wk	CP
Fluidization Technology (L0431)	Lecture	2	2
Practical Course Fluidization Technology (L1369)	Practical Course	1	1
Technical Applications of Particle Technology (L0955)	Lecture	2	2
Exercises in Fluidization Technology (L1372)	Recitation Section (small)	1	1

Module Responsible	Prof. Stefan Heinrich
Admission Requirements	None
Recommended Previous Knowledge	Knowledge from the module particle technology
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After completion of the module the students will be able to describe based on examples the assembly of solids engineering processes consisting of multiple apparatuses and subprocesses. They are able to describe the coaction and interrelation of subprocesses.
Skills	Students are able to analyze tasks in the field of solids process engineering and to combine suitable subprocesses in a process chain.
Personal Competence	
Social Competence	Students are able to discuss technical problems in a scientific manner.
Autonomy	Students are able to acquire scientific knowledge independently and discuss technical problems in a scientific manner.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: Yes; Bonus: None; Form: Written elaboration; Description: drei Berichte (pro Versuch ein Bericht) à 5-10 Seiten
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0431: Fluidization Technology

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Stefan Heinrich
Language	EN
Cycle	WiSe
Content	Introduction: definition, fluidization regimes, comparison with other types of gas/solids reactors Typical fluidized bed applications Fluidmechanical principle Local fluid mechanics of gas/solid fluidization Fast fluidization (circulating fluidized bed) Entrainment Solids mixing in fluidized beds Application of fluidized beds to granulation and drying processes
Literature	Kunii, D.; Levenspiel, O.: Fluidization Engineering. Butterworth Heinemann, Boston, 1991.

Course L1369: Practical Course Fluidization Technology	
Typ	Practical Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Heinrich
Language	EN
Cycle	WiSe
Content	Experiments: • Determination of the minimum fluidization velocity • heat transfer • granulation • drying
Literature	Kunii, D.; Levenspiel, O.: Fluidization Engineering. Butterworth Heinemann, Boston, 1991.

Course L0955: Technical Applications of Particle Technology	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Werner Sitzmann
Language	DE
Cycle	WiSe
Content	Unit operations like mixing, separation, agglomeration and size reduction are discussed concerning their technical applicability from the perspective of the practician. Machines and apparatuses are presented, their designs and modes of action are explained and their application in production processes for chemicals, food and feed and in recycling processes are illustrated.
Literature	Stieß M: Mechanische Verfahrenstechnik I und II, Springer - Verlag, 1997

Course L1372: Exercises in Fluidization Technology	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Heinrich
Language	EN
Cycle	WiSe
Content	Exercises and calculation examples for the lecture Fluidization Technology
Literature	Kunii, D.; Levenspiel, O.: Fluidization Engineering. Butterworth Heinemann, Boston, 1991.

Module M1424: Integration of Renewable Energies

Courses

Title	Typ	Hrs/wk	CP
Integration of Renewable Energies I (L2049)	Lecture	1	1
Integration of Renewable Energies I (L2050)	Recitation Section (small)	1	1
Integration of Renewable Energies II (L2051)	Lecture	1	1
Integration of Renewable Energies II (L2052)	Recitation Section (small)	1	1
Sustainable Mobility (L0010)	Lecture	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals of renewable energies and the energy system
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	With the completion of the module the students are able to use and apply the previously learned technical basics of the different fields of renewable energies. Current problems concerning the integration of renewable energies in the energy system are presented and analyzed. In particular, the sectors electricity, heat and mobility will be addressed, giving students insights into sector coupling activities.
Skills	By completing this module, students can apply the basics learned to various sector coupling problems and, in this context, assess the potentials as well as the limits of sector coupling in the German energy system. In particular, the students should use the application and linking of already learned methods and knowledge here, so that a vision of the different technologies is achieved.
Personal Competence	
Social Competence	The students will be able to discuss problems in the areas of sector coupling and the integration of renewable energies.
Autonomy	The students are able to acquire own sources based on the main topics of the lecture and to increase their knowledge. Furthermore, the students can search further technologies and interconnection possibilities for the energy system itself.
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	Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory

Course L2049: Integration of Renewable Energies I	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	WiSe
Content	1. Introduction 2. Fossil-dominated energy system 3. Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity 5. Integration of renewables - electricity I 6. Integration of renewables - electricity II 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat II 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - mobility 12. Communications technology and control engineering 13. Reduction in consumption 14. Load management 15. Interaction of renewable generation and controlled reduction in demand
Literature	• D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer,Cham, Heielberg, New York, Dordrecht, London, 2015 • R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttgart 1965 • K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016 • M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Auflage, Springer

Course L2050: Integration of Renewable Energies I	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L2051: Integration of Renewable Energies II	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	SoSe
Content	1. Introduction 2. Power-to-Hydrogen 3. Power-to-Gas 4. Power-to-Liquid 5. Power-to-Heat 6. Hybrid Technologies 7. Combined Technology Concepts I 8. Combined Technology Concepts II 9. Link-up with renewable industrial production 10. Utilization of residual materials from renewable energy provision 11. Biomass as system stabilizer I 12. Biomass as system stabilizer II 13. System modelling - fundamentals 14. System modelling - approaches and results 15. Planning tools
Literature	• D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer,Cham, Heielberg, New York, Dordrecht, London, 2015 • R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttgart 1965 • K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016 • M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Auflage, Springer Berlin Heidelberg, 2006 • Bundesministerium für Wirtschaft und Energie: Die Energie der Zukunft.

Course L2052: Integration of Renewable Energies II	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0010: Sustainable Mobility	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Karsten Wilbrand
Language	DE
Cycle	SoSe
Content	• Global megatrends and future challenges of energy supply • Energy Scenarios to 2060 and importance for the mobility sector • Sustainable air, sea, rail and road traffic • Developments in vehicle and drive technology • Overview of Today's fuels (production and use) • Biofuels of 1 and 2 Generation (availability, production, compatibility) • Natural gas (GTL, CNG, LNG) • Electromobility based on batteries and hydrogen fuel cell • Well-to-Wheel CO2 analysis of the various options • Legal framework for people and freight
Literature	• Eigene Unterlagen • Veröffentlichungen • Fachliteratur

Module M1354: Advanced Fuels

Courses

Title	Typ	Hrs/wk	CP
Second generation biofuels and electricity based fuels (L2414)	Lecture	2	2
Carbon dioxide as an economic determinant in the mobility sector (L1926)	Lecture	1	1
Mobility and climate protection (L2416)	Recitation Section (small)	2	2
Sustainability aspects and regulatory framework (L2415)	Lecture	1	1

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Bachelor degree in Process Engineering, Bioprocess Engineering or Energy- and Environmental Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Within the module, students learn about different provision pathways for the production of advanced fuels (biofuels like e.g. alcohol-to-jet; electricity-based fuels like e.g. power-to-liquid). The different processes chains are explained and the regulatory framework for sustainable fuel production is examined. This includes, for example, the requirements of the Renewable Energies Directive II and the conditions and aspects for a market ramp-up of these fuels. For the holistic assessment of the various fuel options, they are also examined under environmental and economic factors.
Skills	After successfully participating, the students are able to solve simulation and application tasks of renewable energy technology: • Module-spanning solutions for the design and presentation of fuel production processes resp. the fuel provision chains • Comprehensive analysis of various fuel production options in technical, ecological and economic terms Through active discussions of the various topics within the lectures and exercises of the module, the students improve their understanding and application of the theoretical foundations and are thus able to transfer the learned to the practice.
Personal Competence	
Social Competence	The students can discuss scientific tasks in a subject-specific and interdisciplinary way and develop joint solutions.
Autonomy	The students are able to access independent sources about the questions to be addressed and to acquire the necessary knowledge. They are able to assess their respective learning situation concretely in consultation with their supervisor and to define further questions and solutions.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: Yes; Bonus: 20 %; Form: Written elaboration; Description: Details werden in der ersten Veranstaltung bekannt gegeben.
Examination	Written exam
Examination duration and scale	2 hours written exam
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory

