



## **Module Manual**

Master of Science (M.Sc.)

# **International Management and Engineering**

Cohort: Winter Term 2021

Updated: 27th January 2023



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## Program description

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### Content

It is the major objective of the Masters degree programme „International Management and Engineering“ to offer students the opportunity to acquire the competencies which they will need for their future career, e.g. in a technical or management department of companies in different branches of industry, or for a future career in research (i.e. a PhD) in the area of Management and Engineering. The students' future sphere of activities hence may include research and development, leadership and management of international projects or tasks in operational or strategic management.

In particular, after having finished their studies, students are supposed to be able to carry out managerial functions in international companies and to act successfully at the interface of management and technology. They can successfully apply methods for solving managerial as well as technical problems, and they are also able to solve new problems in changing and volatile situations. Moreover, they will develop a critical attitude towards these methods and are also able to advance the methods, whenever necessary. Hence, they have a sound foundation for acting responsibly in their jobs and for taking ethical aspects and consequences of their decisions in account.

### Career prospects

Graduates of the „International Management and Engineering“ programme find many job opportunities in industry, in particular in international companies, in service companies, in particular in consulting, and in research and development. They are particularly qualified for responsible and leading positions at the interface of management and technology.

### Learning target

The graduates have acquired the basic skills, specialized knowledge and additional competences required for a national and/or international career in the interdisciplinary field of industrial engineering. They have gained scientifically based specialized knowledge of business sciences, as well as an in-depth knowledge of engineering disciplines. Hence, they are qualified for performing interdisciplinary tasks, and they are able to pursue stand-alone tasks at the interface of business management and technology. Moreover, the graduates have the capability to work in strategic and operational management functions in different types of enterprises, including multinationals, or to pursue an academic career, i.e. a PhD.

In particular, the graduates are able to apply the methods and techniques required to solve both business-related and technological tasks, to critically analyze these methods, and to improve their development by applying new insights.

Furthermore, the graduates have acquired competences that enable them:

- To transfer their theoretical knowledge into practice
- To take on complex planning tasks in global value-added networks and successfully apply their theoretical knowledge of the management and engineering sciences in practice.
- To participate, in a leading function, in international technology and management-oriented projects.
- To analyze and critically assess processes, systems, and innovative technologies in different business-related areas.
- To also systematically consider the non-technical consequences of engineering activities and incorporate these responsibly and ethically in a socio-economic context.
- To independently acquire relevant knowledge from the scientific literature, to judge relevant publications critically and to write scientific reports.
- To carry out their own research projects
- To successfully communicate with experts from their field and from other fields in German and English

Moreover, the key qualifications acquired in the Bachelor's program were extended and enhanced by means of suitable teaching methods within the Master's degree course. In addition, the students' intercultural competence was developed and their ability to work in a team was improved.

### Program structure

In this degree programme, students gain broad management competencies, especially for the application in an industrial and international operational area. Students can enhance their knowledge in special fields as, e.g. Supply Chain Management, Technology Management, Human Resource Management, Strategic Management or Marketing, Controlling or Operations Research. They can concentrate on different core areas, namely on

- Marketing and Technology
- Supply Chain Management and Logistics
- Corporate Management
- Entrepreneurship

In addition, students can select an engineering specialization. There are different areas of engineering on offer:

- Civil Engineering
- Electrical Engineering
- Power and Environmental Engineering
- Information Technology
- Logistics
- Aviation Systems
- Mechatronics
- Product Development and Production
- Renewable Energy
- Process Engineering and Biotechnology

As the third semester does not contain any compulsory courses, it is particularly well suited for a stay abroad at one of the many partner universities of TUHH. The TUHH strongly supports students when they are planning such a stay abroad.

**Core Qualification**

Module M0560: Institutional Environment of International Management				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Research Methods in International Management (L1911)		Lecture	1	2
Business Environment of Selected Countries (L0159)		Seminar	3	4
<b>Module Responsible</b>	Prof. Thomas Wrona			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic knowledge in international and intercultural management, familiarity with the content of the International Management lecture			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> Knowledge: Students will be able to</p> <ul style="list-style-type: none"> <li>• evaluate the importance of the institutional framework for doing business in different countries</li> <li>• outline and critically reflect the economic and legal framework in selected countries</li> <li>• understand historic, demographic and economic indicators in specific economic areas within an international context</li> <li>• understand and apply methods of analysis of the external environment (competitive analysis , industry structure analysis by Porter, PESTEL analysis, Porter's Diamond and Cluster analysis)</li> <li>• explain different objectives of empirical research in general and in international management research in particular</li> <li>• explain and critically reflect on different ways of organizing empirical research</li> <li>• describe and distinguish ideal-typical research designs</li> </ul> <p><i>Skills</i> Skills: based on the acquired knowledge, Students will be able to</p> <ul style="list-style-type: none"> <li>•</li> <li>• recognize and subsequently assess different risks and other influencing factors while conducting an environmental analysis in an international context</li> <li>• identify typical problems within international management to develop solution proposals</li> <li>• analyze, interpret and present external and internal information in different, international economic contexts</li> <li>• to set up a suitable research design based on specific problems within international management</li> <li>• to assess the influence of different research goals on the selected research design</li> <li>• to conceptualize an ideal research process for a simple research problem</li> <li>• to adequately integrate theoretical knowledge in international management into a research design (qual./quan.)</li> <li>• to critically evaluate the quality and meaningfulness (rigor / relevance) of exemplary empirical studies</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Social competence: After completion of the module Students will be able to</p> <ul style="list-style-type: none"> <li>• conduct subject-specific and interdisciplinary discussions</li> <li>• present results of their work</li> <li>• respectful work in a team</li> </ul> <p><i>Autonomy</i> Self-employment: After completion of the module Students will be able to</p> <ul style="list-style-type: none"> <li>• work independently and to transfer the acquired knowledge to new problem areas</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	33 %	Midterm	
<b>Examination</b>	Subject theoretical and practical work			
<b>Examination duration and scale</b>	approx. 30 pages and presentation			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Core Qualification: Compulsory			

Course L1911: Research Methods in International Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Thomas Wrona
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Foundation of empirical research</li> <li>• Types of scientific statements</li> <li>• Objectives of empirical research (designs)</li> <li>• Special research questions of international management research</li> <li>• Content and process of quantitative international management research</li> <li>• Content and process of qualitative international management research</li> <li>• General issues of empirical research (indication of research designs, quality criteria)</li> <li>• Literature reviews as examples of non-empirical research</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Bortz, J./Döring, N. (2006): Forschungsmethoden und Evaluation für Human- und Sozialwissenschaftler, 4. überarb. Aufl., Nachdruck, Heidelberg 2009.</li> <li>• Brühl, R. (2014): Wie Wissenschaft Wissen schafft - Wissenschaftstheorie für Sozial- und Wirtschaftswissenschaften, Stuttgart 2014 (UTB Taschenbuch)</li> <li>• Bryman, A./Bell, E. (2015). Business research methods. Oxford University Press, USA.</li> <li>• Eisenhardt, K. M./Graebner, M. E. (2007): Theory building from cases: Opportunities and challenges, in: Academy of Management Journal, 50. Jg. 2007, Heft 1, S. 25-32.</li> <li>• Flick, U. (2009). An Introduction to Qualitative Research (4th ed.). Thousand Oaks, CA: Sage Publications.</li> <li>• Kirsch, W./Seidl, D./van Aaken, D. (2007): Betriebswirtschaftliche Forschung. Wissenschaftstheoretische Grundlagen und Anwendungsorientierung, Stuttgart 2007.</li> <li>• Oesterle, Michael-Jörg, and Stefan Schmid. "Internationales Management." Forschung, Lehre, Praxis. Schäffer-Poeschel, Stuttgart (2009).</li> <li>• Töpfer, A. (2009): Erfolgreich forschen, Berlin/Heidelberg 2009.</li> <li>• Wrona, T. (2005): Die Fallstudienanalyse als wissenschaftliche Forschungsmethode, ESCP-EAP Working Paper Nr. 10, Berlin 2005 (wird zum Download zur Verfügung gestellt).</li> <li>• Wrona, T./Bauer, A. (i.V.): Theory-based Qualitative Case Study Research (Lehrbuch in Vorbereitung)</li> </ul> <p>Übungstexte, die während der Vorlesung herausgegeben werden.</p>

Course L0159: Business Environment of Selected Countries	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Thomas Wrona
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Competitiveness of firms/industries/nations/regions</li> <li>• Competition Across Locations &amp; Global Strategy for MNCs</li> <li>• Industry Competition, Strategy and Location</li> <li>• The Diamond Model: developing/developed Economies</li> <li>• Clusters and Cluster Development</li> <li>• Harvard case studies of selected firms/industries/nations/regions</li> <li>• Development and presentation of case studies in groups</li> <li>• Participant-centered learning</li> <li>• Composition of a cluster- and country-related seminar thesis</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Audretsch, D. and Feldman, M. (1996), "Knowledge spillovers and the geography of innovation and production", American Economic Review, Vol. 86 No. 3, pp. 630-640.</li> <li>• Bamberger, I. and Wrona, T. (2012), Strategische Unternehmensführung, 2., erweiterte Auflage, München 2012.</li> <li>• Bamberger, I./Wrona, T. (2012): Strategische Unternehmensführung, 2., erweiterte Auflage, München 2012.</li> <li>• Bell, G.G. (2005), "Clusters, networks, and firm innovativeness", Strategic Management Journal, Vol. 26 No. 3, pp. 287-295.</li> <li>• Krugman, P. (1991), Geography and Trade, MIT Press, Cambridge, MA.</li> <li>• Porter, M.E. (1990), The Competitive Advantage of Nations, Free Press, New York, NY.</li> <li>• Porter, M.E. (1991): Nationale Wettbewerbsvorteile, München 1991</li> <li>• Porter, M.E. (2008): On Competition, Boston MA 2008</li> <li>• Tallman, S., Jenkins, M., Henry, N. and Pinch, S. (2004), "Knowledge, clusters and competitive advantage", Academy of Management Review, Vol. 29 No. 2, pp. 258-271.</li> </ul>

Module M0698: Accounting			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Management and Financial Accounting (L0143)		Lecture	4
Corporate Finance (L0107)		Lecture	2
<b>Module Responsible</b>	Prof. Matthias Meyer		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<p>Basic knowledge of accounting and general business administration.</p> <p>The previous knowledge required for successful completion of this module, in particular of bookkeeping, is imparted within the framework of an e-learning programme.</p> <p>Through an online test, the student can earn points which are added to the final examination result of the module.</p> <p>Students receive access and further information to the corresponding online learning module upon enrolment.</p>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students know ...</p> <ul style="list-style-type: none"> <li>• the basic structure of the current cost recording and allocation and can be used in</li> <li>• Different cost classifications (variable/fixed, individual/joint) and can classify them theoretically;</li> <li>• Subdivide into cost element, cost center and cost object accounting</li> <li>• the concept and necessity of cost centers;</li> <li>• Different costing procedures</li> <li>• simulation-based methods for the design of cost accounting systems</li> <li>• Instruments for cost planning and control;</li> <li>• various partial cost accounting systems as an alternative to full cost accounting and can characterize these comprehensively;</li> <li>• modern developments in cost management;</li> <li>• the Accuracy Effort Tradeoff and variance-based criticisms of Activity-Based Costing</li> <li>• the structure of the balance sheet, and they can explain individual balance sheet items with regard to their approach and valuation</li> <li>• the components of the financial statements according to HGB and IFRS and can explain them;</li> <li>• the difference between the total cost method and the cost of sales method;</li> <li>• Function and methodology of the audit;</li> <li>• the procedure of balance sheet analysis and can explain the steps of method selection, data preparation and data evaluation</li> <li>• the most important financial and performance indicators and can derive them</li> <li>• The role of the finance function in internationally operating companies and the interdependencies between investment and financing</li> <li>• the main theories and models in the field of investment and financing;</li> <li>• Methods for evaluating companies and investment decisions;</li> <li>• Approaches to risk assessment in the field of investment and financing and portfolio theory;</li> <li>• alternative financing options and their specific design and valuation;</li> <li>• the contents and methods of short- and long-term financial planning;</li> </ul> <p><i>Skills</i> The students are able...</p> <ul style="list-style-type: none"> <li>• to explain characteristics of the cost and activity accounting and to apply methods from this range to economical problem definitions</li> <li>• to describe the tasks of cost type, cost centre and cost unit accounting as well as to discuss the classification into the basic schema of cost recording and allocation;</li> <li>to differentiate between different possibilities of the case-by-case special allocation of cost center services and to implement them purposefully;</li> <li>to characterize and apply different calculation methods depending on the homogeneity or heterogeneity of the created activity units;</li> <li>to classify and apply marginal cost accounting as well as contribution margins related to bottlenecks as decision-oriented cost accounting systems and to interpret the results of their analyses;</li> <li>to distinguish cost planning from cost management;</li> <li>To apply process cost accounting and target costing and to interpret the results of their analyses;</li> <li>interpret current research results on the design of cost accounting systems</li> <li>to explain the connections between the different parts of the operational accountancy and to differentiate their addressees and arithmetic variables;</li> <li>to explain and interpret the legal provisions of the German Commercial Code on accounting and bookkeeping and to apply them to common facts of business operations;</li> <li>to identify and critically evaluate differences between HGB and IFRS with respect to material balance sheet items;</li> <li>to explain the technique of balance sheet analysis, to apply it to the annual financial statements of various international companies (including IFRS) and to draw conclusions about the prevailing economic conditions there;</li> <li>to explain theories and models for the investment management of international enterprises, to evaluate their application possibilities and to reflect critically on the results;</li> <li>to apply methods of financial mathematics to investment and financing problems and to use suitable software tools for the calculations;</li> <li>to adequately evaluate investment projects of internationally operating companies using suitable business management methods and indicators, to determine the optimal investment portfolio and to decide on it;</li> </ul>		

# Module Manual M.Sc. "International Management and Engineering"

<p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p><i>Autonomy</i></p>	<p>to determine the capital requirements and capital costs of globally operating companies;  to evaluate financing alternatives and select them based on the results;  to determine, in the context of globalized financial markets, an appropriate level of dividends and the dividend policy of companies, as well as the type, volume, maturity and yield of corporate bonds;  to financially assess the attractiveness of acquisitions by international competitors.</p> <p>The students can...</p> <ul style="list-style-type: none"> <li>• analyse business problems in a team and develop solutions together;</li> <li>present the results of their analyses in an understandable way, also in English;</li> <li>explain the implications of current research results to others and to reflect critically on them together</li> <li>• act as a competent contact within the framework of an audit;</li> <li>• determine the ethical dilemmas of investment and financing decisions and to take them into account within the framework of decision analyses;</li> <li>• assume leadership responsibility in questions of investment and financing in the company, but also in teamwork, and to present technically sound proposals for solutions.</li> </ul> <p>The students are able...</p> <ul style="list-style-type: none"> <li>• to apply the presented methods of cost accounting in order to analyze business problems and to interpret and critically evaluate the results;</li> <li>to critically analyze the capital structure of globally operating companies</li> <li>to transfer the theoretical knowledge about accounting into operational practice;</li> <li>to decide independently which accounting methods can be used for which problems;</li> <li>to acquire knowledge about the subject area independently and to transfer the acquired knowledge to new questions;</li> <li>to use cost accounting systems independently and to design them purposefully;</li> <li>to carry out operational accounting tasks independently, also in internationally active companies;</li> <li>to use methods of the illustration and analysis of the seized business transactions, in order to analyze economical problem definitions and to evaluate the results critically;</li> <li>to interpret and critically evaluate the key figures determined within the framework of a balance sheet analysis;</li> <li>to strategically optimize the capital structure of a company and to use the different forms of corporate financing on the global financial markets in an appropriate manner;</li> <li>to carry out short-term and long-term financial planning;</li> <li>to analyse and optimise the profit and risk position of an internationally operating company;</li> <li>to evaluate companies and make international acquisition decisions.</li> </ul>												
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84												
<b>Credit points</b>	6												
<b>Course achievement</b>	<table border="1"> <thead> <tr> <th>Compulsory</th> <th>Bonus</th> <th>Form</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Yes</td> <td>33 %</td> <td>Midterm</td> <td></td> </tr> <tr> <td>Yes</td> <td>5 %</td> <td>Excercises</td> <td></td> </tr> </tbody> </table>	Compulsory	Bonus	Form	Description	Yes	33 %	Midterm		Yes	5 %	Excercises	
Compulsory	Bonus	Form	Description										
Yes	33 %	Midterm											
Yes	5 %	Excercises											
<b>Examination</b>	Written exam												
<b>Examination duration and scale</b>	120 min												
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Core Qualification: Compulsory												

Course L0143: Management and Financial Accounting	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 64, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Matthias Meyer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>Management Accounting</b></p> <ul style="list-style-type: none"> <li>• Cost type accounting: Cost concepts, recognition and evaluation of resources</li> <li>• Cost center accounting: Expense distribution, stepladder method, equation method, indirect cost apportionment, special settlement of cost center service</li> <li>• Costing: Cause-and-effect principle and marginal principle, output costing, equivalence number costing, overhead calculation, charge rate calculation</li> <li>• Cost unit accounting: unit-of-output costing, cost unit period costing, total cost accounting, cost of sales accounting</li> <li>• Standard cost accounting: Cost resolution, fixed and flexible planned cost calculation, marginal costing</li> <li>• Breakeven analysis: Direct costing, multi-level fixed cost absorption, bottleneck-related contribution margin in operational production program planning</li> <li>• Modern cost management: Relevant Lost, activity based costing, target costing</li> </ul> <p><b>Financial Accounting</b></p> <ul style="list-style-type: none"> <li>• Importance of financial accounting and initial overview</li> <li>• Accounting principles and regulations: General approach, valuation and disclosure regulations (HGB)</li> <li>• Total and sales cost format, annex</li> <li>• International financial reporting (IFRS, US-GAAP)</li> <li>• Accounting policy</li> <li>• Auditing</li> <li>• Balance sheet analysis: Choice of method(s), data processing, data evaluation</li> <li>• Annual report analysis (financial: investment analysis, financing analysis, liquidity analysis; performance: cost analysis, earnings analysis, profitability analysis)</li> </ul> <p><b>Exercise:</b></p> <p>Both parts of the lecture include an exercise. For the Management Accounting part there are also Web-based exercises for self-testing.</p>
<b>Literature</b>	<p><b>Literatur internes Rechnungswesen:</b></p> <ol style="list-style-type: none"> <li>1. Skript und Unterlagen, die zur Vorlesung und Übung herausgegeben werden.</li> <li>2. Ausgewählte Bücher: <ul style="list-style-type: none"> <li>◦ Horngren, C. T. /Bhimani, A./Datar, S. M./Foster, G. (2005): Management and Cost Accounting, 3rd ed., Harlow.</li> <li>• Friedl, G./ Hofmann, C./Pedell, Burkhard. (2010): Kostenrechnung: eine entscheidungsorientierte Einführung, München.</li> <li>• Joos-Sachse, T. (2006): Controlling, Kostenrechnung und Kostenmanagement, 4. Aufl., Stuttgart.</li> <li>• Schweitzer, M./Küpper, H.-U. (2008): Systeme der Kosten- und Erlösrechnung, 9. Aufl., München.</li> <li>• Weber, J./Weißberger, B. (2010): Einführung in das Rechnungswesen, 8. Aufl., Stuttgart.</li> </ul> </li> </ol> <p><b>Literatur externes Rechnungswesen:</b></p> <ol style="list-style-type: none"> <li>1. Skript und Unterlagen, die zur Vorlesung und Übung herausgegeben werden.</li> <li>2. Ausgewählte Bücher: <ul style="list-style-type: none"> <li>◦ Coenenberg, A./Haller, A./Mattner, G./Schultze, W. (2009): Einführung in das Rechnungswesen, 3. Aufl., Stuttgart.</li> <li>• Döring, U./Buchholz, R. (2009): Buchhaltung und Jahresabschluss, 11. Aufl., Berlin.</li> <li>• Heinhold, M. (2010): Buchführung in Fallbeispielen, 11. Aufl., Stuttgart.</li> <li>• Pellens, B./Fülbier, R. U./Gassen, J./Sellhorn, T. (2011): Internationale Rechnungslegung: IFRS 1 bis 9, IAS 1 bis 41, IFRIC-Interpretationen, Standardentwürfe Mit Beispielen, Aufgaben und Fallstudie 8. Aufl., Stuttgart.</li> <li>• Wöhe, G./Döring, U. (2010): Einführung in die allgemeine Betriebswirtschaftslehre, 24. Aufl., München.</li> </ul> </li> </ol> <ol style="list-style-type: none"> <li>1. Gesetzestexte/Standards: <ul style="list-style-type: none"> <li>• Handelsgesetzbuch (HGB) (Achtung: BilMoG!), teilw. Aktiengesetz (AktG)</li> </ul> </li> </ol> <p><a href="http://www.gesetze-im-internet.de/hgb/index.html">http://www.gesetze-im-internet.de/hgb/index.html</a></p>

Course L0107: Corporate Finance	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christian Ringle
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction to corporate finance and financial management of the multinational firm;</li> <li>• Valuation and capital budgeting (e.g., time value of money, valuing stocks and corporate bonds, discounted cash flow, net present value and other criteria, making capital investment decisions);</li> <li>• Risk and return (e.g., measuring risk, risk and diversification, the cost of capital, dividend decisions, valuation principles such as WACC, APV, multiples and real options);</li> <li>• Capital structure (e.g., equity financing and stocks, debt financing and corporate bonds, leasing and off-balance-sheet financing);</li> <li>• Options and futures (e.g., call and put options, warrants and convertibles, financial risk management with derivatives);</li> <li>• Financing and financial planning of the multinational firm (e.g., financial statement analysis, short and long-term financial planning, cash and credit management);</li> <li>• International corporate finance (e.g., foreign exchange exposure and management, international portfolio investments, international mergers and acquisitions);</li> <li>• Comparison of Germany to other countries, especial to the USA, using e.g. case studies and exercises on internationally important topics (financial markets, companies, pension and stock markets, company risk, investments, level of debt).</li> </ul>
<b>Literature</b>	<p><b>Mandatory literature:</b></p> <p>Brealey, R.A./Myers, S.C./Marcus, A.J (2020): Fundamentals of Corporate Finance, 10e, New York: McGraw-Hill.</p> <p><b>Additional literature:</b></p> <p>Brealey, R.A./Myers, S.C./Allen, F. (2020): Principles of Corporate Finance, 13e, New York: McGraw-Hill.</p> <p>Berk, J./DeMarzo, P. (2017): Corporate Finance, 5e, Boston: Pearson.</p> <p>Eun, C.S./Resnick, B.G. (2018): International Financial Management, 8e, New York: McGraw-Hill.</p> <p>Ross, S./Westerfield, R./Jaffe, J./Jordan, B. (2016): Corporate Finance, 11e, New York: McGraw-Hill.</p> <p>Ross, S.A./Westerfield, R.W./Jaffe, J./Jordan, B. (2018): Corporate Finance: Core Principles and Applications, 5e, New York: McGraw-Hill.</p>

Module M0820: International Business			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Business-to-Business Marketing (L0762)	Lecture	2	2
Intercultural Management and Communication (L0846)	Lecture	2	2
International Management (L0157)	Lecture	2	2
<b>Module Responsible</b>	Prof. Christian L�uthje		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<p>Bachelor-level knowledge in marketing and (international) strategic management; basic understanding of market segmentation, modes of market entry, strategic management, pricing theory and marketing instruments.</p> <p>The previous knowledge which is required for this module is taught by e-learning modules. Students receive access data and information regarding the online learning module after enrolment at TUHH.</p>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students will develop a thorough understanding of the following:</p> <ul style="list-style-type: none"> <li>• Selling to organizations and marketing strategies in B2B markets</li> <li>• Relevant theories, methods and tools for operational B2B marketing</li> <li>• Relevant theories for intercultural communication</li> <li>• Theoretical knowledge of                             <ul style="list-style-type: none"> <li>◦ the importance of globalization for firms and the challenges facing companies in the context of their international operations;</li> <li>◦ methods of measuring the internationalization degree of companies and the resulting practical implications;</li> <li>◦ target market strategies, market entry strategies and foreign operation modes and allocation strategies;</li> <li>◦ different types of international organizational structures (e.g. global organization, network organization, transnational organization);</li> <li>◦ "culture" and its impact on human interaction;</li> <li>◦ important aspects of (intercultural) communication issues.</li> <li>◦ methods of analysis and assessment of market entry risks by applying modern theories such as the "Innovator's Dilemma" framework;</li> <li>◦ modes of cooperation such as prime contractor and consortium models and their industrial cooperation related advantages and disadvantages;</li> <li>◦ special methods of assessment of specific country risks;</li> </ul> </li> </ul> <p><i>Skills</i> The students will be able to apply this knowledge to</p> <ul style="list-style-type: none"> <li>• identify and systematically address relevant partners when selling to business organizations;</li> <li>• place, price and communicate industrial products with the help state-of-the-art B2B marketing tools;</li> <li>• define the specifics of global industries and respond to them deriving appropriate practical recommendations (global competitors, regional consumers, local and global suppliers, etc.);</li> <li>• derive advantages and disadvantages of different target market, market entry, timing and allocation strategies;</li> <li>• apply the theoretical knowledge to business cases or real examples (e.g. internationalization processes of well-known hotel chains or franchise companies, etc.);</li> <li>• interpret symbols, rituals and gestures appropriately in an intercultural context.</li> </ul> <p><b>Based on these skills, the students will be able to</b></p> <ul style="list-style-type: none"> <li>• analyze market-entry options and market positioning in B2B markets;</li> <li>• systematically analyze, work up and present information needed for making the decision for or against internationalization of company's operations and regarding HOW, WHEN and WHAT;</li> <li>• analyze and evaluate risks in the context of international business operations;</li> <li>• decide which mode of market entry (e.g. franchising) yields most potential;</li> <li>• make methodically based internationalization decisions as well as master the specifics of strategic management in an international context and apply concrete planning processes;</li> <li>• develop strategies when approaching international client companies and manage relationships with complex client entities;</li> <li>• develop sophisticated market-entry strategies and to position innovative industrial goods in global business-to-business markets;</li> <li>• develop communication strategies in the domain of industrial goods, develop pricing plans by applying state-of-the-art tools like Vickrey-auctions to measure willingness-to-pay and methods such as tender-bidding models.</li> <li>• solve complex operating planning tasks independently or in a team applying appropriate methods and comprehensibly present the results of their analysis;</li> <li>• identify problems and resolve cultural issues in multi-cultural teams and in intercultural collaborations</li> <li>• successfully manage cultural diversity.</li> </ul>		
<b>Personal Competence</b>	<p><i>Social Competence</i> The students will be able to</p> <ul style="list-style-type: none"> <li>• have fruitful professional discussions;</li> <li>• present and defend the results of their work in a group of students;</li> <li>• work successfully in multi-cultural teams</li> <li>• communicate and collaborate successfully and respectfully with others, also on an intercultural basis.</li> </ul>		

Module Manual M.Sc. "International Management and Engineering"

<i>Autonomy</i>	The students will be able to <ul style="list-style-type: none"> <li>• acquire knowledge in the specific context independently and to map this knowledge onto other new complex problem fields.</li> </ul>								
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84								
<b>Credit points</b>	6								
<b>Course achievement</b>	<table border="1"> <thead> <tr> <th>Compulsory</th> <th>Bonus</th> <th>Form</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Yes</td> <td>5 %</td> <td>Excercises</td> <td></td> </tr> </tbody> </table>	Compulsory	Bonus	Form	Description	Yes	5 %	Excercises	
Compulsory	Bonus	Form	Description						
Yes	5 %	Excercises							
<b>Examination</b>	Subject theoretical and practical work								
<b>Examination duration and scale</b>	3 written tests during the semester								
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Core Qualification: Compulsory								

<b>Course L0762: Business-to-Business Marketing</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christian Lüthje
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>Contents</b></p> <p>Business-to-business (B2B) markets play an important role in most economies. At the same time, B2B markets differ strongly from consumer goods markets. For example, companies' buying decisions follow different rules than those of consuming individuals. Consequently, marketing mix decisions in B2B markets need to follow the specific circumstances in such markets.</p> <p>The aim of this lecture is to enable students to understand the specifics of marketing in B2B markets. At the beginning, students learn which strategic marketing decisions may be most appropriate in industrial markets. Following that, the lecture will focus more on different options to design marketing mix elements - Pricing, Communication and Distribution - in B2B markets. We extend the student's basic knowhow in marketing and focus on the specific requirements in B2B markets.</p> <p>Topics</p> <ul style="list-style-type: none"> <li>• The importance, specific characteristics and developments of B2B markets today</li> <li>• Organizational buying behavior and the corporate buying process</li> <li>• B2B marketing strategies regarding modes and time of market entry with focus on innovative industrial products</li> <li>• Types of project-related cooperation in the B2B project business</li> <li>• Specific operational marketing methods in communication (success factors of fairs and exhibitions, importance of public relations for B2B markets); pricing (measuring willingness-to-pay via auctions; value-based pricing in industrial markets, bidding models and auctioning); distribution and channel strategies for B2B markets</li> <li>• Marketing in complex value chains: Solving the problem of direct customers' unwillingness to adopt innovative products by directly addressing indirect customers</li> </ul> <p><b>Knowledge</b></p> <p>The students will develop a thorough understanding of:</p> <ul style="list-style-type: none"> <li>• How organizations and firms buy</li> <li>• How marketing can be performed in complex value chains</li> <li>• Promising market and competitive strategies in B2B markets</li> <li>• Modes of cooperation in B2B markets</li> <li>• Marketing-Mix decisions in B2B marketing (communication, pricing, distribution)</li> </ul> <p><b>Skills</b></p> <ul style="list-style-type: none"> <li>• analyzing the advantages and disadvantages of different target market, market entry, timing and allocation strategies;</li> <li>• identifying and systematically address relevant partners when selling to business organizations;</li> <li>• developing context-specific market-entry and timing strategies;</li> <li>• making appropriate decisions for the pricing and communication of industrial products;</li> <li>• applying the theoretical knowledge to business cases or real examples</li> </ul> <p><b>Social Competence</b></p> <p>The students will be able to</p> <ul style="list-style-type: none"> <li>• having fruitful professional discussions;</li> <li>• presenting and defending the results of their work in groupwork;</li> </ul> <p><b>Self-reliance</b></p> <ul style="list-style-type: none"> <li>• acquiring knowledge in the specific context independently and to map this knowledge onto other new complex problem fields.</li> </ul> <p><b>Assessment</b></p> <p>Written examination &amp; Class participation in interactive elements (presentations, homework)</p>
<b>Literature</b>	<p>Blythe, J., Zimmerman, A. (2005) Business-to-Business Marketing: A global perspective, London, Thomson</p> <p>Monroe, K. B. (2002). Pricing: Making Profitable Decisions, 3<sup>rd</sup> Edition</p> <p>Morris, M., Pitt, L., Honeycutt, E. (2001), Business-to-Business Marketing, New York, Sage Publishing, 3rd Edition</p> <p>Nagle, T., Hogan, J., Zale, J. (2009), Strategy and Tactics of Pricing, New York, Prentice Hall, 5th Edition</p>

Course L0846: Intercultural Management and Communication	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Elke Christiane Fismer
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Globalization of business processes and the revolution in information and communication technologies (ICT) have resulted in distributed workflows across geographic boundaries. These developments as well as increased immigration emanating, for example, as a consequence of a shortage of skilled labour in many industrialized nations, have led to the creation of (virtual) multi-cultural, multi-ethnic teams with diverse cultural backgrounds. Such diversity generally has a positive impact on creativity and innovativeness, as many empirical studies confirm. Nevertheless, varying cultural practices, communication styles, and contextual sensibilities have the potential to disturb or even disrupt collaborative work processes, if left unmanaged.</p> <p>This course focuses on inter-cultural management from both, theoretical as well as practical, points of view to provide a solid fundament to students enabling them to operate successfully in cross-cultural settings. Case studies and guest lecture(s) will be used to provide added practical relevance to the course. In addition, where practicable, student assignments will be used to foster autonomous learning.</p> <p>Some of the main topics covered in this course include:</p> <ul style="list-style-type: none"> <li>• Understanding "culture" and its impact on human interaction</li> <li>• Verbal and non-verbal communication</li> <li>• High and low context communication</li> <li>• Role of formality and non-formality in communication</li> <li>• Varying interpretations of symbols, rituals &amp; gestures</li> <li>• Managing diversity in domestic settings</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Bartlett, C.A. / Ghoshal, S. (2002): Managing Across Borders: The Transnational Solution, 2<sup>nd</sup> edition, Boston</li> <li>• Deresky, H. (2006): International Management: Managing Across Borders and Cultures, 3<sup>rd</sup> edition, Upper Saddle River</li> <li>• French, R. (2010): Cross-cultural Management in Work Organisations, 2<sup>nd</sup> edition, London</li> <li>• Hofstede, G. (2003): Culture's Consequences : Comparing Values, Behaviors, Institutions and Organizations across Nations, 2<sup>nd</sup> edition, Thousand Oaks</li> <li>• Hofstede, G. / Hofstede, G.J. (2006): Cultures and Organizations: Software of the mind, 2<sup>nd</sup> edition, New York</li> </ul>

Course L0157: International Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thomas Wrona
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Growing internationalization of companies and increased globalization require dealing with operations and specifics of international management as well as creating an understanding of intercultural differences. In order to help the students to understand these specifics and challenges accompanying international companies, the course will be divided in the following parts:</p> <ul style="list-style-type: none"> <li>• Important Aspects in International Management</li> <li>• Theories of Internationalization</li> <li>• Specific characteristics of international companies and their strategies</li> <li>• Organizational Structure and Leadership in international companies</li> </ul> <p>During the course, the content will be covered from a theoretical as well as a practical point of view by using examples of different companies. In order to provide practical relevance to the course, a guest speaker from a well-known international company will be invited or alternatively a company visit will be organized as well as an analysis of a case study will take place.</p>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Course notes and materials provided before the lecture.</li> <li>2. Selected books: <ul style="list-style-type: none"> <li>◦ Bartlett/Ghoshal (2002): Managing Across Borders, The Transnational Solution, 2nd edition, Boston</li> <li>◦ Buckley, P.J./Ghauri, P.N. (1998), The Internationalization of the Firm, 2nd edition</li> <li>◦ Czinkota, Ronkainen, Moffett, Marinova, Marinov (2009), International Business, Hoboken</li> <li>◦ Dunning, J.H. (1993), The Globalization of Business: The Challenge of the 1990s, London</li> <li>◦ Ghoshal, S. (1987), Global Strategy: An Organizing Framework, Strategic Management Journal, p. 425-440</li> <li>◦ Praveen Parboteeah, K., Cullen, J.B. (2011), Strategic International Management, International 5th Edition</li> <li>◦ Rugman, A.M./Collinson, S. (2012): International Business, 6th Edition, Essex 2012</li> </ul> </li> </ol>

Module M0524: Non-technical Courses for Master	
<b>Module Responsible</b>	Dagmar Richter
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	None
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b> <i>Knowledge</i>	<p><b>The Nontechnical Academic Programms (NTA)</b></p> <p>imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its <b>teaching architecture</b>, in its <b>teaching and learning arrangements</b>, in <b>teaching areas</b> and by means of teaching offerings in which students can qualify by opting for <b>specific competences</b> and a <b>competence level</b> at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.</p> <p><b>The Learning Architecture</b></p> <p>consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechnical academic programms follow the specific profiling of TUHH degree courses.</p> <p>The learning architecture demands and trains independent educational planning as regards the individual development of competences. It also provides orientation knowledge in the form of "profiles".</p> <p>The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in one to two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making the transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation to study these subjects in one or two specific semesters during the course of studies.</p> <p><b>Teaching and Learning Arrangements</b></p> <p>provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dealing with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are deliberately encouraged in specific courses.</p> <p><b>Fields of Teaching</b></p> <p>are based on research findings from the academic disciplines cultural studies, social studies, arts, historical studies, 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.</p> <p>The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging goal-oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations.</p> <p><b>The Competence Level</b></p> <p>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.</p> <p>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.</p> <p><b>Specialized Competence (Knowledge)</b></p> <p>Students can</p> <ul style="list-style-type: none"> <li>• explain specialized areas in context of the relevant non-technical disciplines,</li> <li>• outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area,</li> <li>• different specialist disciplines relate to their own discipline and differentiate it as well as make connections,</li> <li>• 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,</li> <li>• Can communicate in a foreign language in a manner appropriate to the subject.</li> </ul>
<b>Personal Competence</b> <i>Social Competence</i>	<p><b>Professional Competence (Skills)</b></p> <p>In selected sub-areas students can</p> <ul style="list-style-type: none"> <li>• apply basic and specific methods of the said scientific disciplines,</li> <li>• question a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline,</li> <li>• to handle simple and advanced questions in aforementioned scientific disciplines in a successful manner,</li> <li>• justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.</li> </ul> <p><b>Personal Competences (Social Skills)</b></p>

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<p><i>Autonomy</i></p>	<p>Students will be able</p> <ul style="list-style-type: none"> <li>• to learn to collaborate in different manner,</li> <li>• to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees,</li> <li>• 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),</li> <li>• to explain nontechnical items to auditorium with technical background knowledge.</li> </ul> <p><b>Personal Competences (Self-reliance)</b></p> <p>Students are able in selected areas</p> <ul style="list-style-type: none"> <li>• to reflect on their own profession and professionalism in the context of real-life fields of application</li> <li>• to organize themselves and their own learning processes</li> <li>• to reflect and decide questions in front of a broad education background</li> <li>• to communicate a nontechnical item in a competent way in written form or verbally</li> <li>• to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)</li> </ul>
<p><b>Workload in Hours</b></p>	<p>Depends on choice of courses</p>
<p><b>Credit points</b></p>	<p>6</p>

Course L2029: "Lying press"? Functions and current challenges of journalism	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Mündliche Prüfung
<b>Examination duration and scale</b>	20 min
<b>Lecturer</b>	Prof. Horst Pöttker
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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 19<sup>th</sup> 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.</p> <p>Against this background interactive instructions will be given by scholarly literature and practical examples from the German and international media business.</p> <p>Questions like the following will be discussed:</p> <ul style="list-style-type: none"> <li>• Is journalism really a profession? If so - since when?</li> <li>• What is journalism for? (task and duties, functions, self-images)</li> <li>• Do the audience and journalists themselves have a reasonable understanding of tasks, functions, practices, problems of journalism?</li> <li>• What is the current concept of journalistic professionalism? Has it ever been the same?</li> <li>• From an international perspective: Does journalism in Germany have special shortcomings - if so, how can they be removed?</li> <li>• What are the economic challenges for journalism from the digital media upheaval?</li> <li>• In which direction do journalistic professionalism and self-understanding change in the digital media world?</li> </ul> <p>Objective is solid learning about professional tasks, ethics, techniques, endagerments, history and current problems of journalism including science journalism.</p>
<b>Literature</b>	<p>Zur Einführung:</p> <p>Lilienthal, Volker/Neverla, Irene (Hrsg.) (2017): „Lügenpresse“. Anatomie eines politischen Kampfbegriffs. Köln: Kiepenheuer &amp; Witsch. <a href="https://www.kiwi-verlag.de/buch/luegenpresse/978-3-462-31782-4/">https://www.kiwi-verlag.de/buch/luegenpresse/978-3-462-31782-4/</a></p> <p>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. <a href="https://www.springerprofessional.de/en/der-beruf-zur-oeffentlichkeit/5889108">https://www.springerprofessional.de/en/der-beruf-zur-oeffentlichkeit/5889108</a></p> <p>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. <a href="https://medien21.wordpress.com/2011/10/17/weischenberg-das-jahrhundert-des-journalismus-ist-vorbei/">https://medien21.wordpress.com/2011/10/17/weischenberg-das-jahrhundert-des-journalismus-ist-vorbei/</a></p> <p>Eine ausführliche Literaturliste wird am Anfang des Seminars verteilt.</p> <p>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.</p> <p>Eine ausführliche Literaturliste wird am Anfang des Seminars verteilt.</p>

<b>Course L1775: "What's up, Doc?" Science and Stereotypes in Literature and Film</b>	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Dr. Jennifer Henke
<b>Language</b>	EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>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.</p> <p>Requirements for participation: Shelley, Mary: Frankenstein. New York: Norton, 2012. Please pay attention to the exact publication dates.</p>
<b>Literature</b>	Teilnahmevoraussetzungen: Shelley, Mary: Frankenstein. New York: Norton, 2012. Bitte ausschließlich diese Edition anschaffen.

<b>Course L1774: Applied Arts: Form and Function</b>	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Prof. Margarete Jarchow, Dr. Christian Lechelt
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>From Arts &amp; 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.</p> <p>In the course the impact of social developments on these particular genres are discussed.</p>
<b>Literature</b>	<p>Wird noch angegeben</p> <p>Will be announced in lecture</p>

Course L2890: D: Responsible project management in engineering (for dual study program)	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Schriftliche Ausarbeitung
<b>Examination duration and scale</b>	digitalen Lern- und Entwicklungsberichtes (E-Portfolio)
<b>Lecturer</b>	Dr. Henning Haschke
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Theories and methods of project management</li> <li>• Innovation management</li> <li>• Agile project management</li> <li>• Fundamentals of classic and agile methods</li> <li>• Hybrid use of classic and agile methods</li> <li>• Roles, perspectives and stakeholders throughout the project</li> <li>• Initiating and coordinating complex engineering projects</li> <li>• Principles of moderation, team management, team leadership, conflict management</li> <li>• Communication structures: in-house, cross-company</li> <li>• Public information policy</li> <li>• Promoting commitment and empowerment</li> <li>• Sharing experience with specialists and managers from the engineering sector</li> <li>• Documenting and reflecting on learning experiences</li> </ul>
<b>Literature</b>	Seminarapparat

Course L1441: German as a Foreign Language for International Master Programs	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	4
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 64, Study Time in Lecture 56
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	
<b>Lecturer</b>	Dagmar Richter
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>Master's German course in cooperation with IBH e.V. - Master's German courses at different levels</p> <p>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.</p>
<b>Literature</b>	- Will be announced in lectures -

Course L1884: The Hamburger Speicherstadt - From Achievements of Engineering to World Cultural Heritage	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	20 minütiges Referat mit anschließender Diskussion
<b>Lecturer</b>	Dr. Jörg Schilling
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	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.
<b>Literature</b>	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	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Dr. Oliver Schmidt
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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 emergence and 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 of the 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.</p>
<b>Literature</b>	

Course L2367: Digital art	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	Referat ca. 20 min. plus anschließende Diskussion
<b>Lecturer</b>	Dr. Imke Hofmeister
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>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".</p> <p>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.</p>
<b>Literature</b>	folgt

Course L2891: E: Responsible change and transformation management in engineering (for dual study program)	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Schriftliche Ausarbeitung
<b>Examination duration and scale</b>	Anfertigung eines digitalen Lern- und Entwicklungsberichtes
<b>Lecturer</b>	Dr. Henning Haschke
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Basic concepts, opportunities and limits of organisational change</li> <li>• Models and methods of organisational design and development</li> <li>• Strategic orientation and change, and their short-, medium- and long-term consequences for individuals, organisations and society as a whole</li> <li>• Roles, perspectives and stakeholders in change processes</li> <li>• Initiating and coordinating change measures in engineering</li> <li>• Phase models of organisational change (Lewin, Kotter, etc.)</li> <li>• Change-oriented information policy and dealing with resistance and uncertainty</li> <li>• Promoting commitment and empowerment</li> <li>• Successfully handling change and transformation: personally, as an employee, as a manager (personal, professional, organisational)</li> <li>• Company-level and globally (systemic)</li> <li>• Sharing experience with specialists and managers from the engineering sector</li> <li>• Documenting and reflecting on learning experiences</li> </ul>
<b>Literature</b>	Seminarapparat

Course L2479: Introduction to technology journalism: How research, development and solutions reach the public	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	15 Minuten je 3er Team
<b>Lecturer</b>	Prof. Margarete Jarchow, Matthias Kowalski
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>The participants of the seminar receive skills that can enable them to actively contribute to such discussions.</p> <p>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.</p> <p>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.</p>
<b>Literature</b>	Newman, Nic: Journalism, Media & Technology - Trends and predictions 2019, Reuters Institute/ University of Oxford Digital News Publications <a href="http://www.digitalnewsreport.org/publications/2019/journalism-media-technology-trends-predictions-2019/#executive-summary">http://www.digitalnewsreport.org/publications/2019/journalism-media-technology-trends-predictions-2019/#executive-summary</a> ; Schümchen, Andreas: Technikjournalismus (Riehe Praktischer Journalismus), 328 S., UVK-Verlag 2008

Course L2336: Introduction to Marxian Theory of Economy	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Dr. Martin Schütz
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	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.
<b>Literature</b>	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: <a href="http://www.mlwerke.de/me/me23/me23_000.htm">http://www.mlwerke.de/me/me23/me23_000.htm</a> oder <a href="http://www.zeno.org/Philosophie/M/Marx,+Karl/Das+Kapital">http://www.zeno.org/Philosophie/M/Marx,+Karl/Das+Kapital</a> David Harvey, Marx' Kapital lesen, Hamburg 2017, Seiten 1-214 Begleitend: Harvey selbst hat seine ‚Kapital‘-Seminare (auf Englisch) als Stream veröffentlicht: <a href="http://davidharvey.org/reading-capital/">http://davidharvey.org/reading-capital/</a> 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	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Prof. Margarete Jarchow, Matthias Kowalski
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	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.
<b>Literature</b>	

Course L0970: Foreign Language Course	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Dagmar Richter
<b>Language</b>	
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	In the Field of the Nontechnical Complementary Courses students are able to chose foreign language courses. Therefore the Hamburgerer 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.
<b>Literature</b>	Kursspezifische Literatur / selected bibliography depending on special lecture programm.