Course L2414: Second generation biofuels and electricity based fuels

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE/EN
Cycle	WiSe
Content	• General overview of various power-based fuels and their process paths, including power-to-liquid process (Fischer-Tropsch synthesis, methanol synthesis), power-to-gas (Sabatier process) • Origin, production and use of these fuels
Literature	• Vorlesungsskript

Course L1926: Carbon dioxide as an economic determinant in the mobility sector	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Karsten Wilbrand
Language	DE/EN
Cycle	WiSe
Content	• General overview of various advanced biofuels and their process pathways (including gas-to-liquid, HEFA and Alcohol-to-Jet processes) • Origin, production and use of these fuels
Literature	• Babu, V.: Biofuels Production. Beverly, Mass: Scrivener [u.a.], 2013 • Olsson, L.: Biofuels. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg, 2007 • William, L. L.: Distillation Design and Control Using Aspen Simulation; ISBN-10: 0-471-77888-5 • Perry, R.; Green, R.: Perry's Chemical Engineers' Handbook, 8th Edition, McGraw Hill Professional, 20 • Sinnot, R. K.: Chemical Engineering Design, Elsevier, 2014 • Kaltschmitt, M.; Neuling, U. (Ed.): Biokerosene - Status and Prospects; Springer, Berlin, Heidelberg, 2018

Course L2416: Mobility and climate protection	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Benedikt Buchspies, Dr. Karsten Wilbrand
Language	DE/EN
Cycle	WiSe
Content	Application of the acquired theoretical knowledge from the respective lectures on the basis of concrete tasks from practice • Design and simulation of sub-processes of production processes in Aspen Plus ® • Ecological and economic analysis of fuel supply paths • Classification of case studies into applicable regulations
Literature	• Skriptum zur Vorlesung • Aspen Plus® - Aspen Plus User Guide

Course L2415: Sustainability aspects and regulatory framework	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Benedikt Buchspies
Language	DE/EN
Cycle	WiSe
Content	Holistic examination of the different fuel paths with the following main topics, among others: • Consideration of the environmental impact of the various alternative fuels • Economic consideration of the different alternative fuels • Regulatory framework for alternative fuels • Certification of alternative fuels • Market introduction models of alternative fuels
Literature	• European Commission - Joint Research Center (2010): International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Joint Research Center (JRC) Institut for Environment and Sustainability, Luxembourg • Richtlinie (EU) 2018/2001 des Europäischen Parlaments und des Rates vom 11. Dezember 2018 zur Förderung der Nutzung von Energie aus erneuerbaren Quellen

Specialization Solar Energy Systems

Within the specialization "Solar Energy Systems" further knowledge is gained in the theoretical functioning of photovoltaic cells and the properties of used materials. In addition, further information on the design, management and optimization of electrical energy systems are part in this specialization in order to demonstrate and evaluate the challenges of using solar energy systems in existing networks.

Within the specialization "Solar Energy Systems", students have been given the opportunity to study abroad at the "University of Jordan" in Amman, Jordan. Within this foreign stay, additional modules in the field of "solar energy systems" can be choosen. The earned ECTS are recognized at TUHH by agreement.

In addition, students in the "Solar Energy Systems" course can take the module "Modeling and Simulation of Building Integrated Solar Energy Systems" in cooperation with the International Hellenic University in Thessaloniki, Greece, which can be recognized by TUHH. The Exchange is also encouraged.

Students, who are planning to choose the specialization "Solar Energy Systems" are kindly requested to contact the head of the program early for further information about the course of studies and their stay abroad.

Module M1343: Structure and properties of fibre-polymer-composites

Courses

Title	Typ	Hrs/wk	CP
Structure and properties of fibre-polymer-composites (L1894)	Lecture	2	3
Structure and properties of fibre-polymer-composites (L2614)	Project-/problem-based Learning	2	2
Structure and properties of fibre-polymer-composites (L2613)	Recitation Section (large)	1	1

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 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Core Qualification: 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

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 L2614: Structure and properties of fibre-polymer-composites	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	
Literature	

Course L2613: Structure and properties of fibre-polymer-composites	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	
Literature	

Module M0643: Optoelectronics I - Wave Optics

Courses

Title	Typ	Hrs/wk	CP
Optoelectronics I: Wave Optics (L0359)	Lecture	2	3
Optoelectronics I: Wave Optics (Problem Solving Course) (L0361)	Recitation Section (small)	1	1

Module Responsible	Dr. Alexander Petrov
Admission Requirements	None
Recommended Previous Knowledge	Basics in electrodynamics, calculus
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain the fundamental mathematical and physical relations of freely propagating optical waves. They can give an overview on wave optical phenomena such as diffraction, reflection and refraction, etc. Students can describe waveoptics based components such as electrooptical modulators in an application oriented way.
Skills	Students can generate models and derive mathematical descriptions in relation to free optical wave propagation. They can derive approximative solutions and judge factors influential on the components' performance.
Personal Competence	
Social Competence	Students can jointly solve subject related problems in groups. They can present their results effectively within the framework of the problem solving course.
Autonomy	Students are capable to extract relevant information from the provided references and to relate this information to the content of the lecture. They can reflect their acquired level of expertise with the help of lecture accompanying measures such as exam typical exam questions. Students are able to connect their knowledge with that acquired from other lectures.
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Credit points	4
Course achievement	None
Examination	Written exam
Examination duration and scale	60 minutes
Assignment for the Following Curricula	Electrical Engineering: Specialisation Nanoelectronics and Microsystems Technology: Elective Compulsory Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Microelectronics and Microsystems: Specialisation Microelectronics Complements: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory

Course L0359: Optoelectronics I: Wave Optics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Alexander Petrov
Language	EN
Cycle	SoSe
Content	• Introduction to optics • Electromagnetic theory of light • Interference • Coherence • Diffraction • Fourier optics • Polarisation and Crystal optics • Matrix formalism • Reflection and transmission • Complex refractive index • Dispersion • Modulation and switching of light
Literature	Bahaa E. A. Saleh, Malvin Carl Teich, Fundamentals of Photonics, Wiley 2007 Hecht, E., Optics, Benjamin Cummings, 2001 Goodman, J.W. Statistical Optics, Wiley, 2000 Lauterborn, W., Kurz, T., Coherent Optics: Fundamentals and Applications, Springer, 2002

Course L0361: Optoelectronics I: Wave Optics (Problem Solving Course)	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Alexander Petrov
Language	EN
Cycle	SoSe
Content	see lecture Optoelectronics 1 - Wave Optics
Literature	see lecture Optoelectronics 1 - Wave Optics

Module M0932: Process Measurement Engineering

Courses

Title	Typ	Hrs/wk	CP
Process Measurement Engineering (L1077)	Lecture	2	3
Process Measurement Engineering (L1083)	Recitation Section (large)	1	1

Module Responsible	Prof. Roland Harig
Admission Requirements	None
Recommended Previous Knowledge	Fundamental principles of electrical engineering and measurement technology
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students possess an understanding of complex, state-of-the-art process measurement equipment. They can relate devices and procedures to a variety of commonly used measurement and communications technology.
Skills	The students are capable of modeling and evaluating complex systems of sensing devices as well as associated communications systems. An emphasis is placed on a system-oriented understanding of the measurement equipment.
Personal Competence	
Social Competence	Students can communicate the discussed technologies using the English language.
Autonomy	Students are capable of gathering necessary information from provided references and relate this information to the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture. Based on respective feedback, students are expected to adjust their individual learning process. They are able to draw connections between their knowledge obtained in this lecture and the content of other lectures (e.g. Fundamentals of Electrical Engineering, Analysis, Stochastic Processes, Communication Systems).
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Credit points	4
Course achievement	None
Examination	Oral exam
Examination duration and scale	45 min
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory

Course L1077: Process Measurement Engineering	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Roland Harig
Language	DE/EN
Cycle	SoSe

Content	• Process measurement engineering in the context of process control engineering
	  ◦ Challenges of process measurement engineering
	  ◦ Instrumentation of processes
	  ◦ Classification of pickups
	• Systems theory in process measurement engineering
	  ◦ Generic linear description of pickups
	  ◦ Mathematical description of two-port systems
	  ◦ Fourier and Laplace transformation
	• Correlational measurement
	  ◦ Wide band signals
	  ◦ Auto- and cross-correlation function and their applications
	  ◦ Fault-free operation of correlational methods
	• Transmission of analog and digital measurement signals
	  ◦ Modulation process (amplitude and frequency modulation)
	  ◦ Multiplexing
	  ◦ Analog to digital converter

Literature	- Färber: „Prozeßrechentechnik“, Springer-Verlag 1994 - Kiencke, Kronmüller: „Meßtechnik“, Springer Verlag Berlin Heidelberg, 1995 - A. Ambardar: „Analog and Digital Signal Processing“ (1), PWS Publishing Company, 1995, NTC 339 - A. Papoulis: „Signal Analysis“ (1), McGraw-Hill, 1987, NTC 312 (LB) - M. Schwartz: „Information Transmission, Modulation and Noise“ (3,4), McGraw-Hill, 1980, 2402095 - S. Haykin: „Communication Systems“ (1,3), Wiley&Sons, 1983, 2419072 - H. Sheingold: „Analog-Digital Conversion Handbook“ (5), Prentice-Hall, 1986, 2440072 - J. Fraden: „AIP Handbook of Modern Sensors“ (5,6), American Institute of Physics, 1993, MTB 346

Course L1083: Process Measurement Engineering	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Roland Harig
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1425: Power electronics

Courses

Title	Typ	Hrs/wk	CP
Power electronics (L2053)	Lecture	2	4
Power electronics (L2054)	Recitation Section (small)	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Basics of Electrical Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are taught the basics of power converter technology and modern power electronics. Furthermore, the essential properties of conventional and modern power semiconductors will be presented and their driving techniques will be presented. The students also learn about the most important circuit topologies of self-commutated power converters and their control methods.
Skills	In addition to the basics of power converter commutation, the students learn methods for determining the on-state and switching losses of the components. Using simple examples, the participants will learn methods for the mathematical description of the transmission behavior of power electronic circuits.
Personal Competence	
Social Competence	Students will be able to discuss problems in related topics in the field of photovoltaics and power electronics with fellow students.
Autonomy	The students can independently access sources based on the main topics of the lectures and transfer the acquired knowledge to a wider field
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	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory

Course L2053: Power electronics

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Klaus Hoffmann
Language	DE
Cycle	SoSe

Content	• Fundamentals of power electronics
	  ◦ Classification of the power converters according to their internal and external mode of operation
	  ◦ Presentation of modern converter systems
	• Introduction of power semiconductors
	  ◦ Fields of application and limits of use of modern power semiconductors
	  ◦ Power diodes and conventional power semiconductors (thyristor and GTO)
	  ◦ Modern power semiconductors: power MOSFET, IGBT and IGCT
	  ◦ On-state and switching losses
	  ◦ Commutation processes in modern power converter circuits
	  ◦ Development trends in the field of power semiconductors
	• Introduction to self-commutated converter circuits
	  ◦ DC converter with turn-off power semiconductors
	  ◦ Control method (pulse width modulation, tolerance band control)
	  ◦ H-bridge topology with modern turn-off power semiconductors in clocked inverter and rectifier operation
	  ◦ Three-phase bridge circuit with modern turn-off power semiconductors
	• Brief introduction to the line-commutated converter circuits

Literature	Hilfsblätter und Literaturhinweise werden im Rahmen der Vorlesung ausgeteilt.

Course L2054: Power electronics	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Klaus Hoffmann
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1287: Risk Management, Hydrogen and Fuel Cell Technology

Courses

Title	Typ	Hrs/wk	CP
Applied Fuel Cell Technology (L1831)	Lecture	2	2
Risk Management in the Energy Industry (L1748)	Lecture	2	2
Hydrogen Technology (L0060)	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 completion of this module students can explain basics of risk management involving thematical adjacent contexts and can describe an optimal management of energy systems. Furthermore, students can reproduce solid theoretical knowledge about the potentials and applications of new information technologies in logistics and explain technical aspects of the use, production and processing of hydrogen.
Skills	With completion of this module students are able to evaluate risks of energy systems with respect to energy economic conditions in an efficient way. This includes that the students can assess the risks in operational planning of power plants from a technical, economic and ecological perspective. In this context, students can evaluate the potentials of logistics and information technology in particular on energy issues. In addition, students are able to describe the energy transfer medium hydrogen according to its applications, the given security and its existing service capacities and limits as well as to evaluate these aspects from a technical, environmental and economic perspective.
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 on the emphasis of the lectures and acquire the contained knowledge. In this way, they can recognize their lacks of knowledge 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	Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory

Course L1831: Applied Fuel Cell Technology

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	SoSe
Content	The lecture provide an insight into the various possibilities of fuel cells in the energy system (electricity, heat and transport). These are presented and discussed for individual fuel types and application-oriented requirements; also compared with alternative technologies in the system. These different possibilities will be presented regardind the state-of-the-art development of the technologies and exemplary applications from Germany and worldwide. Also the emerging trends and lines of development will be discussed. Besides to the technical aspects, which are the focus of the event, also energy, environmental and industrial policy aspects are discussed - also in the context of changing circumstances in the German and international energy system.
Literature	Vorlesungsunterlagen

Course L1748: Risk Management in the Energy Industry	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Christian Wulf
Language	DE
Cycle	SoSe

Content	• Basics of risk management
	  ◦ Definition of terms
	  ◦ Risk types
	  ◦ Risk management process
	  ◦ Enterprise risk management
	• Markets and instruments in energy trading
	  ◦ Basics of futures and spot trading
	  ◦ Notation in energy markets
	  ◦ Options
	• Kennzahlendefinition
	  ◦ Assessing of market risks
	  ◦ Assessing of credit risks
	  ◦ Assessing of operational risks
	  ◦ Assessing of liquidy risks
	• Risk monitoring and reporting
	• Risk treatment

Literature	• Roggi, O. (2012): Risk Taking: A Corporate Governance Perspective, International Finance Corporation, New York • Hull, J. C. (2012): Options, Futures, and other Derivatives, 8. Auflage, Pearson Verlag, New York • Albrecht, P.; Maurer, R. (2008): Investment- und Risikomanagement, 3. Auflage, Schäffer-Poeschel Verlag, Stuttgart • Rittenberg, L.; Martens, F. (2012): Understanding and Communicating Risk Appetite, Treadway Commission, Durham

Course L0060: Hydrogen Technology	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Martin Dornheim
Language	DE
Cycle	SoSe
Content	1. Energy economy 2. Hydrogen economy 3. Occurrence and properties of hydrogen 4. Production of hydrogen (from hydrocarbons and by electrolysis) 5. Separation and purification Storage and transport of hydrogen 6. Security 7. Fuel cells 8. Projects
Literature	• Skriptum zur Vorlesung • Winter, Nitsch: Wasserstoff als Energieträger • Ullmann’s Encyclopedia of Industrial Chemistry • Kirk, Othmer: Encyclopedia of Chemical Technology • Larminie, Dicks: Fuel cell systems explained

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	3	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 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	40 min
Assignment for the Following Curricula	Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: 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	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
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 M0540: Transport Processes