Course L1844: Stay Cool in Conflict. Nonviolent Communication by Marshall Rosenberg	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	2-3 Seiten bzw. 10-20 Minuten plus anschließende Besprechung
<b>Lecturer</b>	Dr. Claudia Wunram
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>„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?</p> <p>Nonviolent Communication is a concept developed 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.</p> <p>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 necessary for that.</p>
<b>Literature</b>	<p>German:</p> <ul style="list-style-type: none"> <li>Rosenberg, Marshall. (2001) Gewaltfreie Kommunikation. Eine Sprache des Lebens. Junfermann</li> <li>Rosenberg, Marshall B. und Seils, Gabriele. (15. Auflage 2012) Konflikte lösen durch Gewaltfreie Kommunikation. Ein Gespräch mit Gabriele Seils. Herder Taschenbuch</li> <li>Larsson, Liv. (2013) 42 Schlüsselunterscheidungen in der GFK. Für ein tieferes Verständnis der Gewaltfreien Kommunikation. Junfermann</li> <li>De Haen, Nayoma V. und Torsten Hardieß. (2015) 30 Minuten Gewaltfreie Kommunikation. Gabal</li> <li>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</li> <li>Dietz, Angela. (2015) Macht ohne Machtwort. Verantwortung übernehmen, Potenziale entfalten. Business Village</li> <li>Miyashiro, Marie R. (2013) Der Faktor Empathie. Ein Wettbewerbsvorteil für Teams und Organisationen. Junfermann</li> <li>Brüggemeier, Beate. (2010) Wertschätzende Kommunikation im Business. Wer sich öffnet, kommt weiter. Wie Sie die GFK im Berufsalltag nutzen. Junfermann</li> <li>Heim, Vera und Lindemann, Gabriele. (2016) Beziehungskompetenz im Beruf. Brücken bauen mit Empathie und Gewaltfreier Kommunikation. Haufe Taschen Guide</li> </ul> <p>English:</p> <ul style="list-style-type: none"> <li>Rosenberg, Marshall B., Ph.D. (3<sup>rd</sup> Edition 2015) Nonviolent Communication: A Language of Life. Create your Life, your Relationships, and your World in Harmony with your Values. Puddledancer Press</li> <li>Connor, Jane, Ph.D. and Killian, Dian, Ph.D. (2<sup>nd</sup> edition 2012) Connecting Across Differences: Finding Common Ground with Anyone, Anywhere, Anytime. Puddledancer Press</li> <li>Miyashiro, Marie R. (2011) The Empathy Factor. Your Competitive Advantage for Personal, Team and Business Success. Puddledancer Press</li> <li>Roele, Hugo and Rich-Tolsma, Matthew, Drs. (2015) The Book of Needs. A Structural Model for Listening. Kommunikasie.nl</li> <li>Kashtan, Miki. (2014) Reweaving our Human Fabric. Working Together to Create a Nonviolent Future. Fearless Heart Publications</li> </ul>

Course L2345: Theory, Research and Practice of University Teaching	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Fachtheoretisch-fachpraktische Arbeit
<b>Examination duration and scale</b>	Schriftliche Ausarbeitung (in mehreren Teilen) sowie eine Präsentation
<b>Lecturer</b>	Prof. Christian Kautz, Jenny Alice Rohde
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>For prior knowledge / the event requirements:</p> <p>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.</p>

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, S.L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H. & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. 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 Torenqualifizierung - 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 hochschullehre (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

die hochschullehre 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., Grützmaker, J. & Naumann, H. (2015a). Randauszahlung Studienqualitätsmonitor 2014, Technische Universität Hamburg-Harburg, Online-Befragung Studierender im Sommersemester 2014, DZHW - Deutsches Zentrum für Hochschul- und Wissenschaftsforschung.

Willige, J., Woisch, A., Grützmaker, J. & Naumann, H. (2015b). Randauszahlung 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.

# Module Manual M.Sc. "International Management and Engineering"

Course L1509: Intercultural Communication	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Prof. Margarete Jarchow, Anna Katharina Bartel
<b>Language</b>	EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>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.</p> <p>Content</p> <ul style="list-style-type: none"> <li>• How to enrich the personal character of your presentations <b>by referring to European and your own culture</b></li> <li>• How to properly arrange <b>content and structure</b>.</li> <li>• How to use <b>PowerPoint for visualization</b> (you will use computers in an NIT room).</li> <li>• How to be well-prepared and convincing <b>when delivering</b> your thoughts to your audience.</li> </ul>
<b>Literature</b>	<p>Literaturhinweise werden zu Beginn des Seminars bekanntgegeben.</p> <p>Literature will be announced at the beginning of the seminar.</p>

Course L2015: Intercultural Management - Theory and Awareness Training	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Schriftliche Ausarbeitung
<b>Examination duration and scale</b>	15 Minuten Vortrag und dessen schriftliche Ausarbeitung (10 Seiten)
<b>Lecturer</b>	Prof Jürgen Rothlauf
<b>Language</b>	EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	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.
<b>Literature</b>	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	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Fachtheoretisch-fachpraktische Arbeit
<b>Examination duration and scale</b>	90 Stunden Arbeitsaufwand
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>General procedure of a challenge:</p> <ol style="list-style-type: none"> <li>1. The mini challenge is provided by a city, region or business stakeholder and is entered on the ECIU University Challenge platform (<a href="https://challenges.eciu.org">challenges.eciu.org</a>).</li> <li>2. You register to the mini challenge you find relevant on the platform.</li> <li>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.</li> <li>4. You work with the team on the mini challenge, engage, investigate, and propose non-technical solutions using the challenge-based learning methodology (<a href="https://eciu.tuhh.de/challenge-based-learning/">https://eciu.tuhh.de/challenge-based-learning/</a>).</li> <li>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.</li> <li>6. Finally, teams deliver their outputs - which may include services, products, research questions, start-ups and spin-offs.</li> </ol> <p>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.</p> <p>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: <a href="https://challenges.eciu.org">challenges.eciu.org</a></p> <p><b>"Mini challenges"</b> 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. <a href="https://eciu.tuhh.de/cbl-in-more-detail/">https://eciu.tuhh.de/cbl-in-more-detail/</a></p> <p>This course is aimed at Master students from member universities of the ECIU network (<a href="http://www.eciu.org">www.eciu.org</a>). 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.</p>
<b>Literature</b>	<p>ECIU UNIVERSITY 2030, CONNECTS U FOR LIFE</p> <p><a href="https://www.eciu.org/news/eciu-university-2030-connects-u-for-life">https://www.eciu.org/news/eciu-university-2030-connects-u-for-life</a></p> <p>TOWARDS A EUROPEAN MICRO-CREDENTIALS INITIATIVE</p> <p><a href="https://www.eciu.org/news/towards-a-european-micro-credentials-initiative">https://www.eciu.org/news/towards-a-european-micro-credentials-initiative</a></p>

Course L2852: Join Nano Challenges of the ECIU University	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Examination Form</b>	Fachtheoretisch-fachpraktische Arbeit
<b>Examination duration and scale</b>	30 Stunden Arbeitsaufwand
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>General procedure of a challenge:</p> <ol style="list-style-type: none"> <li>1. The nano challenge is provided by a city, region or business stakeholder and is entered on the ECIU University Challenge platform (<b>challenges.eciu.org</b>).</li> <li>2. You register to the nano challenge you find relevant on the platform.</li> <li>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.</li> <li>4. You work with the team on the nano challenge, engage, investigate, and propose non-technical solutions using the challenge-based learning methodology (<a href="https://eciu.tuhh.de/challenge-based-learning/">https://eciu.tuhh.de/challenge-based-learning/</a>).</li> <li>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.</li> <li>6. Finally, teams deliver their outputs - which may include services, products, research questions, start-ups and spin-offs.</li> </ol> <p>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.</p> <p>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: <a href="https://challenges.eciu.org">challenges.eciu.org</a></p> <p><b>"Nano challenges"</b> 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. <a href="https://eciu.tuhh.de/cbl-in-more-detail/">https://eciu.tuhh.de/cbl-in-more-detail/</a></p> <p>This course is aimed at Master students from member universities of the ECIU network (<a href="http://www.eciu.org">www.eciu.org</a>). 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.</p>
<b>Literature</b>	<p>ECIU UNIVERSITY 2030, CONNECTS U FOR LIFE</p> <p><a href="https://www.eciu.org/news/eciu-university-2030-connects-u-for-life">https://www.eciu.org/news/eciu-university-2030-connects-u-for-life</a></p> <p>TOWARDS A EUROPEAN MICRO-CREDENTIALS INITIATIVE</p> <p><a href="https://www.eciu.org/news/towards-a-european-micro-credentials-initiative">https://www.eciu.org/news/towards-a-european-micro-credentials-initiative</a></p>

Course L2853: Join Standard Challenges of the ECIU University	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	6
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84
<b>Examination Form</b>	Fachtheoretisch-fachpraktische Arbeit
<b>Examination duration and scale</b>	180 Stunden Arbeitsaufwand
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>General procedure of a challenge:</p> <ol style="list-style-type: none"> <li>1. The standard challenge is provided by a city, region or business stakeholder and is entered on the ECIU University Challenge platform (<a href="https://challenges.eciu.org">challenges.eciu.org</a>).</li> <li>2. You register to the standard challenge you find relevant on the platform.</li> <li>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.</li> <li>4. You work with the team on the standard challenge, engage, investigate, and propose non-technical solutions using the challenge-based learning methodology (<a href="https://eciu.tuhh.de/challenge-based-learning/">https://eciu.tuhh.de/challenge-based-learning/</a>).</li> <li>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.</li> <li>6. Finally, teams deliver their outputs - which may include services, products, research questions, start-ups and spin-offs.</li> </ol> <p>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.</p> <p>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: <a href="https://challenges.eciu.org">challenges.eciu.org</a></p> <p><b>"Standard challenges"</b> 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. <a href="https://eciu.tuhh.de/cbl-in-more-detail/">https://eciu.tuhh.de/cbl-in-more-detail/</a></p> <p>This course is aimed at Master students from member universities of the ECIU network (<a href="http://www.eciu.org">www.eciu.org</a>). 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.</p>
<b>Literature</b>	<p>ECIU UNIVERSITY 2030, CONNECTS U FOR LIFE</p> <p><a href="https://www.eciu.org/news/eciu-university-2030-connects-u-for-life">https://www.eciu.org/news/eciu-university-2030-connects-u-for-life</a></p> <p>TOWARDS A EUROPEAN MICRO-CREDENTIALS INITIATIVE</p> <p><a href="https://www.eciu.org/news/towards-a-european-micro-credentials-initiative">https://www.eciu.org/news/towards-a-european-micro-credentials-initiative</a></p>

Course L2176: Culture of Communication - Theories and Methods of Successful Communication	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Anna Katharina Bartel
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>However, this is not always simple. For example:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> If we are part of a context in which many conflicts arise</li> <li><input type="checkbox"/> If we have to switch between different contexts frequently</li> <li><input type="checkbox"/> 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.</li> </ul> <p>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..</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Knoblauch, H. (1995). Kommunikationskultur: Die kommunikative Konstruktion kultureller Kontexte (Materiale Soziologie, Band 5). de Gruyter.</li> <li>• 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.</li> <li>• Bay, Rolf H. (2006) Erfolgreiche Gespräche durch aktives Zuhören. Ehningen. Expert-Verlag.</li> <li>• Cohn, Ruth (1975). Von der Psychoanalyse zur Themenzentrierten Interaktion. Stuttgart. Klett - Cotta</li> <li>• Fongler, Jörg (1998) Feedback geben. Weinheim. Beltz.</li> <li>• Lumma, Klaus (2006). Die Teamfibel oder das Einmaleins der Team- &amp; Gruppenqualifizierung im sozialen und betrieblichen Bereich. Windmühle.</li> <li>• Spies, Stefan. (2010). Der Gedanke lenkt den Körper: Körpersprache - Erfolgsstrategien eines Regisseurs. Hoffmann und Campe.</li> </ul>

Course L2369: Literature and Culture for international students of Master's degree programs in English (non-native speakers of German)	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	4
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 64, Study Time in Lecture 56
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	45 min. Präsentation und anschließende Diskussion
<b>Lecturer</b>	Bertrand Schütz
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>The seminar LITERATURE AND CULTURE investigates what culture is, especially what characterises epistemic cultures.</p> <p>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".</p> <p>There is a growing awareness that Europe cannot lay claim to possess the ultimate standards of knowledge.</p> <p>A topography of our contemporary world is to be sketched by highlighting its historical and cultural premises.</p> <p>For more information please refer to the German description and the StudIP.</p>
<b>Literature</b>	<p>Je nach Thematik des Semesters wird eine spezifische Literatur-Liste erstellt.</p> <p>cf. StudIP</p>

<b>Course L1846: Classical Journalism and New Media</b>	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	Ca. 20 min. plus anschließende Diskussion
<b>Lecturer</b>	Dieter Bednarz
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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“?</p> <p>Keeping a close eye on the real challenges of journalism, the seminar will discuss the standards of ethics in politics and media.</p>
<b>Literature</b>	Wird im Seminar genannt

Course L1023: Politics	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Dr. Stephan Albrecht
<b>Language</b>	EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>The goals of the seminar include:</p> <ul style="list-style-type: none"> <li>• Raising awareness and increasing knowledge about the political implications of scientific work and institutions;</li> <li>• Improving the understanding of different concepts and designs of innovation and technology policies;</li> <li>• Increasing knowledge about the status and perspectives of sustainable development as framework concept for technological and scientific progress;</li> <li>• Understanding core elements of recent arguments, conflicts, and crises on technological innovations, e.g. geo-engineering or bio-economy;</li> <li>• Improving the understanding of scientists' responsibility for impacts of their professional activities;</li> <li>• Embedding individual professional responsibility in social and political contexts.</li> </ul> <p>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.</p> <p>The seminar will start with a profound overarching introduction. Issues will be introduced by a short presentation and a Q &amp; 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.</p>
<b>Literature</b>	Literatur wird zu Beginn des Seminars abgesprochen.

Module Manual M.Sc. "International Management and Engineering"

Course L1856: Politics and Science - in German	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	Referat ca. 20 min. plus anschließende Diskussion
<b>Lecturer</b>	Dr. Mirko Himmel, Dr. Ines Krohn-Molt
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	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.
<b>Literature</b>	Wird im Seminar genannt

Course L1779: Politics and Science - in English	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Dr. Frederik Postelt, Dr. Gunnar Jeremias
<b>Language</b>	EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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 subject to political interpretation. Also, politics are significantly influencing scientific progress by framing research agendas and by funding decisions.</p> <p>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:</p> <ul style="list-style-type: none"> <li>• Governments,</li> <li>• International organizations,</li> <li>• Scientific associations,</li> <li>• Industry,</li> <li>• Civil society, and</li> <li>• Individual scientists.</li> </ul> <p>The guiding questions will be:</p> <ul style="list-style-type: none"> <li>• How does and should science influence politics?</li> <li>• How does and should politics influence science?</li> </ul> <p>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:</p> <ul style="list-style-type: none"> <li>• Biographies and motivations of famous scientists,</li> <li>• Individual responsibility of scientists for the implications of their work, and</li> <li>• The role of codes of conduct as guidelines for responsible behaviour.</li> </ul> <p>The goals of the seminar include:</p> <ul style="list-style-type: none"> <li>• Raising awareness and increasing knowledge about the political dimensions of scientific work,</li> <li>• Providing guidelines for evaluating political implications of scientific research,</li> <li>• Improving the understanding of scientists' and engineers' responsibility for the results of their professional activities,</li> <li>• Taking decisions at the institutional, national and international level about rules and regulations concerning scientific conduct, and</li> <li>• Choosing arguments and defending positions in situations of conflicting interests.</li> </ul> <p>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.</p> <p>Issues will be introduced by short presentations and a Q&amp;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.</p>
<b>Literature</b>	<p>will be announced in lecture</p> <p>wird im Seminar bekannt gegeben</p>

Course L1734: Projectrealisation: TUHH Goes Circular - Sustainability in Research, Education and Campus Management	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<b>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.</b>
<b>Literature</b>	Wird im Seminar bekannt gegeben Will be announced in lecture.

Course L3052: Becoming resilient: Connecting Narratives between Nature and Culture	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	45 Minuten Referat mit schriftlicher Ausarbeitung (Handout)
<b>Lecturer</b>	Jacobus Bracker
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	
<b>Literature</b>	

Course L2649: Brave New World? Technology, Society and Digitalitization in Cinematic Dystopias	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	45 Minuten
<b>Lecturer</b>	Dr. Marlis Bussacker
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	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.
<b>Literature</b>	Wird im Seminar bekannt gegeben.

Course L1872: Social Learning: Social Commitment in Refugee Issues / Master	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Schriftliche Ausarbeitung
<b>Examination duration and scale</b>	10 Seiten
<b>Lecturer</b>	Muthana Al-Temimi
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>This seminar is intended to enable and promote social engagement for refugees and migrants and the social learning that goes along with it.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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</p> <p>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.</p> <p>In addition, the participants are given the opportunity to specifically exchange information with other students from the Master's programs about their social activities.</p>
<b>Literature</b>	<p>Wird im Seminar bekannt gegeben.</p> <p>Will be announced in lecture.</p>

Course L2485: Social Learning: Social Engagement for Sustainability - M.Sc.	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Schriftliche Ausarbeitung
<b>Examination duration and scale</b>	10 Seiten + mündliche Präsentation
<b>Lecturer</b>	Tatjana Grimm
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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.</p>
<b>Literature</b>	-

Course L2480: Social Learning: Social commitment to preservation of historical cultural assets - MSc	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Examination Form</b>	Schriftliche Ausarbeitung
<b>Examination duration and scale</b>	10 Seiten + mündliche Präsentation
<b>Lecturer</b>	Tatjana Grimm
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>This seminar is intended to promote social engagement in the field of natural- and technical history and the associated social learning.</p> <p>"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.</p> <p>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.</p> <p>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.</p>
<b>Literature</b>	-

Course L1771: The Arabic Spring an its Consequences	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Dieter Bednarz
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	<p>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:</p> <p>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.</p> <p>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.</p>
<b>Literature</b>	<p>Wird im Seminar angegeben und besprochen.</p> <p>Will be announced in the lecture.</p>

Course L1885: Urban Life - City and Technology	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	Referat mit Handout
<b>Lecturer</b>	Dr. Anke Rees
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	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.
<b>Literature</b>	Wird im Seminar bekannt gegeben.

Course L1991: What can philosophy do?	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Dr. Ursula Töller
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	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.
<b>Literature</b>	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 Jhd.  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	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Schriftliche Ausarbeitung
<b>Examination duration and scale</b>	Präsentation und schriftliche Ausarbeitung
<b>Lecturer</b>	Dr. Robinson Peric
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	

Course L2343: Academic Writing and Presentation for Master-Students	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2

# Module Manual M.Sc. "International Management and Engineering"

<b>Workload in Hours Examination Form</b>	Independent Study Time 32, Study Time in Lecture 20 Referat
<b>Examination duration and scale</b>	etwa 20 Minuten Präsentation und 10-20 Minuten Diskussion
<b>Lecturer</b>	Dr. Sigrid Vierck
<b>Language</b>	DE
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	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.
<b>Literature</b>	<p><b>Ascheron</b>, Klaus: Die Kunst des wissenschaftlichen Präsentierens und Publizierens. Ein Praxisleitfaden für junge Wissenschaftler. München 2007.</p> <p>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.</p> <p><b>Eufinger</b>, Günther: Dokumente perfekt gestalten. München 2007.</p> <p>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.</p> <p><b>Feuerbacher</b>, Bernd: Professionell Präsentieren in den Natur- und Ingenieurwissenschaften. Weinheim 2009.</p> <p>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.</p> <p><b>Hug</b>, Theo (Hrsg.): Wie kommt Wissenschaft zu Wissen, Band 1: Einführung in das wissenschaftliche Arbeiten. Hohengehren 2001.</p> <p>Weitreichende Einführung, die bereits in den späteren Praxisbereich übergreift. Intensive Behandlung der internetbezogenen Arbeit.</p> <p><b>Kremer</b>, Bruno P.: Vom Referat bis zur Abschlussarbeit. Naturwissenschaftliche Texte perfekt produzieren, präsentieren und publizieren. 5. Aufl. 2018. Berlin, Heidelberg (Imprint: Springer Spektrum).</p> <p>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 Werkstatthanleitung, praxisnah und ermunternd.</p> <p><b>Prexl</b>, Lydia: Mit digitalen Quellen arbeiten: richtig zitieren aus Datenbanken, E-Books, YouTube &amp; Co. 3., aktualisierte und überarbeitete Auflage, Paderborn, Stuttgart 2019 (UTB) <a href="https://elibrary.utb.de/doi/book/10.36198/9783838550725">https://elibrary.utb.de/doi/book/10.36198/9783838550725</a> (Lizenzpflichtig)</p> <p>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.</p> <p><b>Pöhm</b>, Matthias: Präsentieren Sie noch oder faszinieren Sie schon? Der Irrtum PowerPoint. 6. Aufl. Heidelberg 2009.</p> <p>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.</p> <p><b>Pukas</b>, Dietrich: Lernmanagement. Einführung in Lern- und Arbeitstechniken. 3. aktual. Aufl. Rinteln 2008.</p> <p>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.</p> <p><b>Reynolds</b>, Garr: Zen oder die Kunst der Präsentation. München u.a. 2010.</p> <p>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.</p> <p><b>Rost</b>, Friedrich: Lern- und Arbeitstechniken für das Studium. 8., überarb. u. aktual. Aufl. Wiesbaden 2018.</p> <p>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.</p> <p><b>Sesink</b>, Werner: Einführung in das wissenschaftliche Arbeiten: inklusive E-Learning, Web-Recherche, digitale Präsentation u.a. 9., vollst. überarb. u. aktual. Aufl. München 2014.</p> <p>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.</p>

**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 M0554: Quantitative Methods - Statistics and Operations Research			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Quantitative Methods - Statistics and Operations Research (L0127)	Lecture	3	4
Quantitative Methods - Statistics and Operations Research (L0250)	Recitation Section (small)	2	2
<b>Module Responsible</b>	Prof. Kathrin Fischer		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge of Mathematics on the Bachelor Level. Relevant previous knowledge is taught and tested by an online module.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	<p>The students know</p> <ul style="list-style-type: none"> <li>• different methods from the field of descriptive statistics and can explain them and their importance for Business Analysis;</li> <li>• different discrete and continuous distribution functions and can explain their meaning and their areas of application</li> <li>• the laws of probability theory as, e.g. the Bayes rule, and can explain them;</li> <li>• different methods of inferential statistics - e.g. confidence intervals, hypothesis testing and regression analysis - and can explain their theoretical background;</li> <li>• fields of research in which statistical methods are applied;</li> <li>• the history and relevance of Operations Research;</li> <li>• linear programming methods for solving planning problems and can explain them;</li> <li>• selected methods of transportation and network optimization and can explain them;</li> <li>• integer programming models and methods, e.g. for location planning;</li> <li>• appropriate software for solving these problems;</li> <li>• relevant areas of OR research.</li> </ul>		
<i>Skills</i>	<p>Students are able to</p> <ul style="list-style-type: none"> <li>• collect empirical data by appropriate methods, to aggregate, classify and analyze the data and to draw conclusions from them also in complex and realistic situations, e.g. for time series;</li> <li>• recognize different distribution functions and to apply them in the solution of Business problems;</li> <li>• apply laws of probability, as e.g. the Bayes rule, to construct solutions for Business and Engineering problems;</li> <li>• select appropriate methods of inferential statistics, apply them to Business problems and evaluate the results of their analysis;</li> <li>• construct appropriate quantitative - linear or integer - models for Business and Engineering planning situations;</li> <li>• apply methods from linear and integer programming and interpret and evaluate the results;</li> <li>• apply methods from transport and network planning and interpret and evaluate the results;</li> <li>• solve the problems with appropriate software, carry out sensitivity analyses and evaluate the results;</li> <li>• develop a critical judgement of the different methods and their applicability;</li> <li>• use models and methods from Statistics and OR to analyse problems from the areas of business and engineering and to evaluate the results;</li> <li>• apply their theoretical knowledge of the different methods to practical problems, in particular in international value chains and also to apply their knowledge to specific research problems.</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	<p>Students are able to</p> <ul style="list-style-type: none"> <li>• engage in scientific discussions on topics from the fields of Statistics and OR;</li> <li>• present the results of their work to specialists;</li> <li>• work successfully and respectfully in a team.</li> </ul>		
<i>Autonomy</i>	<p>Students are able to</p> <ul style="list-style-type: none"> <li>• carry out complex data analyses independently, individually or in a team;</li> <li>• solve complex Business planning problems independently or in a team, selecting and using appropriate software;</li> <li>• gather knowledge in the area independently and research-based, and to apply their knowledge also in new and unknown situations;</li> <li>• critically evaluate the results of their work and the consequences.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>
	Yes	2.5 %	Excercises
	Yes	47.5 %	Midterm
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	3 hours		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Core Qualification: Compulsory		

<b>Course L0127: Quantitative Methods - Statistics and Operations Research</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>Statistics</b></p> <ul style="list-style-type: none"> <li>• Descriptive Statistics: Graphical representations, calculation of relevant measures of central tendency etc., also by using a computer; application of methods for large data sets, analysis and comparison of results, critical discussion and evaluation of methods and their use in scientific projects and business practice</li> <li>• Probability theory: important laws, dependent probabilities, Bayes Rule; application to practical problems</li> <li>• Use and application of probability distributions , as e.g. Binomial and Normal distribution to Management and Engineering problems</li> <li>• Methods of inferential statistics: confidence intervals: theoretical background and applications; hypothesis testing: theoretical background and application to business problems; regression analysis: theoretical background and application in research practice.</li> </ul> <p><b>Operations Research</b></p> <ul style="list-style-type: none"> <li>• Linear Programming: Modelling business decision situations, solving problems by Simplex method and by using software, theoretical background of Simplex procedure, Dual Simplex procedure and blocked variables, special cases (degeneracy etc.); sensitivity analysis and interpretation</li> <li>• Transportation planning: Modellung transportation and transshipment problems in global networks; Solving transportation problems using software</li> <li>• Network Optimization problems: modelling production and transportation networks, solving planning problems in networks, Network Planning as a research topic</li> <li>• Integer Programming: Models using integer variables, e.g. in location decisions, branch and bound procedure</li> </ul>
<b>Literature</b>	<p>Ausgewählte Bücher:</p> <p>D.R. Anderson / D.J. Sweeney / T.A. Williams / Martin: Quantitative Methods for Business. 11th Edition, Thomson, South Western 2008.</p> <p>Bluman, Alan G.: Elementary Statistics - A brief version. Third Edition, McGrawHill 2006.</p> <p>Bowerman, Bruce L. and O'Connell, Richard T.: Business Statistics in Practice, 8th edition, McGraw-Hill 2016.</p> <p>Domschke, W., Drexl, A.: Einführung in Operations Research, 9. Auflage, Springer, Berlin et al. 2015.</p> <p>Domschke, W. / A. Drexl / R. Klein / A. Scholl / S. Voß: Übungen und Fallbeispiele zum Operations Research, 8. Auflage, Springer, Berlin et al. 2015</p> <p>Hillier, F.S., Lieberman, G.J.: Introduction to Operations Research. 11th Edition, McGraw-Hill, 2014.</p> <p>Schira, J.: Statistische Methoden der VWL und BWL - Theorie und Praxis. 5. Auflage, Pearson Verlag 2016.</p> <p>Zudem: Skript und Unterlagen, die zur Vorlesung herausgegeben werden.</p>

Course L0250: Quantitative Methods - Statistics and Operations Research	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>Statistics</b></p> <ul style="list-style-type: none"> <li>• Descriptive Statistics: Graphical representations, calculation of relevant measures of central tendency etc., also by using a computer; application of methods for large data sets, analysis and comparison of results, critical discussion and evaluation of methods and their use in scientific projects and business practice</li> <li>• Probability theory: important laws, dependent probabilities, Bayes Rule; application to practical problems</li> <li>• Use and application of probability distributions , as e.g. Binomial and Normal distribution to Management and Engineering problems</li> <li>• Methods of inferential statistics: confidence intervals: theoretical background and applications; hypothesis testing: theoretical background and application to business problems; regression analysis: theoretical background and application in research practice.</li> </ul> <p><b>Operations Research</b></p> <ul style="list-style-type: none"> <li>• Linear Programming: Modelling business decision situations, solving problems by Simplex method and by using software, theoretical background of Simplex procedure, Dual Simplex procedure and blocked variables, special cases (degeneracy etc.); sensitivity analysis and interpretation</li> <li>• Transportation planning: Modellung transportation and transshipment problems in global networks; Solving transportation problems using software</li> <li>• Network Optimization problems: modelling production and transportation networks, solving planning problems in networks, Network Planning as a research topic</li> <li>• Integer Programming: Models using integer variables, e.g. in location decisions, branch and bound procedure</li> </ul>
<b>Literature</b>	<p>Ausgewählte Bücher:</p> <p>D.R. Anderson / D.J. Sweeney / T.A. Williams / Martin: Quantitative Methods for Business. 11th Edition, Thomson, South Western 2008.</p> <p>Bluman, Alan G.: Elementary Statistics - A brief version. Third Edition, McGrawHill 2006.</p> <p>Bowerman, Bruce L. and O'Connell, Richard T.: Business Statistics in Practice, 8th edition, McGraw-Hill 2016.</p> <p>Domschke, W., Drexl, A.: Einführung in Operations Research, 9. Auflage, Springer, Berlin et al. 2015.</p> <p>Domschke, W. / A. Drexl / R. Klein / A. Scholl / S. Voß: Übungen und Fallbeispiele zum Operations Research, 8. Auflage, Springer, Berlin et al. 2015</p> <p>Hillier, F.S., Lieberman, G.J.: Introduction to Operations Research. 11th Edition, McGraw-Hill, 2014.</p> <p>Schira, J.: Statistische Methoden der VWL und BWL - Theorie und Praxis. 5. Auflage, Pearson Verlag 2016.</p> <p>Zudem: Skript und Unterlagen, die zur Vorlesung herausgegeben werden.</p>

Module M1002: Production and Logistics Management				
Courses				
Title	Typ	Hrs/wk	CP	
Operative Production and Logistics Management (L1198)	Lecture	2	2	
Strategic Production and Logistics Management (L1089)	Project-/problem-based Learning	3	4	
<b>Module Responsible</b>	Prof. Wolfgang Kersten			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Introduction to Business and Management  The previous knowledge, that is necessary for the successful participation in this module is accessible via e-learning. Log-in and additional information will be distributed during the admission process.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>Students will be able</p> <ul style="list-style-type: none"> <li>- to differentiate between strategic and operational production and logistics management,</li> <li>- to describe the areas of production and logistics management,</li> <li>- understand the difference between traditional and new concepts of production planning and control,</li> <li>- to describe and explain the actual challenges and research areas of production and logistics management, esp. in an international context.</li> </ul> <p><i>Skills</i></p> <p>Based on the acquired knowledge students are capable of</p> <ul style="list-style-type: none"> <li>- Applying methods of production and logistics management in an international context,</li> <li>- Selecting sufficient methods of production and logistics management to solve practical problems,</li> <li>- Selecting appropriate methods of production and logistics management also for non-standardized problems,</li> <li>- Making a holistic assessment of areas of decision in production and logistics management and relevant influence factors,</li> <li>- Design a production and logistics strategy and a global manufacturing footprint systematically.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>After completion of the module students can</p> <ul style="list-style-type: none"> <li>- lead discussions and team sessions,</li> <li>- arrive at work results in groups and document them,</li> <li>- develop joint solutions in mixed teams and present them to others,</li> <li>- present solutions to specialists and develop ideas further.</li> </ul> <p><i>Autonomy</i></p> <p>After completion of the module students can</p> <ul style="list-style-type: none"> <li>- assess possible consequences of their professional activity,</li> <li>- define tasks independently, acquire the requisite knowledge and use suitable means of implementation,</li> <li>- define and carry out research tasks bearing in mind possible societal consequences.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	2.5 %	Exercises	Online-Modul
	No	15 %	Subject theoretical and practical work	PBL
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory International Management and Engineering: Core Qualification: Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Compulsory			

Course L1198: Operative Production and Logistics Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thorsten Blecker
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Further knowledge of operational production management</li> <li>• Traditional production planning and control concepts</li> <li>• Recent production planning and control concepts</li> <li>• Understanding and application of quantitative methods</li> <li>• Further concepts regarding operational production management</li> </ul>
<b>Literature</b>	<p>Corsten, H.: Produktionswirtschaft: Einführung in das industrielle Produktionsmanagement, 12. Aufl., München 2009.</p> <p>Dyckhoff, H./Spengler T.: Produktionswirtschaft: Eine Einführung, 3. Aufl., Berlin Heidelberg 2010.</p> <p>Heizer, J./Render, B: Operations Management, 10. Auflage, Upper Saddle River 2011.</p> <p>Kaluza, B./Blecker, Th. (Hrsg.): Produktions- und Logistikmanagement in Virtuellen Unternehmen und Unternehmensnetzwerken, Berlin et al. 2000.</p> <p>Kaluza, B./Blecker, Th. (Hrsg.): Erfolgsfaktor Flexibilität. Strategien und Konzepte für wandlungsfähige Unternehmen, Berlin 2005.</p> <p>Kurbel, K.: Produktionsplanung und -steuerung, 5., Aufl., München - Wien 2003.</p> <p>Schweitzer, M.: Industriebetriebslehre, 2. Auflage, München 1994.</p> <p>Thonemann, Ulrich (2005): Operations Management, 2. Aufl., München 2010.</p> <p>Zahn, E./Schmid, U.: Produktionswirtschaft I: Grundlagen und operatives Produktionsmanagement, Stuttgart 1996</p> <p>Zäpfel, G.: Grundzüge des Produktions- und Logistikmanagement, 2. Aufl., München - Wien 2001</p>

<b>Course L1089: Strategic Production and Logistics Management</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Wolfgang Kersten
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Identification of the scope of production, operations and logistics management</li> <li>• Understanding of actual challenges concerning production and logistics strategy</li> <li>• Understanding operations as a competitive weapon</li> <li>• Identification and design of the main elements of an operations strategy (level of vertical integration, technology strategy, location strategy, capacity strategy) of a company</li> <li>• Understanding of international conditions for the development of a production and logistics strategy</li> <li>• In depth discussion of different roles and design elements of a global manufacturing footprint</li> <li>• Evaluation of operation strategies of different companies and industrial sectors</li> <li>• In depth discussion of methods and concepts of production and logistics management</li> <li>• In depth discussion of lean management: Main goals and measures of lean management and lean production concepts, impact of lean management on production and logistics strategies</li> <li>• Analysis of the impact of digitalization on production and logistics strategies</li> <li>• Presentation and discussion of current research topics in the field of production and logistics management</li> <li>• Integration of Problem-Based-Learning sessions in order to enhance teamworking and problem solving skills as well as presentation skills</li> </ul>
<b>Literature</b>	<p>Arvis, J.-F. et al. (2018): Connecting to Compete - Trade Logistics in the Global Economy, Washington, DC, USA: The World Bank Group, Download: <a href="https://openknowledge.worldbank.org/handle/10986/29971">https://openknowledge.worldbank.org/handle/10986/29971</a></p> <p>Corsten, H. /Gössinger, R. (2016): Produktionswirtschaft - Einführung in das industrielle Produktionsmanagement, 14. Auflage, Berlin/ Boston: De Gruyter/ Oldenbourg.</p> <p>Heizer, J./ Render, B./ Munson, Ch. (2016): Operations Management (Global Edition), 12. Auflage, Pearson Education Ltd.: Harlow, England.</p> <p>Kersten, W. et al. (2017): Chancen der digitalen Transformation. Trends und Strategien in Logistik und Supply Chain Management, Hamburg: DVV Media Group</p> <p>Nyhuis, P./ Nickel, R./ Tullius, K. (2008): Globales Varianten Produktionssystem - Globalisierung mit System, Garbsen: Verlag PZH Produktionstechnisches Zentrum GmbH.</p> <p>Porter, M. E. (2013): Wettbewerbsstrategie - Methoden zur Analyse von Branchen und Konkurrenten, 12. Auflage, Frankfurt/Main: CampusVerlag.</p> <p>Schröder, M./ Wegner, K., Hrsg. (2019): Logistik im Wandel der Zeit - Von der Produktionssteuerung zu vernetzten Supply Chains, Wiesbaden: Springer Gabler</p> <p>Slack, N./ Lewis, M. (2017): Operations Strategy, 5/e Pearson Education Ltd.: Harlow, England.</p> <p>Swink, M./ Melnyk, S./ Cooper, M./ Hartley, J. (2011): Managing Operations across the Supply Chain, New York u.a.</p> <p>Wortmann, J. C. (1992): Production management systems for one-of-a-kind products, Computers in Industry 19, S. 79-88</p> <p>Womack, J./ Jones, D./ Roos, D. (1990): The Machine that changed the world; New York.</p> <p>Zahn, E. /Schmid, U. (1996): Grundlagen und operatives Produktionsmanagement, Stuttgart: Lucius &amp; Lucius</p> <p>Zäpfel, G.(2000): Produktionswirtschaft: Strategisches Produktions-Management, 2. Aufl., München u.a.</p>

Module M0750: Economics				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
International Economics (L0700)		Lecture	2	2
Main Theoretical and Political Concepts (L0641)		Lecture	2	2
Economics (L2714)		Project-/problem-based Learning	1	2
<b>Module Responsible</b>	Prof. Timo Heinrich			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<p>Basic knowledge of economics is expected.</p> <p>The prior knowledge in the field of economics required for successful completion of this module is imparted as an e-learning offering. Students will receive access and further information on the associated online learning module when they enroll.</p> <p>By taking an associated online test, the student can acquire points that are added to the result of the final examination of the Economics module.</p>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	<p>The students know</p> <ul style="list-style-type: none"> <li>the most important principles of individual decision making in a national and international context,</li> <li>different market structures,</li> <li>types of market failure,</li> <li>the functioning of a single economy (including money market, financial and goods markets, labor market),</li> <li>the difference between and the interdependence of short and long run equilibria,</li> <li>the significance of expectations on the effects of economic policy,</li> <li>the various links between economies and</li> <li>different economic policies (trade, monetary, fiscal and exchange rate policy) and their effects on the home and foreign economies.</li> </ul>			
<i>Skills</i>	<p>The students are able to model analytically or graphically</p> <ul style="list-style-type: none"> <li>the most important principles of individual decision making in a national and international context,</li> <li>the market results of different market structures and market failure,</li> <li>the welfare effects of the market results,</li> <li>the functioning of an economy (including money market, financial and goods markets, labor market),</li> <li>links between economies and</li> <li>the effects of economic policies (trade, monetary, fiscal and exchange rate policies).</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	<p>The students are able</p> <ul style="list-style-type: none"> <li>to anticipate expectations and decisions of individuals or groups of individuals. These may be inside or outside of the own firm,</li> <li>to take these decisions into account while deciding themselves and</li> <li>to understand the behavior of markets and to assess the opportunities and risks with respect to the own business activities.</li> </ul>			
<i>Autonomy</i>	<p>With the methods taught the students will be able</p> <ul style="list-style-type: none"> <li>to analyze empirical phenomena in single economies and the world economy and to reconcile them with the studied theoretical concepts and</li> <li>to design, analyze and evaluate micro- and macroeconomic policies against the background of different models.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	33 %	Presentation	
	Yes	5 %	Excercises	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	60 min			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Core Qualification: Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory			

Course L0700: International Economics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Timo Heinrich
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• International Trade Theory and Policy:                             <ul style="list-style-type: none"> <li>◦ Comparative Advantage - the Ricardian Model</li> <li>◦ The Heckscher-Ohlin Model</li> <li>◦ The Standard Trade Model</li> <li>◦ Intra-sectoral Trade</li> <li>◦ International Trade Policy</li> </ul> </li> <li>• Open Economy Macroeconomics:                             <ul style="list-style-type: none"> <li>◦ The Foreign Exchange Market</li> <li>◦ Determinants of Prices, Interest Rates, Exchange Rates, Output in the Short Run</li> <li>◦ Determinants of Prices, Interest Rates, Exchange Rates, Output in the Long Run</li> <li>◦ Monetary and Fiscal and Exchange Rate Policies in Open Economies in the Long and the Short Run</li> </ul> </li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Mankiw/Taylor: Economics, Cengage, 5<sup>th</sup> ed., 2020</li> <li>• Krugman/Obstfeld/Mehltitz: International Economics, Pearson, 11<sup>th</sup> ed. 2018</li> <li>• The CORE Team: The Economy: Economics for a Changing World, Oxford University Press, 2017</li> </ul>

Course L0641: Main Theoretical and Political Concepts	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Timo Heinrich
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• <b>Introduction: Ten Principles of Economics</b></li> <li>• Microeconomics:                             <ul style="list-style-type: none"> <li>◦ Theory of the Household</li> <li>◦ Theory of the Firm</li> <li>◦ Competitive Markets in Equilibrium</li> <li>◦ Market Failure: Monopoly and External Effects</li> <li>◦ Government Policies</li> </ul> </li> <li>• Macroeconomics:                             <ul style="list-style-type: none"> <li>◦ A Nation's Real Income and Production</li> <li>◦ The Real Economy in the Long Run: Capital and Labour Market</li> <li>◦ Money and Prices in the Long Run</li> <li>◦ Aggregate Demand and Supply: Short-Run Economic Fluctuations</li> <li>◦ Monetary and Fiscal Policy in the Short and the Long Run</li> </ul> </li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Mankiw/Taylor: Economics, Cengage, 5<sup>th</sup> ed., 2020</li> <li>• Pindyck/Rubinfeld, Microeconomics, Pearson, 9<sup>th</sup> ed., 2018</li> <li>• The CORE Team: The Economy: Economics for a Changing World, Oxford University Press, 2017</li> </ul>