Courses

Title	Typ	Hrs/wk	CP
Multiphase Flows (L0104)	Lecture	2	2
Reactor Design Using Local Transport Processes (L0105)	Project-/problem-based Learning	2	2
Heat & Mass Transfer in Process Engineering (L0103)	Lecture	2	2

Module Responsible	Prof. Michael Schlüter
Admission Requirements	None
Recommended Previous Knowledge	All lectures from the undergraduate studies, especially mathematics, chemistry, thermodynamics, fluid mechanics, heat- and mass transfer.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to: • describe transport processes in single- and multiphase flows and they know the analogy between heat- and mass transfer as well as the limits of this analogy. • explain the main transport laws and their application as well as the limits of application. • describe how transport coefficients for heat- and mass transfer can be derived experimentally. • compare different multiphase reactors like trickle bed reactors, pipe reactors, stirring tanks and bubble column reactors. • are known. The Students are able to perform mass and energy balances for different kind of reactors. Further more the industrial application of multiphase reactors for heat- and mass transfer are known.
Skills	The students are able to: • optimize multiphase reactors by using mass- and energy balances, • use transport processes for the design of technical processes, • to choose a multiphase reactor for a specific application.
Personal Competence	
Social Competence	The students are able to discuss in international teams in english and develop an approach under pressure of time.
Autonomy	Students are able to define independently tasks, to solve the problem "design of a multiphase reactor". The knowledge that s necessary is worked out by the students themselves on the basis of the existing knowledge from the lecture. The students are able to decide by themselves what kind of equation and model is applicable to their certain problem. They are able to organize their own team and to define priorities for different 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	15 min Presentation + 90 min multiple choice written examen
Assignment for the Following Curricula	Bioprocess Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Process Engineering: Core Qualification: Compulsory

Course L0104: Multiphase Flows	
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	WiSe
Content	• Interfaces in MPF (boundary layers, surfactants) • Hydrodynamics & pressure drop in Film Flows • Hydrodynamics & pressure drop in Gas-Liquid Pipe Flows • Hydrodynamics & pressure drop in Bubbly Flows • Mass Transfer in Film Flows • Mass Transfer in Gas-Liquid Pipe Flows • Mass Transfer in Bubbly Flows • Reactive mass Transfer in Multiphase Flows • Film Flow: Application Trickle Bed Reactors • Pipe Flow: Application Turbular Reactors • Bubbly Flow: Application Bubble Column Reactors
Literature	Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971. Clift, R.; Grace, J.R.; Weber, M.E.: Bubbles, Drops and Particles, Academic Press, New York, 1978. Fan, L.-S.; Tsuchiya, K.: Bubble Wake Dynamics in Liquids and Liquid-Solid Suspensions, Butterworth-Heinemann Series in Chemical Engineering, Boston, USA, 1990. Hewitt, G.F.; Delhaye, J.M.; Zuber, N. (Ed.): Multiphase Science and Technology. Hemisphere Publishing Corp, Vol. 1/1982 bis Vol. 6/1992. Kolev, N.I.: Multiphase flow dynamics. Springer, Vol. 1 and 2, 2002. Levy, S.: Two-Phase Flow in Complex Systems. Verlag John Wiley & Sons, Inc, 1999. Crowe, C.T.: Multiphase Flows with Droplets and Particles. CRC Press, Boca Raton, Fla, 1998.

Course L0105: Reactor Design Using Local Transport Processes	
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 Schlüter
Language	EN
Cycle	WiSe
Content	In this Problem-Based Learning unit the students have to design a multiphase reactor for a fast chemical reaction concerning optimal hydrodynamic conditions of the multiphase flow. The four students in each team have to: • collect and discuss material properties and equations for design from the literature, • calculate the optimal hydrodynamic design, • check the plausibility of the results critically, • write an exposé with the results. This exposé will be used as basis for the discussion within the oral group examen of each team.
Literature	see actual literature list in StudIP with recent published papers

Course L0103: Heat & Mass Transfer 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	WiSe
Content	• Introduction - Transport Processes in Chemical Engineering • Molecular Heat- and Mass Transfer: Applications of Fourier's and Fick's Law • Convective Heat and Mass Transfer: Applications in Process Engineering • Unsteady State Transport Processes: Cooling & Drying • Transport at fluidic Interfaces: Two Film, Penetration, Surface Renewal • Transport Laws & Balance Equations with turbulence, sinks and sources • Experimental Determination of Transport Coefficients • Design and Scale Up of Reactors for Heat- and Mass Transfer • Reactive Mass Transfer • Processes with Phase Changes – Evaporization and Condensation • Radiative Heat Transfer - Fundamentals • Radiative Heat Transfer - Solar Energy
Literature	1. Baehr, Stephan: Heat and Mass Transfer, Wiley 2002. 2. Bird, Stewart, Lightfood: Transport Phenomena, Springer, 2000. 3. John H. Lienhard: A Heat Transfer Textbook, Phlogiston Press, Cambridge Massachusetts, 2008. 4. Myers: Analytical Methods in Conduction Heat Transfer, McGraw-Hill, 1971. 5. Incropera, De Witt: Fundamentals of Heat and Mass Transfer, Wiley, 2002. 6. Beek, Muttzall: Transport Phenomena, Wiley, 1983. 7. Crank: The Mathematics of Diffusion, Oxford, 1995. 8. Madhusudana: Thermal Contact Conductance, Springer, 1996. 9. Treybal: Mass-Transfer-Operation, McGraw-Hill, 1987.

Module M1710: Smart Grid Technologies

Courses

Title	Typ	Hrs/wk	CP
Smart Grid Technologies (L2706)	Lecture	3	4
Smart Grid Technologies (L2707)	Project-/problem-based Learning	2	2

Module Responsible	Prof. Christian Becker
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals of Electrical Engineering, Introduction to Control Systems, Mathematics I, II, III Electrical Power Systems I Electrical Power Systems II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to explain in detail and critically evaluate methods and technologies for operation of smart grids (i.e. intelligent distribution grids).
Skills	With completion of this module the students are able to analyze the impact of emerging technologies (such as renewables, energy storage and demand response) on the electric power system. They can formulate and apply computational intelligence techniques to power system operation problems. They can also explain what ICT technologies (such as digital twins and IoT) are relevant and suitable for distribution grid operation.
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 and apply it within further research activities.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Presentation
Examination duration and scale	30 min
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems 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

Course L2706: Smart Grid Technologies	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christian Becker, Dr. Davood Babazadeh
Language	DE/EN
Cycle	WiSe/SoSe

Content	**Introduction to Smart Grids**
	• Intelligent Distribution Grids
	• Paradigm shifts: Digitalization & Sustainability
	Emerging technologies in distribution grids
	• Distributed Energy Resource (DER)
	• Battery Energy Storage (BES) technologies
	• Sector-coupling & EV/V2G
	• Microgrids, Inverter-based Systems
	• Modelling and control of PV & BESS
	Distribution grid management & analysis
	• Distribution grid structure (Hamburg example)
	• Distribution grid management and operation architecture and functions
	  ◦ Fault Detection, Isolation & Restoration
	  ◦ Self-Healing in distribution systems
	  ◦ Volt-Var Optimization
	  ◦ Distribution Load Flow
	• Demand Side Management & Demand Response
	• Lab exercise (Smart Grid Operation)
	Computational intelligence and optimization techniques in Smart Grids
	• Computational challenges in Smart grid
	• Heuristic & Analytic Optimization Methods
	• Intelligent Systems (Expert Systems, ML/AL)
	• Applications (optimal load flow, reactive capacitor placement)
	• Lab exercise (optimization formulation)
	ICT Technologies for Smart Grids
	• Advanced Metering Technologies: Smart Meters, RTU, PMU
	• Telecommunication Systems in Smart Grids (network basics and technologies)
	• Interoperability in Smart grids
	  ◦ Smart Grid Architecture Model
	  ◦ Automation and Communication standards (IEC 61850, c37.118)
	• Cyber security
	• Lab exercise (Grid automation protocols)
	Practical lesson-learned: Stromnetz Hamburg (SNH) perspective
	• Definition of Smart Grid and its requirements from industry view
	• Grid digitalization - examples of industrial projects
	• Flexible load management
	• Electromobility & transportation sector integration
	Study visits:
	• Digital Substation in Harburg
	• Electric Bus charging station
	Stromnetz Hamburg Control Center