Module Manual M.Sc. "International Management and Engineering"

Course L2714: Economics	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Timo Heinrich
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	Students work in teams on in-depth questions related to the contents of the lectures and present the results.
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Mankiw/Taylor: Economics, Cengage, 5<sup>th</sup> ed., 2020</li> <li>• Krugman/Obstfeld/Mehlitz: International Economics, Pearson, 11<sup>th</sup> ed. 2018</li> <li>• Pindyck/Rubinfeld, Microeconomics, Pearson, 9<sup>th</sup> ed., 2018</li> <li>• The CORE Team: The Economy: Economics for a Changing World, Oxford University Press, 2017</li> </ul>

Module M1734: Organization and IT of international companies and supply chains			
Courses			
Title	Typ	Hrs/wk	CP
Logistics and Information Technology (L0065)	Lecture	2	3
Organization and Process Management (L1217)	Project-/problem-based Learning	3	3
<b>Module Responsible</b>	Prof. Wolfgang Kersten		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Foundations of business administration and foundations of logistics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students acquire knowledge of:</p> <ul style="list-style-type: none"> <li>Information systems in logistics and supply chain management as well as critical appraisal of potentials against the background of solid theoretical knowledge</li> <li>Case studies and new technical developments in IT from practice</li> <li>Relevance of information in international companies and supply chains</li> <li>Theoretical knowledge and application of Radio Frequency Identification (RFID)</li> <li>Basics and examples of a process-oriented company organization</li> <li>Design possibilities of the process-oriented structure of organizations for the efficient design of company processes; transfer to nationally and internationally operating practical companies</li> <li>Possibilities of structuring internal and cross-company forms of organization as well as transfer of the theoretically acquired knowledge to examples of international corporate practice; discussion of their applicability in the company as well as considerations of success</li> <li>Possibilities of co-determination on the part of employees and employers in the company; critical discussion and reflection on the legal basis using current examples in corporate practice to promote responsible action</li> <li>Basics on the topics of corporate culture and knowledge management as well as possibilities for shaping them in company practice</li> <li>Digitalization and associated opportunities and challenges for the organization and process management of international companies and supply chains</li> </ul> <p><i>Skills</i> Students acquire the following skills:</p> <ul style="list-style-type: none"> <li>Apply theoretical content, approaches and models of organizational theory and process management</li> <li>Analyze potentials and challenges of digitalization on the organization of international companies and supply chains</li> <li>Evaluate national and international empirical studies in relation to organization and IT in companies and their supply chains</li> <li>Evaluation of the relevance of the availability of information in international companies and supply chains</li> <li>Design and analysis of the process-oriented structure of organizations for the efficient design of corporate processes; transfer to nationally and internationally operating practical companies</li> <li>Weighing up the advantages and disadvantages of process management; developing approaches for its optimization</li> <li>Discussion of practical issues on the basis of theoretical findings or creation of a practical reference through examples and case studies</li> <li>Identification and tracking of technical developments from practice as well as assessment with reference to international companies and supply chains</li> <li>Independent analysis of case studies relevant to the lecture; joint elaboration and development of problem-solving proposals within the framework of intercultural teamwork; preparation of results with the aid of modern presentation media</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to</p> <ul style="list-style-type: none"> <li>work out and develop joint problem-solving proposals within the framework of intercultural teamwork and prepare the results with the help of modern presentation media;</li> <li>to lead subject-specific and interdisciplinary discussions;</li> <li>to represent work results, also in English.</li> </ul> <p><i>Autonomy</i> Students are able to</p> <ul style="list-style-type: none"> <li>independently acquire subject-specific knowledge from the literature, discuss its applicability in the company and weigh up the prospects of success.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 min		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Core Qualification: Elective Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Elective Compulsory		

Course L0065: Logistics and Information Technology	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thorsten Blecker
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Basics of Logistics and Supply Chain Management</li> <li>• Basis of Information Management</li> <li>• Basics of Information Systems</li> <li>• Empirical Studies Related to IT in Supply Chains</li> <li>• Relevance of Information in the Supply Chain</li> <li>• Logistics Information Systems</li> <li>• Radio Frequency Identification (RFID)</li> <li>• E-Logistics</li> <li>• Electronic Sourcing</li> <li>• E-Supply Chains</li> <li>• Case Studies and New Technical Developments</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Kummer, S./Einbock, M., Westerheide, C.: RFID in der Logistik - Handbuch für die Praxis, Wien 2005.</li> </ul> <p>Pepels, W. (Hsg.): E-Business-Anwendungen in der Betriebswirtschaft, Herne/Berlin 2002.</p> <p>Reindl, M./Oberniedermaier, G.: eLogistics: Logistiksysteme und -prozesse im Internetzeitalter, München et al. 2002.</p> <p>Schulte, C.: Logistik, 5. Auflage, München 2009</p> <p>Wildemann, H.: Logistik Prozessmanagement, 4. Aufl., München 2009.</p> <p>Wildemann H. (Hsg.): Supply Chain Management, München 2000.</p>

Course L1217: Organization and Process Management	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Wolfgang Kersten
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Fundamentals of a process-oriented company organization</li> <li>• Analysis of process-oriented business structures for efficient configuration of operational workflows; application to national and international examples from the industry</li> <li>• Description and comparative analysis of possible organizational forms and transfer into the international practice; opportunities to organize a company in practice; pros and cons of different organizational forms</li> <li>• Analysis of possible cooperation forms between companies and applications in the industry</li> <li>• Development of different participation types for employers and employees within the company; discussion and reflection of legal principles based on practical examples</li> <li>• Description of the basics concerning corporate culture and knowledge management, as well as options for the practical implementation</li> <li>• Weighing up the pros and cons of process management; development of optimization options</li> <li>• Digitalization and process management, related requirements for change management</li> <li>• Digitalization and corporate culture including an analysis of different international preconditions</li> <li>• Integration of problem based learning sessions to work on relevant case studies; joint development of possible problem solving solutions within intercultural teams; preparation of the results with modern presentation methods</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Becker, J. / Kugeler, M. / Rosemann, M. (2012): Prozessmanagement: Ein Leitfaden zur prozessorientierten Organisationsgestaltung, 7. Aufl., Berlin.</li> <li>• Bullinger, H.-J. / Warnecke, H. J. (2003): Neue Organisationsformen im Unternehmen, 2. Auflage, Berlin.</li> <li>• Corsten, H., Gössinger, R., Spengler, Th. (Hrsg., 2018): Handbuch Produktions- und Logistikmanagement in Wertschöpfungsnetzwerken, Berlin/Boston</li> <li>• Eversheim, W. (2005): Integrierte Produkt- und Prozessgestaltung, Heidelberg.</li> <li>• Gaitanides, M. (2007): Prozessorganisation: Entwicklung, Ansätze und Programme des Managements von Geschäftsprozessen, 2. Auflage, München.</li> <li>• Hopfenbeck, W. (2002): Allgemeine Betriebswirtschafts- und Managementlehre - das Unternehmen im Spannungsfeld zwischen ökonomischen, sozialen und ökologischen Interessen, 14. Auflage, München.</li> <li>• Kersten, W.; Koller, H.; Lödding, H. (Hrsg.): Industrie 4.0. Wie intelligente Vernetzung und kognitive Systeme unsere Arbeit verändern. Berlin 2014</li> <li>• Kersten, W. et al. (2017): Chancen der digitalen Transformation. Trends und Strategien in Logistik und Supply Chain Management, Bremen</li> <li>• Obermaier, Robert (Hrsg., 2019): Handbuch Industrie 4.0 und Digitale Transformation: Betriebswirtschaftliche, technische und rechtliche Herausforderungen, Wiesbaden</li> <li>• Porter, M. (1999): Wettbewerbsstrategie (competitive strategy): Methoden zur Analyse von Branchen und Konkurrenten, 10. Auflage, Frankfurt.</li> <li>• Schreyögg, G. (2008): Organisation. Grundlagen moderner Organisationsgestaltung. 5. Auflage. GWV Fachverlag. Wiesbaden</li> <li>• Wöhe, G. (2020): Einführung in die Allgemeine Betriebswirtschaftslehre, 27. Aufl., München.</li> </ul>

Module M1733: Foundations in Organizational Design and Human Resource Management			
Courses			
Title	Typ	Hrs/wk	CP
Foundations in Organizational Design and Human Resource Management (Seminar) (L2800)	Seminar	2	3
Foundations in Organizational Design and Human Resource Management (Lecture) (L2799)	Lecture	2	3
<b>Module Responsible</b>	Prof. Christian Ringle		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge on academic writing as well as principles and concepts in business administration.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students will be able to... <ul style="list-style-type: none"> <li>• Explain the core elements and practices of an effective organizational design;</li> <li>• Describe key components of human resource management (e.g., personnel planning, employee testing, training &amp; development) throughout national and international organizations;</li> <li>• Comprehend the meaning and importance of managing human resources in multinational companies and its relation to organizational designs and strategies;</li> <li>• Use adequate data and quantitative methods for decision making in organizational design and human resource management;</li> <li>• Identify critical success in organizations and conduct human resource analytics.</li> </ul>		
<i>Skills</i>	Students will be able to... <ul style="list-style-type: none"> <li>• Apply theoretical knowledge to practical examples;</li> <li>• Write a scientific seminar thesis;</li> <li>• Appropriately present results of their work to others, both in terms of a thesis and oral presentations.</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students will be able to... <ul style="list-style-type: none"> <li>• Respectfully work in teams;</li> <li>• Have fruitful group discussions;</li> <li>• Present their results in written form and oral presentations.</li> </ul>		
<i>Autonomy</i>	The students will be able to... <ul style="list-style-type: none"> <li>• Independently gather knowledge on specific topics;</li> <li>• Critically evaluate and discuss this information;</li> <li>• Transfer the acquired knowledge to practical applications.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 min		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Core Qualification: Elective Compulsory		

Course L2800: Foundations in Organizational Design and Human Resource Management (Seminar)	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christian Ringle
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>This course is structured as a lecture and a seminar. The lecture focuses on gaining an understanding of the fundamentals of human resource management and organizational design. The lecture also introduces quantitative and business analytics methods for decision making in the field. In the lecture, the basic theoretical concepts are explained and discussed, whereas they are applied through the preparation of a seminar thesis in the seminar.</p> <p>Organizational Design &amp; Human Resource Management</p> <ul style="list-style-type: none"> <li>• The processes of developing organizational structures for small and mid-sized corporations as well as for large multinational enterprises;</li> <li>• The adaptation of organizations and their structures to the competitive environment, with special focus on international operating organizations and global markets;</li> <li>• Introduction to human resource management from a strategic and international perspective (incl. the typical challenges of international organizations);</li> <li>• Key elements of human resource management (incl. design of work, employee recruitment, development, separation &amp; retention);</li> <li>• Introduction of methods and models for decision making in organizational design and human resource management.</li> </ul> <p>Possible Applications of the Theoretical Concepts</p> <ul style="list-style-type: none"> <li>• Big data in organizations and human resource analytics;</li> <li>• Business analytics and machine learning methods (e.g., factor analysis, regression analysis, and structural equation modeling);</li> <li>• Models for the management of organizations and human resource management (e.g., job satisfaction and turnover intention, motivation and organizational commitment).</li> </ul>
<b>Literature</b>	<p>This course is structured as a lecture and a seminar. The lecture focuses on gaining an understanding of the fundamentals of human resource management and organizational design. The lecture also introduces quantitative and business analytics methods for decision making in the field. In the lecture, the basic theoretical concepts are explained and discussed, whereas they are applied through the preparation of a seminar thesis in the seminar.</p> <p>Organizational Design &amp; Human Resource Management</p> <ul style="list-style-type: none"> <li>• The processes of developing organizational structures for small and mid-sized corporations as well as for large multinational enterprises;</li> <li>• The adaptation of organizations and their structures to the competitive environment, with special focus on international operating organizations and global markets;</li> <li>• Introduction to human resource management from a strategic and international perspective (incl. the typical challenges of international organizations);</li> <li>• Key elements of human resource management (incl. design of work, employee recruitment, development, separation &amp; retention);</li> <li>• Introduction of methods and models for decision making in organizational design and human resource management.</li> </ul> <p>Possible Applications of the Theoretical Concepts</p> <ul style="list-style-type: none"> <li>• Big data in organizations and human resource analytics;</li> <li>• Business analytics and machine learning methods (e.g., factor analysis, regression analysis, and structural equation modeling);</li> <li>• Models for the management of organizations and human resource management (e.g., job satisfaction and turnover intention, motivation and organizational commitment).</li> </ul>

Course L2799: Foundations in Organizational Design and Human Resource Management (Lecture)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christian Ringle
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>This course is structured as a lecture and a seminar. The lecture focuses on gaining an understanding of the fundamentals of human resource management and organizational design. The lecture also introduces quantitative and business analytics methods for decision making in the field. In the lecture, the basic theoretical concepts are explained and discussed, whereas they are applied through the preparation of a seminar thesis in the seminar.</p> <p>Organizational Design &amp; Human Resource Management</p> <ul style="list-style-type: none"> <li>• The processes of developing organizational structures for small and mid-sized corporations as well as for large multinational enterprises;</li> <li>• The adaptation of organizations and their structures to the competitive environment, with special focus on international operating organizations and global markets;</li> <li>• Introduction to human resource management from a strategic and international perspective (incl. the typical challenges of international organizations);</li> <li>• Key elements of human resource management (incl. design of work, employee recruitment, development, separation &amp; retention);</li> <li>• Introduction of methods and models for decision making in organizational design and human resource management.</li> </ul> <p>Possible Applications of the Theoretical Concepts</p> <ul style="list-style-type: none"> <li>• Big data in organizations and human resource analytics;</li> <li>• Business analytics and machine learning methods (e.g., factor analysis, regression analysis, and structural equation modeling);</li> <li>• Models for the management of organizations and human resource management (e.g., job satisfaction and turnover intention, motivation and organizational commitment).</li> </ul>
<b>Literature</b>	<p>Textbooks</p> <ul style="list-style-type: none"> <li>• Bernardin, H. J. (2006): Human Resource Management: An Experiential Approach, 4e, New York, NY: McGraw-Hill.</li> <li>• Cascio, W. (2015): Managing Human Resources: Productivity, Quality of Work Life, Profits, revised edition, New York, NY: McGraw-Hill.</li> <li>• Dessler, G. (2012): A Framework for Human Resource Management, 7 ed., Upper Saddle River, NJ: Prentice Hall.</li> <li>• French, W., Bell, C. H., Zawacki, R. A. (2004): Organization Development and Transformation: Managing Effective Change, 6e, Chicago, IL: McGraw-Hill.</li> <li>• Gibson, J. L., Ivancevich, J. M., Donnelly, J. H., &amp; Konopaske, R. (2011): Organizations: Behavior, Structure, Processes, 14 ed., New York, NY: McGraw-Hill.</li> <li>• Jones, G. R. (2012): Organizational Theory, Design, and Change, 7 ed., Upper Saddle River, NJ: Prentice Hall.</li> <li>• Noe, R. A., Hollenbeck, J. R., Gerhart, B., Wright, P. M. (2021): Human Resource Management: Gaining a Competitive Advantage, 12 ed., New York, NY: McGraw-Hill.</li> </ul> <p>Methods</p> <ul style="list-style-type: none"> <li>• Hair, J. F., Black, W. C., Babin, B. J. and Anderson, R. E. (2018): Multivariate Data Analysis, Mason, OH: Cengage.</li> <li>• Hair, J. F., Hult, G. T. M., Ringle, C. M. and Sarstedt, M. (2021); A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM), 3 ed., Thousand Oaks, CA: Sage.</li> </ul> <p>Academic writing</p> <ul style="list-style-type: none"> <li>• Davis, M., Davis K. J., &amp; Dunagan, M. M. (2013): Scientific Papers and Presentations. Academic Press.</li> <li>• Katz, M. J. (2009): From Research to Manuscript: A Guide to Scientific Writing. Dordrecht: Springer.</li> </ul>

Module M0916: Project Seminar IWI			
Courses			
Title	Typ	Hrs/wk	CP
Project Seminar IWI (L1064)	Project Seminar	3	6
<b>Module Responsible</b>	Prof. Kathrin Fischer		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Prior knowledge in the relevant area from the relevant Management modules.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The knowledge and the skills which are gained in this module differ depending on the topic of the seminar. In all cases, in-depth knowledge of a certain scientific area and the respective skills are developed by the students, e.g. in-depth knowledge of complexity management in production, in-depth knowledge of the application of simulations in Controlling or in-depth knowledge of specific problems in Strategic Management or Marketing, and the respective skills, e.g. the ability to judge and select different approaches to certain strategic planning problems and to apply them successfully. Hence, the seminar is strongly research oriented.</p> <p><i>Skills</i> Students are able to</p> <ul style="list-style-type: none"> <li>• independently acquire the relevant knowledge to handle their project</li> <li>• independently carry out a (pre-defined) complex research task and/or solve a complex problem</li> <li>• select and use the relevant literature and critically evaluate it</li> <li>• aggregate their knowledge and results and present it to others</li> <li>• write a scientific report on the project / problem at hand, individually or in a team.</li> </ul>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to</p> <ul style="list-style-type: none"> <li>• work respectfully and successfully in a team, organize the team, and solve complex tasks in a team in a given timeframe</li> <li>• analyse a problem in a team and develop a solution for the problem</li> <li>• present the results of their work to specialists.</li> </ul> <p><i>Autonomy</i> Students are able to</p> <ul style="list-style-type: none"> <li>• define the scope of their project</li> <li>• independently acquire relevant scientific knowledge</li> <li>• independently carry out a (pre-defined) complex research task</li> <li>• independently prepare a presentation of the relevant aspects of the project.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written elaboration		
<b>Examination duration and scale</b>	To be announced in seminar.		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Core Qualification: Compulsory		

Course L1064: Project Seminar IWI	
<b>Typ</b>	Project Seminar
<b>Hrs/wk</b>	3
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe/SoSe
<b>Content</b>	Contents differ, depending on the institute which organizes the respective seminar. Topics are always announced at the start of the term.
<b>Literature</b>	Wird je nach Thema angegeben; in der Regel handelt es sich um wissenschaftliche Fachartikel und Publikationen, vorwiegend in englischer Sprache.

**Specialization I. Electives Management**

Module M0855: Marketing (Sales and Services / Innovation Marketing)			
Courses			
Title	Typ	Hrs/wk	CP
Marketing of Innovations (L2009)	Lecture	4	4
PBL Marketing of Innovations (L0862)	Project-/problem-based Learning	1	2
<b>Module Responsible</b>	Prof. Christian L�uthje		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>Module International Business</li> <li>Basic understanding of business administration principles (strategic planning, decision theory, project management, international business)</li> <li>Bachelor-level Marketing Knowledge (Marketing Instruments, Market and Competitor Strategies, Basics of Buying Behavior)</li> <li>Understanding the differences between B2B and B2C marketing</li> <li>Understanding of the importance of managing innovation in global industrial markets</li> <li>Good English proficiency; presentation skills</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students will have gained a deep understanding of</p> <ul style="list-style-type: none"> <li>Specific characteristics in the marketing of innovative products and services</li> <li>Approaches for analyzing the current market situation and the future market development</li> <li>The gathering of information about future customer needs and requirements</li> <li>Concepts and approaches to integrate lead users and their needs into product and service development processes</li> <li>Approaches and tools for ensuring customer-orientation in the development of new products and innovative services</li> <li>Marketing mix elements that take into consideration the specific requirements and challenges of innovative products and services</li> <li>Pricing methods for new products and services</li> <li>The organization of complex sales forces and personal selling</li> <li>Communication concepts and instruments for new products and services</li> </ul> <p><i>Skills</i> Based on the acquired knowledge students will be able to:</p> <ul style="list-style-type: none"> <li>Design and to evaluate decisions regarding marketing and innovation strategies</li> <li>Analyze markets by applying market and technology portfolios</li> <li>Conduct forecasts and develop compelling scenarios as a basis for strategic planning</li> <li>Translate customer needs into concepts, prototypes and marketable offers and successfully apply advanced methods for customer-oriented product and service development</li> <li>Use adequate methods to foster efficient diffusion of innovative products and services</li> <li>Choose suitable pricing strategies and communication activities for innovations</li> <li>Make strategic sales decisions for products and services (i.e. selection of sales channels)</li> <li>Apply methods of sales force management (i.e. customer value analysis)</li> </ul>		
<b>Personal Competence</b>	<p><i>Social Competence</i> The students will be able to</p> <ul style="list-style-type: none"> <li>have fruitful discussions and exchange arguments</li> <li>develop original results in a group</li> <li>present results in a clear and concise way</li> <li>carry out respectful team work</li> </ul> <p><i>Autonomy</i> The students will be able to</p> <ul style="list-style-type: none"> <li>Acquire knowledge independently in the specific context and to map this knowledge on other new complex problem fields.</li> <li>Consider proposed business actions in the field of marketing and reflect on them.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	Written elaboration, exercises, presentation, oral participation		
<b>Assignment for the Following Curricula</b>	Global Technology and Innovation Management & Entrepreneurship: Core Qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory		

<b>Course L2009: Marketing of Innovations</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 64, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Christian Lüthje
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>I. Introduction</p> <ul style="list-style-type: none"> <li>Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing)</li> </ul> <p>II. Methods and approaches of strategic marketing planning</p> <ul style="list-style-type: none"> <li>patterns of industrial development, patent and technology portfolios</li> </ul> <p>III. Strategic foresight and scenario analysis</p> <ul style="list-style-type: none"> <li>objectives and challenges of strategic foresight, scenario analysis, Delphi method</li> </ul> <p>IV. User innovations</p> <ul style="list-style-type: none"> <li>Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis</li> </ul> <p>V. Customer-oriented Product and Service Engineering</p> <ul style="list-style-type: none"> <li>Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting</li> </ul> <p>VII. Pricing</p> <ul style="list-style-type: none"> <li>Basics of Pricing, Value-based pricing, Pricing models</li> </ul> <p>VIII. Sales Management</p> <ul style="list-style-type: none"> <li>Basics of Sales Management, Assessing Customer Value, Planning Customer Visits</li> </ul> <p>IX. Communications</p> <ul style="list-style-type: none"> <li>Diffusion of Innovations, Communication Objectives, Communication Instruments</li> </ul>
<b>Literature</b>	<p><b>Mohr, J., Sengupta, S., Slater, S. (2014). Marketing of high-technology products and innovations, third edition, Pearson education. ISBN-10: 1292040335 . Chapter 6 (188-210), Chapter 7 (227-256), Chapter 10 (352-365), Chapter 12 (419-426).</b></p> <p>Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition, McGraw Hill, Boston et al., 2008</p> <p>Christensen, C. M. (1997). Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Harvard Business Press, Chapter 1: How can great firms fail?, pp. 3-24.</p> <p>Hair, J. F., Bush, R. P., Ortinau, D. J. (2009). Marketing research. 4<sup>th</sup> edition, Boston et al., McGraw Hill</p> <p>Tidd; J. &amp; Hull, Frank M. (Editors) (2007) Service Innovation, London</p> <p>Von Hippel, E.(2005). Democratizing Innovation, Cambridge: MIT Press</p>

<b>Course L0862: PBL Marketing of Innovations</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Christian Lüthje
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>This PBL course is segregated into two afternoon sessions. This course aims at enhancing the students' practical skills in (1) forecasting the future development of markets and (2) making appropriate market-related decisions (particularly segmentation, managing the marketing mix). The students will be prompted to use the knowledge gathered in the lecture of this module and will be invited to (1) Conduct a scenario analysis for an innovative product category and (2) Engage in decision making within a market simulation game.</p>
<b>Literature</b>	

Module M0996: Supply Chain Management				
Courses				
Title	Typ	Hrs/wk	CP	
Supply Chain Management (L1218)	Project-/problem-based Learning	3	4	
Value-Adding Networks (L1190)	Lecture	2	2	
<b>Module Responsible</b>	Prof. Thorsten Blecker			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	no			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>Current developments in international business activities such as outsourcing, offshoring, internationalization and globalization and emerging markets illustrated by examples from practice.</p> <ul style="list-style-type: none"> <li>Theoretical Approaches and methods in logistics and supply chain management and use in practice.</li> <li>to identify fields of decision in SCM .</li> <li>reasons for the formation of networks based on various theories from institutional economics (transaction cost theory, principal-agent theory, property-right theory) and the resource-based view.</li> <li>Selected approaches to explain the development of networks.</li> <li>to illustrate phases of network formation.</li> <li>to understand the functional mechanisms of inter-organizational and international network relationships.</li> <li>to explain and categorize relationships within networks.</li> <li>to categorize sourcing concepts and explain motives/ barriers or advantages and disadvantages.</li> <li>advantages and disadvantages of offshoring and outsourcing and to illustrate the distinction between the two terms .</li> <li>to state criteria/ factors/ parameters that influence production location decisions at the global level (total network costs).</li> <li>to explain methods for location finding/evaluation.</li> <li>to interpret phenotypes of production networks.</li> <li>recognize relationships between R &amp; D and production and their locations and to describe coherent models.</li> <li>to solve sub-problems with the configuration of logistics networks (distribution and spare parts networks ) by the use of appropriate approaches.</li> <li>to categorise special waste logistics including their duties &amp; objectives and to state and describe practical examples of good networking.</li> </ul> <p><i>Skills</i></p> <ul style="list-style-type: none"> <li>to asses trends and challenges in national and international supply chains and logistics networks and their consequences for companies.</li> <li>to evaluate, analyse and systematise networks and network relations based on the lecture.</li> <li>to analyse partners and their suitability for co-operation in collaborations and cooperative relations.</li> <li>to select sourcing concepts for specific products / product components based on the lecture as well as advantages and disadvantages of each approach.</li> <li>to evaluate location decisions for production and R &amp; D based on concepts.</li> <li>to recognize relationships between R &amp; D and production as well as their locations and to evaluate the suitability of specific models for different situations.</li> <li>to transfer the analyzed concepts to international practices.</li> <li>to analyse and evaluate the product development processes.</li> <li>to analyse concepts of Information and communication management in logistics.</li> <li>to design subcontracting, procurement, production and disposal as well as R &amp; D networks to shape,</li> <li>to plan reorganise efficient and flow-oriented enterprise networks.</li> <li>to adopt methods of complexity management and risk management in logistics.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <ul style="list-style-type: none"> <li>to evaluate intercultural and international relationships based on discussed case studies.</li> <li>advance planning and design of network formation and their objectives based on content discussed in the lecture.</li> <li>definition of procurement strategies for individual parts using the gained knowledge of procurement networks.</li> <li>design of the procurement network (external/internal/modules etc.) based on the sourcing concepts and core competencies, as well as on the findings of the case studies.</li> <li>to make decision of location for production taking into account global contexts, evaluation methods and buying/selling markets, which were also discussed in the case studies and their dependence on R &amp; D.</li> <li>Decision on R &amp; D locations based on the insights gained from case studies / practical examples and the selection of an appropriate model.</li> </ul> <p><i>Autonomy</i></p> <p>After completing the module students are capable to work independently on the subject of Supply Chain Management and transfer the acquired knowledge to new problems.</p>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	15 %	Subject	theoretical and practical work
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory			

Course L1218: Supply Chain Management	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Wolfgang Kersten
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Vermittlung eines tiefgreifenden Verständnisses von Logistik und Supply Chain Management</li> <li>• Vermittlung umfassender theoretischer Ansätze und Methoden in der Logistik und im Supply Chain Management; Übertragung der analysierten Konzepte auf Praxisbeispiele</li> <li>• Ausarbeitung und kritische Diskussion unterschiedlicher Supply Chain Konfigurationen sowie strategischer Supply Chain Ansätze (z.B. Effizienz vs. Reaktionsfähigkeit)</li> <li>• Einführung in die Managementprozesse des SCOR-Modells; Vermittlung von Konzepten der Bereiche Planung, Beschaffung/Einkauf und Distribution</li> <li>• Vermittlung von Grundlagen des Supply Chain Risikomanagements; Übertragung der Konzepte auf Praxisbeispiele</li> <li>• Einführung in die digitale Transformation; Identifikation von Trends und Strategien in der Logistik und Supply Chain Management; Ableitung von Chancen der digitalen Transformation in der Logistik und Supply Chain Management</li> <li>• Einführung in die Datenanalyse und -visualisierung mithilfe eines Tools; Anwenden der Kenntnisse auf Themengebiete in der Logistik und Supply Chain Management; Aufbereitung der Ergebnisse mit Hilfe moderner Präsentationsmedien</li> </ul>
<b>Literature</b>	<p>Bowersox, D. J., Closs, D. J. und Cooper, M. B. (2010): Supply chain logistics management, 3<sup>rd</sup> edition, Boston [u.a.]: McGraw-Hill/Irwin.</p> <p>Chopra, S. und Meindl, P. (2016): Supply chain management: strategy, planning, and operation, 6<sup>th</sup> edition, Boston [u.a.]: Pearson.</p> <p>Corsten, H., Gössinger, R. (2007): Einführung in das Supply Chain Management, 2. Aufl., München/Wien: Oldenbourg.</p> <p>Corsten, H., Gössinger, R., Spengler, Th. (Hrsg., 2018): Handbuch Produktions- und Logistikmanagement in Wertschöpfungsnetzwerken, Berlin/Boston.</p> <p>Heiserich O., Helbig, K. und Ullmann, W. (2011): Logistik, 4. vollständig überarbeitete und erweiterte Auflage, Wiesbaden: Gabler Verlag/ Springer Fachmedien.</p> <p>Heizer, J., Render, B., Munson, Ch. (2020): Principles of Operations Management, 11<sup>th</sup> edition, Boston: Pearson.</p> <p>Hugos, M. (2018): Essentials of Supply Chain Management, Wiley.</p> <p>Fisher, M. (1997): What is the right supply chain for your product?, Harvard Business Review, Vol. 75, No. pp., S. 105-117.</p> <p>Kersten, W. Seiter, M., von See, B, and Hackius, N. und Maurer, T. (2017): Trends und Strategien in Logistik und Supply Chain Management: Chancen der digitalen Transformation, DVV Media Group GmbH: Hamburg.</p> <p>Kuhn, A. und Hellingrath, B. (2002): Supply Chain Management: optimierte Zusammenarbeit in der Wertschöpfungskette, Berlin [u.a.]: Springer.</p> <p>Larson, P, Poist, R. and Halldórsson, Á. (2007): Perspectives on logistics vs. SCM: a survey of SCM professionals, in: Journal of Business Logistics, Vol. 28, No. 1, S. 1-24.</p> <p>Kummer, S., Grün, O. und Jammernegg, W. (2018): Grundzüge der Beschaffung, Produktion und Logistik, 4. aktualisierte Auflage, München: Pearson Studium.</p> <p>Obermaier, Robert (Hrsg., 2019): Handbuch Industrie 4.0 und Digitale Transformation: Betriebswirtschaftliche, technische und rechtliche Herausforderungen, Wiesbaden.</p> <p>Porter, M. (1986): Changing Patterns of International Competition, California Management Review, Vol. 28, No. 2, S. 9-40.</p> <p>Schröder, M./ Wegner, K., Hrsg. (2019): Logistik im Wandel der Zeit - Von der Produktionssteuerung zu vernetzten Supply Chains, Wiesbaden: Springer Gabler</p> <p>Simchi-Levi, D., Kaminsky, P. und Simchi-Levi, E. (2008): Designing and managing the supply chain: concepts, strategies and case studies, 3<sup>rd</sup> edition, Boston [u.a.]: McGraw-Hill/Irwin.</p> <p>Supply Chain Council (2014): Supply Chain Operations Reference (SCOR) model: Overview - Version 11.0.</p> <p>Swink, M., Melnyk, S. A., Cooper, M. B. und Hartley, J. L. (2011): Managing Operations - Across the Supply Chain. 2<sup>nd</sup> edition, New York, NY: McGraw-Hill/Irwin.</p> <p>Weele, A. J. v. (2005): Purchasing &amp; supply chain management, 4<sup>th</sup> edition, London [u.a.]: Thomson Learning.</p>

Course L1190: Value-Adding Networks	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thorsten Blecker
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction: Overview of current trade flows and development of global business cooperation</li> <li>• Networks explanations using neo institutional approaches as a theoretical basis</li> <li>• Networks organization and functioning</li> <li>• Development stages of networks</li> <li>• Presentation of different network types such as supplier, production, disposal and logistics network as well as their respective requirements, peculiarities and characteristics</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• <b>Ballou, R.</b> Business Logistics/Supply Chain Management, Upper Saddle River 2004.</li> <li>• <b>Bellmann, K.</b> (Hrsg.): Kooperations- und Netzwerkmanagement, Berlin 2001.</li> <li>• <b>Bretzke, W.R.</b>: Logistische Netzwerke, Berlin Heidelberg 2008.</li> <li>• <b>Blecker, Th. / Gemünden, H. G.</b> (Hrsg.): Wertschöpfungsnetzwerke, Berlin 2006.</li> <li>• <b>Kaluza, B. / Blecker, Th.</b> (Hrsg.): Produktions- und Logistikmanagement in virtuellen Unternehmen und Unternehmensnetzwerken, Berlin et al. 2000.</li> <li>• <b>Sydow, J. / Möllering</b>: Produktion in Netzwerken, Berlin 2009.</li> <li>• <b>Willibald A. G.</b> (Hrsg.): Neue Wege in der Automobillogistik, Berlin Heidelberg 2007.</li> </ul>

Module M1034: Technology Entrepreneurship			
Courses			
Title	Typ	Hrs/wk	CP
Creation of Business Opportunities (L1280)	Project-/problem-based Learning	3	4
Entrepreneurship (L1279)	Lecture	2	2
<b>Module Responsible</b>	Prof. Christoph Ihl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge in business economics obtained in the compulsory modules as well as an interest in new technologies and the pursuit of new business opportunities either in corporate or startup contexts.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Wissen (subject-related knowledge and understanding):</p> <ul style="list-style-type: none"> <li>• develop a working knowledge and understanding of the entrepreneurial perspective</li> <li>• understand the difference between a good idea and scalable business opportunity</li> <li>• understand the process of taking a technology idea and finding a high-potential commercial opportunity</li> <li>• understand the components of business models</li> <li>• understand the components of business opportunity assessment and business plans</li> </ul> <p><i>Skills</i></p> <ul style="list-style-type: none"> <li>• Fertigkeiten (subject-related skills):                             <ul style="list-style-type: none"> <li>◦ identify and define business opportunities</li> <li>◦ assess and validate entrepreneurial opportunities</li> <li>◦ create and verify a business model of how to sell and market an entrepreneurial opportunity</li> <li>◦ formulate and test business model assumptions and hypotheses</li> <li>◦ conduct customer and expert interviews regarding business opportunities</li> <li>◦ prepare business opportunity assessment</li> <li>◦ create and verify a plan for gathering resources such as talent and capital</li> <li>◦ pitch a business opportunity to your classmates and the teaching team</li> </ul> </li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Sozialkompetenz (Social Competence):</p> <ul style="list-style-type: none"> <li>• team work</li> <li>• communication and presentation</li> <li>• give and take critical comments</li> <li>• engaging in fruitful discussions</li> </ul> <p><i>Autonomy</i> Selbständigkeit (Autonomy):</p> <ul style="list-style-type: none"> <li>• autonomous work and time management</li> <li>• project management</li> <li>• analytical skills</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	Three presentations on the respective project status		
<b>Assignment for the Following Curricula</b>	Global Technology and Innovation Management & Entrepreneurship: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory		

<b>Course L1280: Creation of Business Opportunities</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Christoph Ihl, Dr. Hannes Lampe
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Important note: This course is part of an 6 ECTS module consisting of two courses "Entrepreneurship" &amp; "Creation of Business Opportunities", which have to be taken together in one semester.</p> <p>Startups are temporary, team-based organizations, which can form both within and outside of established companies, to pursue one central objective: taking a new venture idea to market by designing a business model that can be scaled to a full-grown company. In this course, students will form startup teams around self-selected ideas and run through the process just like real startups would do in the first three months of intensive work. Startup Engineering takes an incremental and iterative approach, in that it favors variety and alternatives over one detailed, linear five-year business plan to reach steady state operations. From a problem solving and systems thinking perspective, student teams create different possible versions of a new venture and alternative hypotheses about value creation for customers and value capture vis-à-vis competitors. We will draw on recent scientific findings about international success factors of new venture design. To test critical hypotheses early on, student teams engage in scientific, evidence-based, experimental trial-and-error learning process that measures real progress.</p> <p>Upon completion of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>· Apply a modern innovation toolkit relevant in both the corporate &amp; startup world</li> <li>· Analyze given business opportunities in terms of its constituent elements</li> <li>· Design new business models by gathering and combining relevant ideas, facts and information</li> <li>· Evaluate business opportunities and derive judgment about next steps &amp; decisions</li> </ul> <p>Course language is English, but participants can decide to give their graded presentations in German. Students are invited to apply to this course module already with a startup idea and/ or team, but this is not a requirement! We will form teams and ideas in the beginning of the course. Class meetings have alternate intervals of lecture inputs, teamwork, mentoring, and peer feedback. Attendance is mandatory for at least 80% of class time due to large proportion of teamwork sessions.</p> <p>Student teams give three presentations and submit them with backup analyses. Grading scheme:</p> <ul style="list-style-type: none"> <li>· Startup discovery presentation after 5 weeks: 30%</li> <li>· Startup validation presentation after 10 weeks: 30%</li> <li>· Final startup pitches after 13 weeks: 40%</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Blank, S. &amp; Dorf, B. (2012). The startup owner's manual.</li> <li>• Gans, J. &amp; Stern, S. (2016). Entrepreneurial Strategy.</li> <li>• Osterwalder, A. &amp; Yves, P. (2010). Business model generation.</li> <li>• Maurya, A. (2012). Running lean: Iterate from plan A to a plan that works.</li> <li>• Maurya, A. (2016). Scaling lean: Mastering the Key Metrics for Startup Growth.</li> <li>• Wilcox, J. (2016). FOCUS Framework: How to Find Product-Market Fit.</li> </ul>

Course L1279: Entrepreneurship	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christoph Ihl
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Important note: This course is part of an 6 ECTS module consisting of two courses "Entrepreneurship" &amp; "Creation of Business Opportunities", which have to be taken together in one semester.</p> <p>Startups are temporary, team-based organizations, which can form both within and outside of established companies, to pursue one central objective: taking a new venture idea to market by designing a business model that can be scaled to a full-grown company. In this course, students will form startup teams around self-selected ideas and run through the process just like real startups would do in the first three months of intensive work. Startup Engineering takes an incremental and iterative approach, in that it favors variety and alternatives over one detailed, linear five-year business plan to reach steady state operations. From a problem solving and systems thinking perspective, student teams create different possible versions of a new venture and alternative hypotheses about value creation for customers and value capture vis-à-vis competitors. We will draw on recent scientific findings about international success factors of new venture design. To test critical hypotheses early on, student teams engage in scientific, evidence-based, experimental trial-and-error learning process that measures real progress.</p> <p>Upon completion of this course, students will be able to:</p> <ul style="list-style-type: none"> <li>· Apply a modern innovation toolkit relevant in both the corporate &amp; startup world</li> <li>· Analyze given business opportunities in terms of its constituent elements</li> <li>· Design new business models by gathering and combining relevant ideas, facts and information</li> <li>· Evaluate business opportunities and derive judgment about next steps &amp; decisions</li> </ul> <p>Course language is English, but participants can decide to give their graded presentations in German. Students are invited to apply to this course module already with a startup idea and/ or team, but this is not a requirement! We will form teams and ideas in the beginning of the course. Class meetings have alternate intervals of lecture inputs, teamwork, mentoring, and peer feedback. Attendance is mandatory for at least 80% of class time due to large proportion of teamwork sessions. Student teams give three presentations and submit them with backup analyses. Grading scheme:</p> <ul style="list-style-type: none"> <li>· Startup discovery presentation after 5 weeks: 30%</li> <li>· Startup validation presentation after 10 weeks: 30%</li> <li>· Final startup pitches after 13 weeks: 40%</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Blank, S. &amp; Dorf, B. (2012). The startup owner's manual.</li> <li>• Gans, J. &amp; Stern, S. (2016). Entrepreneurial Strategy.</li> <li>• Osterwalder, A. &amp; Yves, P. (2010). Business model generation.</li> <li>• Maurya, A. (2012). Running lean: Iterate from plan A to a plan that works.</li> <li>• Maurya, A. (2016). Scaling lean: Mastering the Key Metrics for Startup Growth.</li> <li>• Wilcox, J. (2016). FOCUS Framework: How to Find Product-Market Fit.</li> </ul>

Module M0866: EIP and Productivity Management				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Elements of Integrated Production Systems (L0927)		Project-/problem-based Learning	2	3
Productivity Management (L0928)		Project-/problem-based Learning	2	2
Productivity Management (L0931)		Recitation Section (small)	1	1
<b>Module Responsible</b>	Prof. Hermann Lödding			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic lecture in Production Organization or Production Management			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	not available			
<i>Skills</i>	not available			
<b>Personal Competence</b>				
<i>Social Competence</i>	not available			
<i>Autonomy</i>	Students are able to define research-related tasks, to acquire the requisite knowledge and to apply it to a problem.			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Excercises	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	180 Minuten			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory			

Course L0927: Elements of Integrated Production Systems	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Hermann Lödding
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	not available
<b>Literature</b>	<p>Harris, R.; Harris, C.; Wilson, E.: Making Materials Flow, Lean Enterprise Institute, Cambridge, 2003.</p> <p>Ohno, T.: Das Toyota-Produktionssystem, Campus-Verlag, Frankfurt et al, 1993.</p> <p>Rother, M.: Die Kata des Weltmarktführers. Toyotas Erfolgsmethoden, Campus-Verlag, Frankfurt et al, 2009.</p> <p>Rother, M.; Shook, J.: Sehen lernen: Mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen, Lean Management Institut, Aachen, 2006.</p> <p>Rother, M.; Harris, R.: Creating Continuous Flow, Lean Enterprise Institute, Brookline, 2001.</p> <p>Shingo, S.: A Revolution in Manufacturing. The SMED System, Productivity Press, 2006.</p> <p>Womack, J. P. et al: Die zweite Revolution in der Autoindustrie, Frankfurt/New York, Campus Verlag, 1992.</p>

Course L0928: Productivity Management	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Hermann Lödding
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Principles of productivity management</li> <li>• Shop floor management and standardisation</li> <li>• Takt analysis and design of manual operations</li> <li>• Maintenance Principles</li> <li>• Total Productive Maintenance (TPM)</li> <li>• Optimisation of set-up operations</li> <li>• Analysis of interlinked production systems</li> </ul>
<b>Literature</b>	<p>Bokranz, R.; Landau, K.: Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.</p> <p>Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.</p> <p>Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.</p> <p>Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985</p>