Literature	• Buchholz and Styczynski - 2020 - “Smart Grids: Fundamentals and Technologies in Electric Power Systems of the Future”, Springer • Bernardon and Garcia - 2018 - “Smart Operation for Power Distribution Systems: Concepts and Applications”, Springer • Momoh, 2012; “Smart Grid: Fundamentals of Design and Analysis”, Wiley

Course L2707: Smart Grid Technologies	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Becker, Dr. Davood Babazadeh
Language	DE/EN
Cycle	WiSe/SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1424: Integration of Renewable Energies

Courses

Title	Typ	Hrs/wk	CP
Integration of Renewable Energies I (L2049)	Lecture	1	1
Integration of Renewable Energies I (L2050)	Recitation Section (small)	1	1
Integration of Renewable Energies II (L2051)	Lecture	1	1
Integration of Renewable Energies II (L2052)	Recitation Section (small)	1	1
Sustainable Mobility (L0010)	Lecture	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals of renewable energies and the energy system
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	With the completion of the module the students are able to use and apply the previously learned technical basics of the different fields of renewable energies. Current problems concerning the integration of renewable energies in the energy system are presented and analyzed. In particular, the sectors electricity, heat and mobility will be addressed, giving students insights into sector coupling activities.
Skills	By completing this module, students can apply the basics learned to various sector coupling problems and, in this context, assess the potentials as well as the limits of sector coupling in the German energy system. In particular, the students should use the application and linking of already learned methods and knowledge here, so that a vision of the different technologies is achieved.
Personal Competence	
Social Competence	The students will be able to discuss problems in the areas of sector coupling and the integration of renewable energies.
Autonomy	The students are able to acquire own sources based on the main topics of the lecture and to increase their knowledge. Furthermore, the students can search further technologies and interconnection possibilities for the energy system itself.
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	Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory

Course L2049: Integration of Renewable Energies I	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	WiSe
Content	1. Introduction 2. Fossil-dominated energy system 3. Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity 5. Integration of renewables - electricity I 6. Integration of renewables - electricity II 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat II 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - mobility 12. Communications technology and control engineering 13. Reduction in consumption 14. Load management 15. Interaction of renewable generation and controlled reduction in demand
Literature	• D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer,Cham, Heielberg, New York, Dordrecht, London, 2015 • R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttgart 1965 • K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016 • M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Auflage, Springer

Course L2050: Integration of Renewable Energies I	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L2051: Integration of Renewable Energies II	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	SoSe
Content	1. Introduction 2. Power-to-Hydrogen 3. Power-to-Gas 4. Power-to-Liquid 5. Power-to-Heat 6. Hybrid Technologies 7. Combined Technology Concepts I 8. Combined Technology Concepts II 9. Link-up with renewable industrial production 10. Utilization of residual materials from renewable energy provision 11. Biomass as system stabilizer I 12. Biomass as system stabilizer II 13. System modelling - fundamentals 14. System modelling - approaches and results 15. Planning tools
Literature	• D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer,Cham, Heielberg, New York, Dordrecht, London, 2015 • R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttgart 1965 • K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016 • M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Auflage, Springer Berlin Heidelberg, 2006 • Bundesministerium für Wirtschaft und Energie: Die Energie der Zukunft.

Course L2052: Integration of Renewable Energies II	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0010: Sustainable Mobility	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Karsten Wilbrand
Language	DE
Cycle	SoSe
Content	• Global megatrends and future challenges of energy supply • Energy Scenarios to 2060 and importance for the mobility sector • Sustainable air, sea, rail and road traffic • Developments in vehicle and drive technology • Overview of Today's fuels (production and use) • Biofuels of 1 and 2 Generation (availability, production, compatibility) • Natural gas (GTL, CNG, LNG) • Electromobility based on batteries and hydrogen fuel cell • Well-to-Wheel CO2 analysis of the various options • Legal framework for people and freight
Literature	• Eigene Unterlagen • Veröffentlichungen • Fachliteratur

Module M1354: Advanced Fuels

Courses

Title	Typ	Hrs/wk	CP
Second generation biofuels and electricity based fuels (L2414)	Lecture	2	2
Carbon dioxide as an economic determinant in the mobility sector (L1926)	Lecture	1	1
Mobility and climate protection (L2416)	Recitation Section (small)	2	2
Sustainability aspects and regulatory framework (L2415)	Lecture	1	1

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Bachelor degree in Process Engineering, Bioprocess Engineering or Energy- and Environmental Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Within the module, students learn about different provision pathways for the production of advanced fuels (biofuels like e.g. alcohol-to-jet; electricity-based fuels like e.g. power-to-liquid). The different processes chains are explained and the regulatory framework for sustainable fuel production is examined. This includes, for example, the requirements of the Renewable Energies Directive II and the conditions and aspects for a market ramp-up of these fuels. For the holistic assessment of the various fuel options, they are also examined under environmental and economic factors.
Skills	After successfully participating, the students are able to solve simulation and application tasks of renewable energy technology: • Module-spanning solutions for the design and presentation of fuel production processes resp. the fuel provision chains • Comprehensive analysis of various fuel production options in technical, ecological and economic terms Through active discussions of the various topics within the lectures and exercises of the module, the students improve their understanding and application of the theoretical foundations and are thus able to transfer the learned to the practice.
Personal Competence	
Social Competence	The students can discuss scientific tasks in a subject-specific and interdisciplinary way and develop joint solutions.
Autonomy	The students are able to access independent sources about the questions to be addressed and to acquire the necessary knowledge. They are able to assess their respective learning situation concretely in consultation with their supervisor and to define further questions and solutions.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: Yes; Bonus: 20 %; Form: Written elaboration; Description: Details werden in der ersten Veranstaltung bekannt gegeben.
Examination	Written exam
Examination duration and scale	2 hours written exam
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory

Course L2414: Second generation biofuels and electricity based fuels

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE/EN
Cycle	WiSe
Content	• General overview of various power-based fuels and their process paths, including power-to-liquid process (Fischer-Tropsch synthesis, methanol synthesis), power-to-gas (Sabatier process) • Origin, production and use of these fuels
Literature	• Vorlesungsskript

Course L1926: Carbon dioxide as an economic determinant in the mobility sector	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Karsten Wilbrand
Language	DE/EN
Cycle	WiSe
Content	• General overview of various advanced biofuels and their process pathways (including gas-to-liquid, HEFA and Alcohol-to-Jet processes) • Origin, production and use of these fuels
Literature	• Babu, V.: Biofuels Production. Beverly, Mass: Scrivener [u.a.], 2013 • Olsson, L.: Biofuels. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg, 2007 • William, L. L.: Distillation Design and Control Using Aspen Simulation; ISBN-10: 0-471-77888-5 • Perry, R.; Green, R.: Perry's Chemical Engineers' Handbook, 8th Edition, McGraw Hill Professional, 20 • Sinnot, R. K.: Chemical Engineering Design, Elsevier, 2014 • Kaltschmitt, M.; Neuling, U. (Ed.): Biokerosene - Status and Prospects; Springer, Berlin, Heidelberg, 2018

Course L2416: Mobility and climate protection	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Benedikt Buchspies, Dr. Karsten Wilbrand
Language	DE/EN
Cycle	WiSe
Content	Application of the acquired theoretical knowledge from the respective lectures on the basis of concrete tasks from practice • Design and simulation of sub-processes of production processes in Aspen Plus ® • Ecological and economic analysis of fuel supply paths • Classification of case studies into applicable regulations
Literature	• Skriptum zur Vorlesung • Aspen Plus® - Aspen Plus User Guide