Course L0931: Productivity Management	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Hermann Lödding
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0558: Business Optimization - Advanced Operations Research				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Business Optimization and Operations Research (L0155)		Lecture	2	2
Project Modelling in Operations Research (L1793)		Project-/problem-based Learning	1	1
Seminar Operations Research (L0156)		Seminar	2	3
<b>Module Responsible</b>	Prof. Kathrin Fischer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Knowledge from the module "Quantitative Methods": Linear Programming, Network Optimization and basics of Integer Programming.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	After taking this module, students have an in-depth knowledge of the following areas: They are able to			
	<ul style="list-style-type: none"> <li>explain complex quantitative models for applications, e.g. production models with integrated inventory holding over time, portfolio models, revenue management models</li> <li>Discuss advanced topics in linear programming, e.g. duality theory and its application, special structures as upper/lower bounds for variables; revised simplex method etc.</li> <li>Analyze problems with multiple objectives and under uncertainty, i.e. the adaption of linear programming models to realistic applications as e.g. international humanitarian logistics problems (distribution of relief goods);</li> <li>Discuss advanced topics in integer programming: complex problems, e.g. from vehicle routing, and logical constraints; advanced solutions procedures as branch and bound, cutting-plane procedures etc.</li> <li>Examine dynamic and non-linear programming problems and applications in Management;</li> <li>Solve OR problems using appropriate software;</li> <li>Understand and explain OR reserach projects they learn about in the course.</li> </ul>			
<i>Skills</i>	Students have in-depth abilities in the following areas: They are able to			
	<ul style="list-style-type: none"> <li>formulate complex quantitative models for applications, e.g. production models with integrated inventory holding over time, portfolio models, revenue management models</li> <li>Apply duality theory in linear programming and analyze special structures as upper/lower bounds for variables; use the revised simplex method etc.</li> <li>Analyze problems with multiple objectives and under uncertainty, i.e. the adaption of linear programming models to realistic applications</li> <li>Set up advanced models in integer programming and solve them, e.g. problems from vehicle routing, or logical constraints</li> <li>Analyze dynamic and non-linear programming problems and applications in Management</li> <li>to understand a specified planning problem of OR research, to implement a solution and to document and explain their approach in a concise way.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to			
	<ul style="list-style-type: none"> <li>work successfully in a team, organize the team, and solve complex tasks in a team in a given time frame</li> <li>give structured feedback, following feedback rules, and also accept deeback from their fellow students</li> <li>lead discussions on problems from the field of OR</li> <li>present the results of their work to specialists.</li> </ul>			
<i>Autonomy</i>	Students are able to			
	<ul style="list-style-type: none"> <li>independently acquire relevant scientific knowledge from the literature</li> <li>independently carry out a (pre-defined) complex research task</li> <li>aggregate their knowledge and results and present it to others</li> <li>apply their knowledge and experience also to new problems and unknown situations.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	5 %	Group discussion	
<b>Examination</b>	Subject theoretical and practical work			
<b>Examination duration and scale</b>	To be announced in Lecture			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Logistics, Infrastructure and Mobility: Core Qualification: Elective Compulsory			

Course L0155: Business Optimization and Operations Research	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Complex quantitative models for applications, e.g. production models with integrated inventory holding over time, portfolio models, revenue management models</li> <li>• Advanced topics in linear programming, e.g. duality theory and its application, special structures as upper/lower bounds for variables; revised simplex method etc.</li> <li>• Problems with multiple objectives and under uncertainty: adaption of linear programming models to realistic applications</li> <li>• Topics from current OR research, e.g. from the field of humanitarian logistics and revenue management</li> <li>• Advanced topics in integer programming: Modelling complex problems, e.g. from vehicle routing, and logical constraints; advanced solutions procedures as branch and bound, cutting-plane procedures etc.</li> <li>• Dynamic and non-linear programming and its applications in Management</li> <li>• Applications of models and methods in the area of supply chain management and logistics, e.g. in location planning etc.</li> </ul>
<b>Literature</b>	<p>Bücher:</p> <p>Albright, C., Winston, W.: Management Science Modeling. Revised Third Edition, South-Western 2009.</p> <p>Eiselt, H.A., Sandblom, C.-L.: Linear Programming and its Applications, Springer 2007.</p> <p>Eiselt, H.A., Sandblom, C.-L.: Integer Programming and Network Models, Springer 2000.</p> <p>Eiselt, H.A., Sandblom, C.-L.: Decision Analysis, Location Models, and Scheduling Problems, Springer 2004.</p> <p>Suhl, L., Mellouli, T.: Optimierungssysteme. Springer, Berlin et al., 2. Auflage, 2009.</p> <p>Williams, H.P.: Model Building in Mathematical Programming. 5th edition, Wiley &amp; Sons, 2013.</p> <p>Winston, W., Venkataramanan, M.: Mathematical Programming. Operations Research, Volume 1, 4th Edition, Thomson, London et al. 2003.</p> <p>Sowie ein Skript, das zur Vorlesung herausgegeben wird.</p>

Course L1793: Project Modelling in Operations Research	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>In this course, students develop a computer-based realization for a business application problem in a team of students.</p> <p>In particular, they are required to carry out the following steps:</p> <ul style="list-style-type: none"> <li>• Modeling the planning situation</li> <li>• Implementation and documentation</li> <li>• Generation of appropriate test data</li> <li>• Testing the implementation, sensitivity analyses etc.</li> <li>• Documentation of results and critical evaluation</li> </ul>
<b>Literature</b>	Siehe Vorlesung Operations Research

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<b>Course L0156: Seminar Operations Research</b>	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Special topics from different areas of the lecture are discussed in the seminar.</p> <p>Students are required to use current publications from highly esteemed journals in their assignment and to write an essay on a relevant OR topic. Moreover, they have to prepare and give a talk on that topic.</p> <p>The seminar is research-oriented and focuses on relevant research topics from the field. Students get a first-hand experience in carrying out a research project in a well-defined, limited area of OR.</p> <p>There is a limitation of the number of seminar participants (36 students). If necessary, selection of participants will be based on the results in the Quantitative Methods module which is a prerequisite for this course.</p>
<b>Literature</b>	Fachartikel (Journal Papers), die zu Beginn des Seminars bekanntgegeben werden.

Module M0697: Management Control				
Courses				
Title	Typ	Hrs/wk	CP	
Management Control (L0496)	Lecture	3	3	
Management Control (L0495)	Seminar	2	3	
<b>Module Responsible</b>	Prof. Matthias Meyer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic knowledge of financial and cost accounting			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	On successful completion of this module, the students will know about: <ul style="list-style-type: none"> <li>• Important concepts of German-language controlling research;</li> <li>• International differences and traditions in corporate management</li> <li>• Central controlling tasks such as the provision of information, planning and control as well as coordination</li> <li>• Differences between data, information and knowledge and they can explain them;</li> <li>• Digitization and impact on controlling</li> <li>• Instruments of operational, tactical and strategic planning;</li> <li>• Selected concepts of game theory, information economics and principal-agent theory;</li> <li>• Performance measures and coordination;</li> <li>• The concept of value-based management and key value-oriented key performance indicators;</li> <li>• Functions and methods for determining transfer prices;</li> <li>• Risk and project controlling instruments and concepts;</li> <li>• Monte Carlo simulation method, also as a research method;</li> </ul>			
<i>Skills</i>	On successful completion of this module, the students will be able to: <ul style="list-style-type: none"> <li>• Explain the origin and nature of controlling in practice and to locate it internationally;</li> <li>• Explain important concepts of German-language controlling research;</li> <li>• Assess essential areas of responsibility of and requirements for controllers;</li> <li>• Explain various key figures and systems and classify their advantages and disadvantages;</li> <li>• Explain and apply the levers of reporting design;</li> <li>• Derive design recommendations for the supply of information;</li> <li>• Apply and evaluate essential (planning) instruments of controlling;</li> <li>• Comprehend tactical and strategic issues within companies;</li> <li>• Carry out game theoretical modelling and evaluation of decision-making problems;</li> <li>• Carry out a Monte Carlo simulation and interpret its results</li> <li>• Design and assess transfer prices according to different procedures;</li> <li>• Help shape the process of risk management and to be able to calculate and interpret aggregated risk measures;</li> <li>• Assign psychological theories to individual controlling problems and to derive design recommendations from them.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	On successful completion of this module, the students can: <ul style="list-style-type: none"> <li>• Take over controlling tasks and to successfully transfer the theoretical knowledge into operational practice and apply it there;</li> <li>• Decide independently which controlling instruments can and must be used for which problem;</li> <li>• Work together with other team members, to discuss and come to a result together;</li> <li>• Apply concepts from psychology, game theory, information economics and principal-agent theory to new questions;</li> <li>• Present the results of their analyses in an understandable manner, also in English;</li> <li>• Solve business management problems within Controlling and its sub-areas independently and in a team;</li> <li>• Take on complex planning tasks in international companies, also in a managerial capacity.</li> </ul>			
<i>Autonomy</i>	The students are able... <ul style="list-style-type: none"> <li>• To acquire knowledge by themselves and to transfer the knowledge acquired to new problems.</li> <li>• To argue the case for their findings (including in English).</li> <li>• develop their own critical understanding of research results</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	8.3 %	Excercises	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory			

Course L0496: Management Control	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Matthias Meyer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Information provision: Ratios and ratio systems, balanced scorecard, reporting, information supply design</p> <ul style="list-style-type: none"> <li>• Operative planning: Budgeting, operative production planning</li> <li>• Operative controlling: Deviation analysis and forecasting</li> <li>• Tactical planning: Quantitative and qualitative business planning</li> <li>• Strategic planning: Portfolio analysis, SWOT analysis, resource-based view, experience curve concept</li> <li>• Coordination: Economies of scope, value-oriented business ratios, transfer pricing, incentive systems, principal-agent theory</li> <li>• Risk controlling: Value at risk, risk analysis, risk aggregation, risk management, risk control</li> <li>• Project controlling</li> </ul>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Skript und Unterlagen, die zur Vorlesung und Übung herausgegeben werden.</li> <li>2. Ausgewählte Bücher:</li> <li>3. Balakrishnan, R./Sivaramakrishnan, K./Sprinkle, G. (2009): Managerial Accounting, Hoboken.</li> <li>4. Ewert, R./Wagenhofer, A. (2008): Interne Unternehmensrechnung, 7. Aufl., Berlin.</li> <li>5. Merchant, K./Van der Stede, W. (2012): Management Control Systems: Performance Measurement, Evaluation, and Incentives, London.</li> <li>6. Weber, J./Schäffer, U. (2011): Einführung in das Controlling, 13. Aufl., Stuttgart.</li> </ol>

Course L0495: Management Control	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Matthias Meyer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Skript und Aufgaben, die zur Vertiefung herausgegeben werden.</li> <li>2. Weiterführende Literatur, die jeweils mit Blick auf die gesetzten Themenschwerpunkte spezifiziert wird</li> </ol>

Module M0543: Advanced Topics in Management, Organization, and Human Resource Management				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Advanced Topics in Management, Organization, and Human Resource Management (L0110)		Lecture	2	3
Advanced Topics in Management, Organization, and Human Resource Management (L0111)		Seminar	2	3
<b>Module Responsible</b>	Prof. Christian Ringle			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Foundations in Organizational Design and Human Resource Management Basic knowledge on academic writing as well as principles and concepts in business administration and foundations in organizational design and human resource management.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students are able to...			
	<ul style="list-style-type: none"> <li>Explain the different organizational designs and strategies in an international environment with a focus on selected forms of cooperation (e.g., virtual organizations or strategic alliances) to compete in global business;</li> <li>Map the need of organizational changes in light of new business lines, strategies, altering employees' attitudes, and international competition;</li> <li>Explain the models and approaches for appropriately measuring employee relations (e.g., job satisfaction models), incl. the development and estimation of causal models.</li> </ul>			
<i>Skills</i>	The students are able to...			
	<ul style="list-style-type: none"> <li>Work with empirical data, apply business process management and multivariate techniques to the data collected using standard software, and critically evaluate and interpret the results;</li> <li>Critically rethink theoretical concepts and gain analytical abilities in organization management and human resource management;</li> <li>Use their practical knowledge of the analytical toolset to successfully tackle the management challenges in organization and human resource management in internationally acting companies;</li> <li>Present their results in written and oral form.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to...			
	<ul style="list-style-type: none"> <li>Respectfully work in teams;</li> <li>Have fruitful group discussions;</li> <li>Present their results in written form and oral presentations.</li> </ul>			
<i>Autonomy</i>	The students are able to...			
	<ul style="list-style-type: none"> <li>Acquire further relevant information independently;</li> <li>Critically reflect and evaluate this information;</li> <li>Transfer the acquired knowledge to practical applications.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	20 %	Presentation	
<b>Examination</b>	Subject theoretical and practical work			
<b>Examination duration and scale</b>	Thesis with presentation and assignments during the semester			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory			

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Course L0110: Advanced Topics in Management, Organization, and Human Resource Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christian Ringle
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>This lecture focuses on multinational firms and advanced issues of management, organizations, and human resource management. This course is structured as a lecture and a seminar. In the lecture, the advanced theoretical concepts are explained and discussed, whereas they are applied in the seminar through the preparation of a seminar thesis. The students learn about the process and structure of a scientific article, and further deepen their knowledge, while working in groups.</p> <p>Example topics:</p> <ul style="list-style-type: none"> <li>• Management: change management and corporate social responsibility;</li> <li>• Organization: exploration &amp; exploitation, networks, and organizational identity;</li> <li>• Human Resource Management: human resource metrics &amp; analytics and recruitment &amp; selection.</li> </ul>
<b>Literature</b>	<p>The students will be provided with selected journal articles.</p> <p>Bernardin, H.J. (2006): Human Resource Management: An Experiential Approach, 4e, New York: McGraw-Hill.</p> <p>Cascio, W. (2015): Managing Human Resources: Productivity, Quality of Work Life, Profits, revised edition, New York: McGraw-Hill.</p> <p>French, W./Bell, C.H./Zawacki, R.A. (2004): Organization Development and Transformation: Managing Effective Change, 6e, Chicago: McGraw-Hill.</p> <p>Hitt, M.A./Ireland, R.D./Hoskisson, R.E. (2014): Strategic Management: Competitiveness and Globalization, 11e, Ohio: Cengage Learning.</p> <p>Lynch, R. (2015): Strategic Management, 7e, Harlow: Prentice Hall.</p>

Course L0111: Advanced Topics in Management, Organization, and Human Resource Management	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christian Ringle
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>This course focuses on multinational firms and advanced issues of management, organizations, and human resource management. The students learn about the process and structure of a scientific article and deepen their knowledge while working in groups. Selected topics focus, for example, on:</p> <ul style="list-style-type: none"> <li>• Human Resource Management: aging workforce, e-human resource management, generation X, Y, Z, human resource metrics/ analytics, recruitment/ selection/ hiring</li> <li>• Organisation: employee voice, exploration/ exploitation, networks, organisational identity, trust measurement</li> <li>• Management: change management, corporate social responsibility, firm performance measurement, gender, innovation management</li> </ul>
<b>Literature</b>	<p>The students will be provided with selected journal articles.</p> <p>Bernardin, H.J. (2006): Human Resource Management: An Experiential Approach, 4e, New York: McGraw-Hill.</p> <p>Cascio, W. (2015): Managing Human Resources: Productivity, Quality of Work Life, Profits, revised edition, New York: McGraw-Hill.</p> <p>French, W./Bell, C.H./Zawacki, R.A. (2004): Organization Development and Transformation: Managing Effective Change, 6e, Chicago: McGraw-Hill.</p> <p>Hitt, M.A./Ireland, R.D./Hoskisson, R.E. (2014): Strategic Management: Competitiveness and Globalization, 11e, Ohio: Cengage Learning.</p> <p>Lynch, R. (2015): Strategic Management, 7e, Harlow: Prentice Hall.</p>

Module M0559: Strategic Management				
Courses				
Title	Typ		Hrs/wk	CP
Strategic Management (L0158)	Lecture		4	6
<b>Module Responsible</b>	Prof. Thomas Wrona			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic principles in International and Intercultural Management			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>Students will accumulate extensive knowledge about different aspects of strategic management after having participated in this module. Apart from strategic planning, students will be able to discern different contingency factors in strategic decision making and apply various strategies accordingly.</p> <p>Students will gain competences in the following areas:</p> <ul style="list-style-type: none"> <li>• The historical and theoretical development of strategic management</li> <li>• Different forms of strategy formation</li> <li>• Content and process view of strategic management</li> <li>• Formulation and implementation of strategic options</li> <li>• Management systems and their influence on strategies</li> <li>• The origins of competitive advantage</li> </ul> <p><i>Skills</i></p> <ul style="list-style-type: none"> <li>• Students are able to analyze and interpret external and internal information in the context of strategic choice</li> <li>• Students are able to differentiate environmental contingencies and assess risk potentials</li> <li>• Students are able to evaluate the attractiveness of different industries</li> <li>• Students are able to evaluate the pros and cons of strategic options and adequately select strategies during implementation</li> <li>• In essence, students are able to conceptually and theoretically "design" strategic decision processes and considers industry and corporate peculiarities during strategic planning</li> </ul> <p>Those skills refer to competences in information seeking and analysis, the consolidation of data and their presentation in teams. These skills will be continuously shaped...</p> <ul style="list-style-type: none"> <li>• During case studies and strategic role plays, where students identify, develop and implement solutions for strategic problems</li> <li>• During complex data analyses, which are performed in groups and discussed in class</li> <li>• By making educated guesses about (yet unknown) corporate phenomena and decision makers attitudes, which are based on prior theoretical knowledge</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>After attending the module students will be able...</p> <ul style="list-style-type: none"> <li>• To interact and share own thoughts with group members during case study sessions or strategic role plays</li> <li>• To lead and take part in strategy-related discussions</li> <li>• To present results, both in written and verbal form</li> </ul> <p><i>Autonomy</i></p> <p>After attending the module students will be able...</p> <ul style="list-style-type: none"> <li>• To accumulate knowledge about specified strategic problems and transfer it to other related areas of interest</li> <li>• To identify related literature and integrate relevant findings during problem solution</li> <li>• To present existing and new knowledge about strategic phenomena in own conceptual ways</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	20 %	Subject	theoretical and practical work
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 min			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory			

Course L0158: Strategic Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Thomas Wrona
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction - Basic concepts and objects within the area of strategic management</li> <li>• Objectives, corporate strategies, mission statements and management systems as an object of strategic management</li> <li>• Theoretical perspectives of strategic management</li> <li>• Analysis and design of selected strategies</li> <li>• Strategic (planning) processes</li> <li>• Integrative application of knowledge based on a number of selected case studies</li> </ul> <p>Theoretical, conceptual parts are devoted to the processing and discussion of theoretical contributions from current management research, which are practically applied in case studies and simulations.</p>
<b>Literature</b>	<p>Bamberger, I./Wrona, T. (2012): Strategische Unternehmensführung. Strategien - Systeme - Prozesse, 2. überarbeitete und erweiterte Auflage, München 2012</p> <p>Bamberger, I./Wrona, T. (2012): Strategische Unternehmensberatung, 6. erweiterte Auflage, Wiesbaden 2012</p> <p>Bamberger, I./Wrona, T. (1996): Der Ressourcenansatz und seine Bedeutung für die Strategische Unternehmensführung, in: Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung (zfbf), 2/1996, S. 130-153</p> <p>Bowman, E.H./Singh, H./Thomas, H. (2006): The domain of strategic management: History and evolution, in: Pettigrew, A./Thomas, H./Whittington, R. (Hrsg.): Handbook of strategy and management, London u.a. 2006, S. 31-54</p> <p>Johnson, G./Whittington, R./Scholes, K./Angwin, D./Regnér, D. (2017): Exploring strategy. Text and Cases, 11. Aufl., Harlow 2017</p> <p>Kreikebaum, H./Gilbert, D. U./Behnam, M. (2018): Strategisches Management, Stuttgart.</p> <p>Mintzberg, H./Ahlstrand, B./Lampel, J. (2002): Strategy Safari, New York 2002 (in deutscher Sprache: Dies. (2012): Strategy Safari: Der Wegweiser durch den Dschungel des strategischen Managements, 2. Aufl., München 2012)</p> <p>Porter, M. E. (2013): Wettbewerbsstrategie. Methoden zur Analyse von Branchen und Konkurrenten, 12. Aufl., Frankfurt 2013</p> <p>zu Knyphausen-Aufseß, D. (2012): Theoretische Perspektiven des strategischen Managements, in: Welge, M.K./Al-Laham, A./Kajüter, P. (Hrsg.): Praxis des strategischen Managements, Wiesbaden 2012, S. 39-70</p> <p>Skripte und Textdokumente, die während der Vorlesung herausgegeben werden:</p>

Module M0815: Product Planning				
Courses				
Title	Typ	Hrs/wk	CP	
Product Planning (L0851)	Lecture	3	3	
Product Planning Seminar (L0853)	Project-/problem-based Learning	2	3	
<b>Module Responsible</b>	Prof. Cornelius Herstatt			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Good basic-knowledge of Business Administration			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	Students will gain insights into:			
<i>Knowledge</i>	<ul style="list-style-type: none"> <li>• Product Planning                             <ul style="list-style-type: none"> <li>◦ Process</li> <li>◦ Methods</li> </ul> </li> <li>• Design thinking                             <ul style="list-style-type: none"> <li>◦ Process</li> <li>◦ Methods</li> <li>◦ User integration</li> </ul> </li> </ul>			
<i>Skills</i>	Students will gain deep insights into:			
	<ul style="list-style-type: none"> <li>• Product Planning                             <ul style="list-style-type: none"> <li>◦ Process-related aspects</li> <li>◦ Organisational-related aspects</li> <li>◦ Human-Ressource related aspects</li> <li>◦ Working-tools, methods and instruments</li> <li>◦</li> </ul> </li> </ul>			
<b>Personal Competence</b>	<ul style="list-style-type: none"> <li>• Interact within a team</li> <li>• Raise awareness for globabl issues</li> </ul>			
<i>Social Competence</i>				
<i>Autonomy</i>	<ul style="list-style-type: none"> <li>• Gain access to knowledge sources</li> <li>• Interpret complex cases</li> <li>• Develop presentation skills</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	20 %	Subject	theoretical and practical work
<b>Examination</b>	Thesis			
<b>Examination duration and scale</b>	90 minutes			
<b>Assignment for the Following Curricula</b>	Global Innovation Management: Core Qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