Course L2415: Sustainability aspects and regulatory framework	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Benedikt Buchspies
Language	DE/EN
Cycle	WiSe
Content	Holistic examination of the different fuel paths with the following main topics, among others: • Consideration of the environmental impact of the various alternative fuels • Economic consideration of the different alternative fuels • Regulatory framework for alternative fuels • Certification of alternative fuels • Market introduction models of alternative fuels
Literature	• European Commission - Joint Research Center (2010): International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Joint Research Center (JRC) Institut for Environment and Sustainability, Luxembourg • Richtlinie (EU) 2018/2001 des Europäischen Parlaments und des Rates vom 11. Dezember 2018 zur Förderung der Nutzung von Energie aus erneuerbaren Quellen

Specialization Wind Energy Systems

Within the specialization "Wind Energy Systems" advanced knowledge for the utilization of wind energy in the offshore as well as in the onshore sector is provided. In particular, maritime and logistical constraints during the installation and use of offshore wind farms are discussed. In this context, the management of risks which may occur during construction and operation of such large energy projects are explained.

In addition, in a separate module, the material-specific basis for the composition of components of wind turbines is provided.

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 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

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 M0527: Marine Soil Technics

Courses

Title	Typ	Hrs/wk	CP
Analysis of Maritime Systems (L0068)	Lecture	2	2
Analysis of Maritime Systems (L0069)	Recitation Section (small)	1	1
Offshore Geotechnical Engineering (L0067)	Lecture	2	3

Module Responsible	Dr. Isabel Höfer
Admission Requirements	None
Recommended Previous Knowledge	Knowledge in analysis and differential equations Basics of maritime technology
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can use the basic techniques for the analysis of offshore systems, including the related studies of the properties of the seabed, to provide an overview about that topic. Furthermore they can explain the associated content taking into account the specialist adjacent contexts.
Skills	Students are able to model and evaluate dynamic offshore systems. Consequently they are also able to think system-oriented and to break down complex system into subsystems .
Personal Competence	
Social Competence	none
Autonomy	Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions. Furthermore, they can concrete assess their specific learning level within the exercise hours guided by teachers and can consequently define the further workflow.
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	2 hours written exam
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: 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 L0067: Offshore Geotechnical Engineering	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Jan Dührkop
Language	DE
Cycle	SoSe
Content	• Overview and Introduction Offshore Geotechnics • Introduction to Soil Mechanics • Offshore soil investigation • Focus on cyclical effects • Geotechnical design of offshore foundations • Monopiles • Jackets • Heavyweight foundations • Geotechnical preliminary exploration for the use of lift boats and platforms
Literature	• Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press. • Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London • BSH-Standard Baugrunderkundung für Offshore-Windenergieparks • Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen. • EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst & Sohn, 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 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

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 M1343: Structure and properties of fibre-polymer-composites

Courses

Title	Typ	Hrs/wk	CP
Structure and properties of fibre-polymer-composites (L1894)	Lecture	2	3
Structure and properties of fibre-polymer-composites (L2614)	Project-/problem-based Learning	2	2
Structure and properties of fibre-polymer-composites (L2613)	Recitation Section (large)	1	1

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 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Core Qualification: 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

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 L2614: Structure and properties of fibre-polymer-composites	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	
Literature	

Course L2613: Structure and properties of fibre-polymer-composites	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	
Literature	

Module M1287: Risk Management, Hydrogen and Fuel Cell Technology

Courses

Title	Typ	Hrs/wk	CP
Applied Fuel Cell Technology (L1831)	Lecture	2	2
Risk Management in the Energy Industry (L1748)	Lecture	2	2
Hydrogen Technology (L0060)	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 completion of this module students can explain basics of risk management involving thematical adjacent contexts and can describe an optimal management of energy systems. Furthermore, students can reproduce solid theoretical knowledge about the potentials and applications of new information technologies in logistics and explain technical aspects of the use, production and processing of hydrogen.
Skills	With completion of this module students are able to evaluate risks of energy systems with respect to energy economic conditions in an efficient way. This includes that the students can assess the risks in operational planning of power plants from a technical, economic and ecological perspective. In this context, students can evaluate the potentials of logistics and information technology in particular on energy issues. In addition, students are able to describe the energy transfer medium hydrogen according to its applications, the given security and its existing service capacities and limits as well as to evaluate these aspects from a technical, environmental and economic perspective.
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 on the emphasis of the lectures and acquire the contained knowledge. In this way, they can recognize their lacks of knowledge 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	Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory

Course L1831: Applied Fuel Cell Technology

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	SoSe
Content	The lecture provide an insight into the various possibilities of fuel cells in the energy system (electricity, heat and transport). These are presented and discussed for individual fuel types and application-oriented requirements; also compared with alternative technologies in the system. These different possibilities will be presented regardind the state-of-the-art development of the technologies and exemplary applications from Germany and worldwide. Also the emerging trends and lines of development will be discussed. Besides to the technical aspects, which are the focus of the event, also energy, environmental and industrial policy aspects are discussed - also in the context of changing circumstances in the German and international energy system.
Literature	Vorlesungsunterlagen

Course L1748: Risk Management in the Energy Industry	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Christian Wulf
Language	DE
Cycle	SoSe

Content	• Basics of risk management
	  ◦ Definition of terms
	  ◦ Risk types
	  ◦ Risk management process
	  ◦ Enterprise risk management
	• Markets and instruments in energy trading
	  ◦ Basics of futures and spot trading
	  ◦ Notation in energy markets
	  ◦ Options
	• Kennzahlendefinition
	  ◦ Assessing of market risks
	  ◦ Assessing of credit risks
	  ◦ Assessing of operational risks
	  ◦ Assessing of liquidy risks
	• Risk monitoring and reporting
	• Risk treatment

Literature	• Roggi, O. (2012): Risk Taking: A Corporate Governance Perspective, International Finance Corporation, New York • Hull, J. C. (2012): Options, Futures, and other Derivatives, 8. Auflage, Pearson Verlag, New York • Albrecht, P.; Maurer, R. (2008): Investment- und Risikomanagement, 3. Auflage, Schäffer-Poeschel Verlag, Stuttgart • Rittenberg, L.; Martens, F. (2012): Understanding and Communicating Risk Appetite, Treadway Commission, Durham

Course L0060: Hydrogen Technology	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Martin Dornheim
Language	DE
Cycle	SoSe
Content	1. Energy economy 2. Hydrogen economy 3. Occurrence and properties of hydrogen 4. Production of hydrogen (from hydrocarbons and by electrolysis) 5. Separation and purification Storage and transport of hydrogen 6. Security 7. Fuel cells 8. Projects
Literature	• Skriptum zur Vorlesung • Winter, Nitsch: Wasserstoff als Energieträger • Ullmann’s Encyclopedia of Industrial Chemistry • Kirk, Othmer: Encyclopedia of Chemical Technology • Larminie, Dicks: Fuel cell systems explained

Module M1709: Applied optimization in energy and process engineering

Courses

Title	Typ	Hrs/wk	CP
Applied optimization in energy and process engineering (L2693)	Integrated Lecture	2	3
Applied optimization in energy and process engineering (L2695)	Recitation Section (small)	2	3

Module Responsible	Prof. Mirko Skiborowski
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals in the field of mathematical modeling and numerical mathematics, as well as a basic understanding of process engineering processes. In particular the contents of the module Process and Plant Engineering II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The module provides a general introduction to the basics of applied mathematical optimization and deals with application areas on different scales from the identification of kinetic models, to the optimal design of unit operations and the optimization of entire (sub)processes, as well as production planning. In addition to the basic classification and formulation of optimization problems, different solution approaches are discussed and tested during the exercises. Besides deterministic gradient-based methods, metaheuristics such as evolutionary and genetic algorithms and their application are discussed as well. • Introduction to Applied Optimization • Formulation of optimization problems • Linear Optimization • Nonlinear Optimization • Mixed-integer (non)linear optimization • Multi-objective optimization • Global optimization
Skills	After successful participation in the module "Applied Optimization in Energy and Process Engineering", students are able to formulate the different types of optimization problems and to select appropriate solution methods in suitable software such as Matlab and GAMS and to develop improved solution strategies. Furthermore, students will be able to interpret and critically examine the results accordingly.
Personal Competence	
Social Competence	Students are capable of: •develop solutions in heterogeneous small groups
Autonomy	Students are capable of: •taping new knowledge on a special subject by literature research
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	35 min
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory

Course L2693: Applied optimization in energy and process engineering	
Typ	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mirko Skiborowski
Language	DE/EN
Cycle	SoSe
Content	The lecture offers a general introduction to the basics and possibilities of applied mathematical optimization and deals with application areas on different scales from kinetics identification, optimal design of unit operations to the optimization of entire (sub)processes, and production planning. In addition to the basic classification and formulation of optimization problems, different solution approaches are discussed. Besides deterministic gradient-based methods, metaheuristics such as evolutionary and genetic algorithms and their application are discussed as well. - Introduction to Applied Optimization - Formulation of optimization problems - Linear Optimization - Nonlinear Optimization - Mixed-integer (non)linear optimization - Multi-objective optimization - Global optimization
Literature	Weicker, K., Evolutionäre Algortihmen, Springer, 2015 Edgar, T. F., Himmelblau D. M., Lasdon, L. S., Optimization of Chemical Processes, McGraw Hill, 2001 Biegler, L. Nonlinear Programming - Concepts, Algorithms, and Applications to Chemical Processes, 2010 Kallrath, J. Gemischt-ganzzahlige Optimierung: Modellierung in der Praxis, Vieweg, 2002

Course L2695: Applied optimization in energy and process engineering	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mirko Skiborowski
Language	DE/EN
Cycle	SoSe
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	3	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 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Oral exam
Examination duration and scale	40 min
Assignment for the Following Curricula	Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: 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	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
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 M1710: Smart Grid Technologies

Courses

Title	Typ	Hrs/wk	CP
Smart Grid Technologies (L2706)	Lecture	3	4
Smart Grid Technologies (L2707)	Project-/problem-based Learning	2	2

Module Responsible	Prof. Christian Becker
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals of Electrical Engineering, Introduction to Control Systems, Mathematics I, II, III Electrical Power Systems I Electrical Power Systems II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to explain in detail and critically evaluate methods and technologies for operation of smart grids (i.e. intelligent distribution grids).
Skills	With completion of this module the students are able to analyze the impact of emerging technologies (such as renewables, energy storage and demand response) on the electric power system. They can formulate and apply computational intelligence techniques to power system operation problems. They can also explain what ICT technologies (such as digital twins and IoT) are relevant and suitable for distribution grid operation.
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 and apply it within further research activities.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Presentation
Examination duration and scale	30 min
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems 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

Course L2706: Smart Grid Technologies	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christian Becker, Dr. Davood Babazadeh
Language	DE/EN
Cycle	WiSe/SoSe

Content	**Introduction to Smart Grids**
	• Intelligent Distribution Grids
	• Paradigm shifts: Digitalization & Sustainability
	Emerging technologies in distribution grids
	• Distributed Energy Resource (DER)
	• Battery Energy Storage (BES) technologies
	• Sector-coupling & EV/V2G
	• Microgrids, Inverter-based Systems
	• Modelling and control of PV & BESS
	Distribution grid management & analysis
	• Distribution grid structure (Hamburg example)
	• Distribution grid management and operation architecture and functions
	  ◦ Fault Detection, Isolation & Restoration
	  ◦ Self-Healing in distribution systems
	  ◦ Volt-Var Optimization
	  ◦ Distribution Load Flow
	• Demand Side Management & Demand Response
	• Lab exercise (Smart Grid Operation)
	Computational intelligence and optimization techniques in Smart Grids
	• Computational challenges in Smart grid
	• Heuristic & Analytic Optimization Methods
	• Intelligent Systems (Expert Systems, ML/AL)
	• Applications (optimal load flow, reactive capacitor placement)
	• Lab exercise (optimization formulation)
	ICT Technologies for Smart Grids
	• Advanced Metering Technologies: Smart Meters, RTU, PMU
	• Telecommunication Systems in Smart Grids (network basics and technologies)
	• Interoperability in Smart grids
	  ◦ Smart Grid Architecture Model
	  ◦ Automation and Communication standards (IEC 61850, c37.118)
	• Cyber security
	• Lab exercise (Grid automation protocols)
	Practical lesson-learned: Stromnetz Hamburg (SNH) perspective
	• Definition of Smart Grid and its requirements from industry view
	• Grid digitalization - examples of industrial projects
	• Flexible load management
	• Electromobility & transportation sector integration
	Study visits:
	• Digital Substation in Harburg
	• Electric Bus charging station
	Stromnetz Hamburg Control Center

Literature	• Buchholz and Styczynski - 2020 - “Smart Grids: Fundamentals and Technologies in Electric Power Systems of the Future”, Springer • Bernardon and Garcia - 2018 - “Smart Operation for Power Distribution Systems: Concepts and Applications”, Springer • Momoh, 2012; “Smart Grid: Fundamentals of Design and Analysis”, Wiley

Course L2707: Smart Grid Technologies	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Becker, Dr. Davood Babazadeh
Language	DE/EN
Cycle	WiSe/SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1424: Integration of Renewable Energies

Courses

Title	Typ	Hrs/wk	CP
Integration of Renewable Energies I (L2049)	Lecture	1	1
Integration of Renewable Energies I (L2050)	Recitation Section (small)	1	1
Integration of Renewable Energies II (L2051)	Lecture	1	1
Integration of Renewable Energies II (L2052)	Recitation Section (small)	1	1
Sustainable Mobility (L0010)	Lecture	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Fundamentals of renewable energies and the energy system
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	With the completion of the module the students are able to use and apply the previously learned technical basics of the different fields of renewable energies. Current problems concerning the integration of renewable energies in the energy system are presented and analyzed. In particular, the sectors electricity, heat and mobility will be addressed, giving students insights into sector coupling activities.
Skills	By completing this module, students can apply the basics learned to various sector coupling problems and, in this context, assess the potentials as well as the limits of sector coupling in the German energy system. In particular, the students should use the application and linking of already learned methods and knowledge here, so that a vision of the different technologies is achieved.
Personal Competence	
Social Competence	The students will be able to discuss problems in the areas of sector coupling and the integration of renewable energies.
Autonomy	The students are able to acquire own sources based on the main topics of the lecture and to increase their knowledge. Furthermore, the students can search further technologies and interconnection possibilities for the energy system itself.
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	Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory

Course L2049: Integration of Renewable Energies I	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	WiSe
Content	1. Introduction 2. Fossil-dominated energy system 3. Mega trends in energy transition 4. Characteristics of renewable energy provision technologies - electricity 5. Integration of renewables - electricity I 6. Integration of renewables - electricity II 7. Characteristics of renewable energy provision technologies - heat 8. Integration of renewables - heat I 9. Integration of renewables - heat II 10. Characteristics of renewable energy provision technologies - mobility 11. Integration of renewables - mobility 12. Communications technology and control engineering 13. Reduction in consumption 14. Load management 15. Interaction of renewable generation and controlled reduction in demand
Literature	• D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer,Cham, Heielberg, New York, Dordrecht, London, 2015 • R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttgart 1965 • K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016 • M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Auflage, Springer

Course L2050: Integration of Renewable Energies I	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L2051: Integration of Renewable Energies II	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	SoSe
Content	1. Introduction 2. Power-to-Hydrogen 3. Power-to-Gas 4. Power-to-Liquid 5. Power-to-Heat 6. Hybrid Technologies 7. Combined Technology Concepts I 8. Combined Technology Concepts II 9. Link-up with renewable industrial production 10. Utilization of residual materials from renewable energy provision 11. Biomass as system stabilizer I 12. Biomass as system stabilizer II 13. System modelling - fundamentals 14. System modelling - approaches and results 15. Planning tools
Literature	• D. Thrän (editor): Smart Bioenergy. Technologies and concepts for a more flexible bioenergy provision in future energy systems. Springer,Cham, Heielberg, New York, Dordrecht, London, 2015 • R. von Miller (Hrsg.): Lexikon der Energietechnik und Kraftmaschinen Band 6 und 7. Deutsche Verlags-Anstalt Stuttgart 1965 • K. Naumann et. al.: Monitoring Biokraftstoffsektor. 3. Auflage, DBFZ Report Nr. 1, Leipzig, 2016 • M. Kaltschmitt, W. Streicher, A. Wiese (Hrsg.): Erneuerbare Energien. Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. 4. Auflage, Springer Berlin Heidelberg, 2006 • Bundesministerium für Wirtschaft und Energie: Die Energie der Zukunft.

Course L2052: Integration of Renewable Energies II	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Volker Lenz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0010: Sustainable Mobility	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Karsten Wilbrand
Language	DE
Cycle	SoSe
Content	• Global megatrends and future challenges of energy supply • Energy Scenarios to 2060 and importance for the mobility sector • Sustainable air, sea, rail and road traffic • Developments in vehicle and drive technology • Overview of Today's fuels (production and use) • Biofuels of 1 and 2 Generation (availability, production, compatibility) • Natural gas (GTL, CNG, LNG) • Electromobility based on batteries and hydrogen fuel cell • Well-to-Wheel CO2 analysis of the various options • Legal framework for people and freight
Literature	• Eigene Unterlagen • Veröffentlichungen • Fachliteratur

Module M0528: Maritime Technology and Offshore Wind Parks

Courses

Title	Typ	Hrs/wk	CP
Introduction to Maritime Technology (L0070)	Lecture	2	2
Introduction to Maritime Technology (L1614)	Recitation Section (small)	1	1
Offshore Wind Parks (L0072)	Lecture	2	3

Module Responsible	Prof. Moustafa Abdel-Maksoud
Admission Requirements	None
Recommended Previous Knowledge	Qualified Bachelor of a natural or engineering science; Solid knowledge and competences in mathematics, mechanics, fluid dynamics. Basic knowledge of ocean engineering topics (e.g. from an introductory class like 'Introduction to Maritime Technology')
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. Based on research topics of present relevance the participants are to be prepared for independent research work in the field. For that purpose specific research problems of workable scope will be addressed in the class. After successful completion of this module, students should be able to • Show present research questions in the field • Explain the present state of the art for the topics considered • Apply given methodology to approach given problems • Evaluate the limits of the present methods • Identify possibilities to extend present methods • Evaluate the feasibility of further developments
Skills **Personal Competence** *Social Competence* *Autonomy*	
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Energy Systems: Specialisation Marine Engineering: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory

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. Walter Kuehnlein, 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. Walter Kuehnlein
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0072: Offshore Wind Parks	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
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.

Module M1354: Advanced Fuels

Courses

Title	Typ	Hrs/wk	CP
Second generation biofuels and electricity based fuels (L2414)	Lecture	2	2
Carbon dioxide as an economic determinant in the mobility sector (L1926)	Lecture	1	1
Mobility and climate protection (L2416)	Recitation Section (small)	2	2
Sustainability aspects and regulatory framework (L2415)	Lecture	1	1

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	Bachelor degree in Process Engineering, Bioprocess Engineering or Energy- and Environmental Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Within the module, students learn about different provision pathways for the production of advanced fuels (biofuels like e.g. alcohol-to-jet; electricity-based fuels like e.g. power-to-liquid). The different processes chains are explained and the regulatory framework for sustainable fuel production is examined. This includes, for example, the requirements of the Renewable Energies Directive II and the conditions and aspects for a market ramp-up of these fuels. For the holistic assessment of the various fuel options, they are also examined under environmental and economic factors.
Skills	After successfully participating, the students are able to solve simulation and application tasks of renewable energy technology: • Module-spanning solutions for the design and presentation of fuel production processes resp. the fuel provision chains • Comprehensive analysis of various fuel production options in technical, ecological and economic terms Through active discussions of the various topics within the lectures and exercises of the module, the students improve their understanding and application of the theoretical foundations and are thus able to transfer the learned to the practice.
Personal Competence	
Social Competence	The students can discuss scientific tasks in a subject-specific and interdisciplinary way and develop joint solutions.
Autonomy	The students are able to access independent sources about the questions to be addressed and to acquire the necessary knowledge. They are able to assess their respective learning situation concretely in consultation with their supervisor and to define further questions and solutions.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: Yes; Bonus: 20 %; Form: Written elaboration; Description: Details werden in der ersten Veranstaltung bekannt gegeben.
Examination	Written exam
Examination duration and scale	2 hours written exam
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory

Course L2414: Second generation biofuels and electricity based fuels

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE/EN
Cycle	WiSe
Content	• General overview of various power-based fuels and their process paths, including power-to-liquid process (Fischer-Tropsch synthesis, methanol synthesis), power-to-gas (Sabatier process) • Origin, production and use of these fuels
Literature	• Vorlesungsskript

Course L1926: Carbon dioxide as an economic determinant in the mobility sector	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Karsten Wilbrand
Language	DE/EN
Cycle	WiSe
Content	• General overview of various advanced biofuels and their process pathways (including gas-to-liquid, HEFA and Alcohol-to-Jet processes) • Origin, production and use of these fuels
Literature	• Babu, V.: Biofuels Production. Beverly, Mass: Scrivener [u.a.], 2013 • Olsson, L.: Biofuels. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg, 2007 • William, L. L.: Distillation Design and Control Using Aspen Simulation; ISBN-10: 0-471-77888-5 • Perry, R.; Green, R.: Perry's Chemical Engineers' Handbook, 8th Edition, McGraw Hill Professional, 20 • Sinnot, R. K.: Chemical Engineering Design, Elsevier, 2014 • Kaltschmitt, M.; Neuling, U. (Ed.): Biokerosene - Status and Prospects; Springer, Berlin, Heidelberg, 2018

Course L2416: Mobility and climate protection	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Benedikt Buchspies, Dr. Karsten Wilbrand
Language	DE/EN
Cycle	WiSe
Content	Application of the acquired theoretical knowledge from the respective lectures on the basis of concrete tasks from practice • Design and simulation of sub-processes of production processes in Aspen Plus ® • Ecological and economic analysis of fuel supply paths • Classification of case studies into applicable regulations
Literature	• Skriptum zur Vorlesung • Aspen Plus® - Aspen Plus User Guide

Course L2415: Sustainability aspects and regulatory framework	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Benedikt Buchspies
Language	DE/EN
Cycle	WiSe
Content	Holistic examination of the different fuel paths with the following main topics, among others: • Consideration of the environmental impact of the various alternative fuels • Economic consideration of the different alternative fuels • Regulatory framework for alternative fuels • Certification of alternative fuels • Market introduction models of alternative fuels
Literature	• European Commission - Joint Research Center (2010): International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Joint Research Center (JRC) Institut for Environment and Sustainability, Luxembourg • Richtlinie (EU) 2018/2001 des Europäischen Parlaments und des Rates vom 11. Dezember 2018 zur Förderung der Nutzung von Energie aus erneuerbaren Quellen

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 Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Global Innovation Management: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory Interdisciplinary Mathematics: Thesis: Compulsory International Production Management: 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 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