<b>Course L0851: Product Planning</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Cornelius Herstatt
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Product Planning Process</p> <p>This integrated lecture is designed to understand major issues, activities and tools in the context of systematic product planning, a key activity for managing the front-end of innovation, i.e.:</p> <ul style="list-style-type: none"> <li>• Systematic scanning of markets for innovation opportunities</li> <li>• Understanding strengths/weakness and specific core competences of a firm as platforms for innovation</li> <li>• Exploring relevant sources for innovation (customers, suppliers, Lead Users, etc.)</li> <li>• Developing ideas for radical innovation, relying on the creativeness of employees, using techniques to stimulate creativity and creating a stimulating environment</li> <li>• Transferring ideas for innovation into feasible concepts which have a high market attractiveness</li> </ul> <p>Voluntary presentations in the third hour (articles / case studies)</p> <ul style="list-style-type: none"> <li>- Guest lectures by researchers</li> <li>- Lecture on Sustainability with frequent reference to current research</li> <li>- Permanent reference to current research</li> </ul> <p>Examination:</p> <p>In addition to the written exam at the end of the module, students have to attend the PBL-exercises and prepare presentations in groups in order to pass the module. Additionally, students have the opportunity to present research papers on a voluntary base. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.</p>
<b>Literature</b>	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010

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

Module M0994: Information Technology in Logistics			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Informationtechnology in Logsitics (L1197)		Practical Course	6
<b>Module Responsible</b>	Prof. Thorsten Blecker		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge from the module "Production and Logistics Management"; Interest in new technologies and their application in logistics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<ul style="list-style-type: none"> <li>• on the relationship between logistics and IT, and representation and description in depth;</li> <li>• information systems and information management, and the application of information systems and information management to logistical issues;</li> <li>• using information technologies that are currently used in logistics, such as RFID, e-logistics and electronic sourcing.</li> </ul> <p><i>Skills</i></p> <ul style="list-style-type: none"> <li>• to assess the use of information technology in logistics issues and to implement appropriate technologies;</li> <li>• to be able to deal critically with the current developments in IT and logistics and to assess them critically;</li> <li>• analyse in depth relevant issues arising from the thematic field of "IT in Logistics" at a scientific level;</li> <li>• to independently work on current topics from the field of "IT in Logistics";</li> <li>• analyse the relationship between logistics and IT;</li> <li>• implementing information technology in logistics successfully</li> <li>• to transfer the theoretical knowledge of information technologies to real situations and to give recommendations of action for solving new tasks;</li> <li>• to solve logistical problems using information technology</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <ul style="list-style-type: none"> <li>• to conduct subject-specific and interdisciplinary discussions;</li> <li>• oral and written presentation of results</li> <li>• respectful team work</li> </ul> <p><i>Autonomy</i></p> <ul style="list-style-type: none"> <li>• work independently on a subject and transfer the acquired knowledge to new problems.</li> </ul>		
<i>Knowledge</i>			
<i>Skills</i>			
<i>Personal Competence</i>			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written elaboration		
<b>Examination duration and scale</b>	-		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory		
Course L1197: Informationtechnology in Logsitics			
<b>Typ</b>	Practical Course		
<b>Hrs/wk</b>	6		
<b>CP</b>	6		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Lecturer</b>	Prof. Thorsten Blecker		
<b>Language</b>	DE		
<b>Cycle</b>	WiSe		
<b>Content</b>	<ul style="list-style-type: none"> <li>• In the beginning the students get insight of the functionality of a service-oriented architecture.</li> <li>• Then the students will get a logistic problem to solve in small groups.</li> <li>• The elaborations result shall be one or more programmed services/module that together with the other groups result completes a total application.</li> </ul>		
<b>Literature</b>	Skripte und Textdokumente, die während der Vorlesung herausgegeben werden		

Module M1003: Management Control Systems for Operations			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Management Control Systems for Operations (L1219)		Lecture	2                  2
Management Control Systems for Operations (Seminar) (L2967)		Seminar	2                  3
Management Control Systems for Operations (Exercise) (L1224)		Recitation Section (small)	1                  1
<b>Module Responsible</b>	Prof. Wolfgang Kersten		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Introduction to Business and Management		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students have acquired in depth knowledge in the following areas and can</p> <ul style="list-style-type: none"> <li>• explain the function and the requirements of management control systems,</li> <li>• explain the targets and the tasks of production and supply chain controlling,</li> <li>• understand management control systems for production in an international context,</li> <li>• explain the major aspects of investment planning and control,</li> <li>• explain the major aspects of cost management,</li> <li>• explain and understand the procedures of budgeting,</li> <li>• present and give a detailed explanation of methods and tools of management control systems for production and supply chains,</li> <li>• describe opportunities and risks of digitalization for the design of management control systems for production and supply chains,</li> <li>• give an overview of relevant research topics for management control systems for production and supply chains.</li> </ul> <p><i>Skills</i> Based on the acquired knowledge students are capable of</p> <ul style="list-style-type: none"> <li>- Applying methods of managerial accounting in production and logistics in an international context,</li> <li>- Selecting sufficient methods of managerial accounting in production and logistics to solve practical problems,</li> <li>- Selecting appropriate methods of managerial accounting in production and logistics also for non-standardized problems,</li> <li>- Making a holistic assessment of areas of decision in management control systems for production and logistics and relevant influence factors.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> After completion of the module students can</p> <ul style="list-style-type: none"> <li>- lead discussions and team sessions,</li> <li>- arrive at work results in groups and document them,</li> <li>- develop joint solutions in mixed teams and present them to others,</li> <li>- present solutions to specialists and develop ideas further.</li> </ul> <p><i>Autonomy</i> After completion of the module students can</p> <ul style="list-style-type: none"> <li>- assess possible consequences of their professional activity,</li> <li>- define tasks independently, acquire the requisite knowledge and use suitable means of implementation,</li> <li>- define and carry out research tasks bearing in mind possible societal consequences.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b> <b>Description</b>
	Yes	20 %	Subject theoretical and practical work
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory		

Course L1219: Management Control Systems for Operations	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Wolfgang Kersten
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Identification of missions and changing requirements on controlling</li> <li>• Differentiating managerial accounting, production management, logistics and supply chain controlling</li> <li>• Considering global dispersed supply chain networks in production management and supply chain controlling</li> <li>• Analyzing investment projects and resulting effects (investment control, risk management in investment)</li> <li>• In depth knowledge in planning, realizing and controlling investments</li> <li>• Developing characteristics of differentiation for cost and activity accounting (aim, purpose, opportunities in structuring etc.)</li> <li>• In depth knowledge in cost management (cost types and units)</li> <li>• Budgeting in practice; Analysis of existing methods</li> <li>• Development of an approach in activity based costing</li> <li>• Application of target costing</li> <li>• Knowing the importance and method of life cycle costing</li> <li>• Applying performance figures in production and logistics</li> <li>• Discussion of opportunities and risks of digitalization for the design of management control systems for production and supply chains</li> <li>• Developing recommendations for problem solving by using research oriented problem based learning sessions for relevant actual topics and cases; thereby preparing and presenting results in intercultural teams</li> </ul>
<b>Literature</b>	<p>Altrogge, G. (1996): Investition, 4. Aufl., Oldenbourg, München</p> <p>Arvis, J.-F. et al. (2018): Connecting to Compete - Trade Logistics in the Global Economy, The World Bank Group, Washington, DC, USA; Download: <a href="https://openknowledge.worldbank.org/handle/10986/29971">https://openknowledge.worldbank.org/handle/10986/29971</a></p> <p>Betge, P. (2000): Investitionsplanung: Methoden, Modelle, Anwendungen, 4. Aufl., Vahlen, München.</p> <p>Christopher, M. (2005): Logistics and Supply Chain Management, 3. Aufl., Pearson Education, Edinburgh.</p> <p>Corsten, H., Gössinger, R., Spengler, Th. (Hrsg., 2018): Handbuch Produktions- und Logistikmanagement in Wertschöpfungsnetzwerken, Berlin/Boston.</p> <p>Eversheim, W., Schuh, G. (2000): Produktion und Management. Betriebshütte: 2 Bde., 7. Aufl., Springer Verlag, Berlin.</p> <p>Friedl, G., Hofmann, C., Pedell, B. (2017): Kostenrechnung - Eine entscheidungsorientierte Einführung, 3. Aufl., Vahlen, München.</p> <p>Günther, H.-O., Tempelmeier, H. (2005): Produktion und Logistik, 6. Aufl., Springer Verlag, Berlin.</p> <p>Hahn, D. Horváth, P., Frese, E. (2000): Operatives und strategisches Controlling, in: Eversheim, W., Schuh, G. (Hrsg.): Produktion und Management. Betriebshütte: 2 Bde. Springer Verlag, Berlin.</p> <p>Hansmann, K.-W. (1987): Industriebetriebslehre, 2. Aufl., Oldenbourg, München.</p> <p>Hoitsch, H.-J. (1993): Produktionswirtschaft: Grundlagen einer industriellen Betriebswirtschaftslehre, 2. Aufl., Vahlen, München.</p> <p>Horváth, P./ Gleich, R./ Seiter, M. (2020): Controlling, 14. Aufl., Vahlen, München.</p> <p>Kersten, W. et al. (2017): Chancen der digitalen Transformation. Trends und Strategien in Logistik und Supply Chain Management, DVV Media Group, Hamburg.</p> <p>Kruschwitz, L. (2009): Investitionsrechnung, 12. Aufl., Oldenbourg, München.</p> <p>Obermaier, Robert (Hrsg., 2019): Handbuch Industrie 4.0 und Digitale Transformation: Betriebswirtschaftliche, technische und rechtliche Herausforderungen, Wiesbaden</p> <p>Preißler, P. R. (2000): Controlling. 12. Aufl., Oldenbourg Wissenschaftsverlag, München.</p> <p>Weber, J./ Wallenburg, C. M. (2010): Logistik- und Supply Chain Controlling, 6. Auflage, Schaeffer Poeschel Verlag, Stuttgart.</p> <p>Wildemann, H. (1987): Strategische Investitionsplanung, Methoden zur Bewertung neuer Produktionstechnologien, Gabler, Wiesbaden.</p> <p>Wildemann, H. (2001): Produktionscontrolling: Systemorientiertes Controlling schlanker Produktionsstrukturen, 4. Aufl. TCW, München.</p>

Course L2967: Management Control Systems for Operations (Seminar)	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Wolfgang Kersten
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	Die angewandte Fachliteratur ist von den jeweils gewählten Themen abhängig und wird passend zu den Semesterthemen aktualisiert. Darüberhinaus steht die Fachliteratur der korrespondierenden Vorlesung zur Verfügung.

Course L1224: Management Control Systems for Operations (Exercise)	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Wolfgang Kersten
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Identification of missions and changing requirements on controlling</li> <li>• Differentiating managerial accounting, production management, logistics and supply chain controlling</li> <li>• Considering global dispersed supply chain networks in production management and supply chain controlling</li> <li>• Analyzing investment projects and resulting effects (investment control, risk management in investment)</li> <li>• In depth knowledge in planning, realizing and controlling investments</li> <li>• Developing characteristics of differentiation for cost and activity accounting (aim, purpose, opportunities in structuring etc.)</li> <li>• In depth knowledge in cost management (cost types and units)</li> <li>• Budgeting in practice; Analysis of existing methods</li> <li>• Development of an approach in activity based costing</li> <li>• Application of target costing</li> <li>• Knowing the importance and method of life cycle costing</li> <li>• Applying performance figures in production and logistics</li> <li>• Developing recommendations for problem solving by using problem based learning sessions for case studies; thereby preparing and presenting results in intercultural teams</li> </ul>
<b>Literature</b>	<p>Altrogge, G. (1996): Investition, 4. Aufl., Oldenbourg, München</p> <p>Betge, P. (2000): Investitionsplanung: Methoden, Modelle, Anwendungen, 4. Aufl., Vahlen, München.</p> <p>Christopher, M. (2005): Logistics and Supply Chain Management, 3. Aufl., Pearson Education, Edinburgh.</p> <p>Eversheim, W., Schuh, G. (2000): Produktion und Management. Betriebshütte: 2 Bde., 7. Aufl., Springer Verlag, Berlin.</p> <p>Günther, H.-O., Tempelmeier, H. (2005): Produktion und Logistik, 6. Aufl., Springer Verlag, Berlin.</p> <p>Hahn, D. Horváth, P., Frese, E. (2000): Operatives und strategisches Controlling, in: Eversheim, W., Schuh, G. (Hrsg.): Produktion und Management. Betriebshütte: 2 Bde. Springer Verlag, Berlin.</p> <p>Hansmann, K.-W. (1987): Industriebetriebslehre, 2. Aufl., Oldenbourg, München.</p> <p>Hoitsch, H.-J. (1993): Produktionswirtschaft: Grundlagen einer industriellen Betriebswirtschaftslehre, 2. Aufl., Vahlen, München.</p> <p>Horváth, P. (2011): Controlling, 12. Aufl., Vahlen, München.</p> <p>Kruschwitz, L. (2009): Investitionsrechnung, 12. Aufl., Oldenbourg, München.</p> <p>Martinich, J. S. (1997): Production and operations management: an applied modern approach. Wiley.</p> <p>Preißler, P. R. (2000): Controlling. 12. Aufl., Oldenbourg Wissenschaftsverlag, München.</p> <p>Weber, J. (2002): Logistik- und Supply Chain Controlling, 5. Auflage, Schaeffer-Poeschel Verlag, Stuttgart.</p> <p>Wildemann, H. (1987): Strategische Investitionsplanung, Methoden zur Bewertung neuer Produktionstechnologien, Gabler, Wiesbaden.</p> <p>Wildemann, H. (2001): Produktionscontrolling: Systemorientiertes Controlling schlanker Produktionsstrukturen, 4. Aufl. TCW, München.</p>

Module M1035: Entrepreneurial Finance				
Courses				
Title	Typ	Hrs/wk	CP	
Entrepreneurial Finance: Case Studies (L1282)	Seminar	3	4	
Entrepreneurial Finance: Lecture (L1281)	Lecture	2	2	
<b>Module Responsible</b>	Prof. Christoph Ihl			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic knowledge in business economics and finance obtained in the compulsory modules and participation in the module "Technology Entrepreneurship" is highly recommended.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> Wissen (subject-related knowledge and understanding):</p> <ul style="list-style-type: none"> <li>understand the structure of a financial plan for a new venture</li> <li>understand the procedures, pros and cons of different valuation methods</li> <li>understand the design of financial contracts and term sheets</li> <li>understand the interests of venture capital funds</li> <li>understand the pros and cons of different growth and exit options</li> </ul> <p><i>Skills</i> Fertigkeiten (subject-related skills):</p> <ul style="list-style-type: none"> <li>prepare a financial plan for a new venture</li> <li>value a new venture in financial terms</li> <li>apply different valuation methods</li> <li>evaluate the attractiveness of financial contracts</li> <li>design VC term sheets</li> <li>design employee contracts in terms of financial compensation</li> <li>design financial contracts and conduct financial negotiations</li> <li>assess and justify possible growth and exit options</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Sozialkompetenz (Social Competence):</p> <ul style="list-style-type: none"> <li>team work</li> <li>communication and presentation</li> <li>give and take critical comments</li> <li>engaging in fruitful discussions</li> </ul> <p><i>Autonomy</i> Selbständigkeit (Autonomy):</p> <ul style="list-style-type: none"> <li>autonomous work and time management</li> <li>project management</li> <li>analytical skills</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	20 %	Group discussion	
<b>Examination</b>	Subject theoretical and practical work			
<b>Examination duration and scale</b>	Presentations and case study work			
<b>Assignment for the Following Curricula</b>	Global Innovation Management: Core Qualification: Elective Compulsory Global Technology and Innovation Management & Entrepreneurship: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory			

<b>Course L1282: Entrepreneurial Finance: Case Studies</b>	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Christoph Ihl
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Entrepreneurial finance is at the center of a clash of two very distant worlds: that of entrepreneurship and that of finance. Finance is disciplined, based on numbers and logical thinking and looking for proven track records. Entrepreneurship is messy, based on intuition and experimentation and treading off the beaten track. Entrepreneurial finance is the provision of funding to young, innovative, growth-oriented companies. Entrepreneurial companies are young, typically less than ten years old, and introduce innovative products or business models. The younger are called "startups," and are typically less than five years old.</p> <p>There is a variety of investors who can finance entrepreneurial companies: family and friends, business angels, accelerators and incubators, crowdfunding platforms, venture capital firms, corporate investors, etc. The course provides a thorough understanding of what motivates them, of the way they invest, and of what support they can provide to a company at what stage in the fundraising cycle. The course addresses the following key questions: How much money can and should be raised? When should it be raised and from whom? What is a reasonable valuation of the company? How should funding, employment contracts and exit decisions be structured?</p> <p>Thus, the course provides an understanding of the whole fundraising cycle, from the moment the entrepreneur conceived her idea to the moment investors exit the company and move on. We examine the entrepreneur's signalling to investors of the qualities of the venture, the investors' evaluation of the venture, the various dimensions of contracting (cash flow rights, control rights, compensation, and other clauses), the negotiation of a deal and the provision of corporate governance, the process of staged financing, the financing through debt, and the exit process through liquidity events such as initial public offering, sale or merger.</p> <p>The following topics will be covered with specific case studies:</p> <ol style="list-style-type: none"> <li>1. Introduction: Evaluating Venture Opportunities</li> <li>2. Financial Planning</li> <li>3. Ownership and Returns</li> <li>4. Valuation Methods</li> <li>5. Term Sheets</li> <li>6. Structuring Deals</li> <li>7. Corporate Governance</li> <li>8. Staged Financing</li> <li>9. Debt Financing</li> <li>10. Exits</li> <li>11. Early Stage &amp; Venture Capital Investors</li> <li>12. Ecosystems</li> </ol>
<b>Literature</b>	Da Rin, Marco, and Thomas Hellmann. Fundamentals of Entrepreneurial Finance. Oxford University Press, 2020.

<b>Course L1281: Entrepreneurial Finance: Lecture</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Christoph Ihl
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Entrepreneurial finance is at the center of a clash of two very distant worlds: that of entrepreneurship and that of finance. Finance is disciplined, based on numbers and logical thinking and looking for proven track records. Entrepreneurship is messy, based on intuition and experimentation and treading off the beaten track. Entrepreneurial finance is the provision of funding to young, innovative, growth-oriented companies. Entrepreneurial companies are young, typically less than ten years old, and introduce innovative products or business models. The younger are called "startups," and are typically less than five years old.</p> <p>There is a variety of investors who can finance entrepreneurial companies: family and friends, business angels, accelerators and incubators, crowdfunding platforms, venture capital firms, corporate investors, etc. The course provides a thorough understanding of what motivates them, of the way they invest, and of what support they can provide to a company at what stage in the fundraising cycle. The course addresses the following key questions: How much money can and should be raised? When should it be raised and from whom? What is a reasonable valuation of the company? How should funding, employment contracts and exit decisions be structured?</p> <p>Thus, the course provides an understanding of the whole fundraising cycle, from the moment the entrepreneur conceived her idea to the moment investors exit the company and move on. We examine the entrepreneur's signalling to investors of the qualities of the venture, the investors' evaluation of the venture, the various dimensions of contracting (cash flow rights, control rights, compensation, and other clauses), the negotiation of a deal and the provision of corporate governance, the process of staged financing, the financing through debt, and the exit process through liquidity events such as initial public offering, sale or merger.</p> <p>The following topics will be covered in lectures:</p> <ol style="list-style-type: none"> <li>1. Introduction: Evaluating Venture Opportunities</li> <li>2. Financial Planning</li> <li>3. Ownership and Returns</li> <li>4. Valuation Methods</li> <li>5. Term Sheets</li> <li>6. Structuring Deals</li> <li>7. Corporate Governance</li> <li>8. Staged Financing</li> <li>9. Debt Financing</li> <li>10. Exits</li> <li>11. Early Stage &amp; Venture Capital Investors</li> <li>12. Ecosystems</li> </ol>
<b>Literature</b>	Da Rin, Marco, and Thomas Hellmann. Fundamentals of Entrepreneurial Finance. Oxford University Press, 2020.

Module M1701: Digital Economics			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Digital Economics (L2715)		Lecture	2
Digital Economics (L2716)		Project-/problem-based Learning	2
<b>CP</b>			
			3
<b>Module Responsible</b>	Prof. Timo Heinrich		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge of economics as taught in the Economics module is expected.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students know <ul style="list-style-type: none"> <li>• basic concepts of game theory, auction theory and mechanism design,</li> <li>• the properties of online advertising markets and matching markets,</li> <li>• basic concepts of social choice,</li> <li>• models of belief formation,</li> <li>• how trust is established in online interactions,</li> <li>• current models of behavioral economics as well as</li> <li>• empirical results concerning these topics.</li> </ul>		
<i>Skills</i>	On the basis of the knowledge acquired, students will be able to <ul style="list-style-type: none"> <li>• analyze and model behavior in digital networks and markets,</li> <li>• understand and discuss current empirical research on the topic and</li> <li>• develop their own empirical research questions.</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students will be able to <ul style="list-style-type: none"> <li>• participate in subject-specific and interdisciplinary discussions on the topics of the course,</li> <li>• present and discuss their work results from empirical studies and</li> <li>• cooperate successfully and respectfully in a team.</li> </ul>		
<i>Autonomy</i>	Students will be able to <ul style="list-style-type: none"> <li>• identify empirical research questions from the areas of the courses and analyze and answer them independently and in a team,</li> <li>• acquire knowledge about the subject area independently and transfer the acquired knowledge to new questions as well as</li> <li>• critically evaluate the results of their work.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	10- to 15-page elaboration		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory		

Course L2715: Digital Economics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Timo Heinrich
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Game theory</li> <li>• Auction theory</li> <li>• Mechanism design</li> <li>• Online advertising markets</li> <li>• Matching markets</li> <li>• Social choice</li> <li>• Beliefs formation</li> <li>• Reputation systems</li> <li>• Behavioral economics</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Parkes/Seuken: Algorithmic Economics: A Design Approach, Unpublished, 2020</li> <li>• Easley/Kleinberg: Networks, Crowds and Markets, Cambridge University Press, 2010</li> <li>• Weimann/Brosig-Koch: Methods in Experimental Economics, Springer, 2019</li> <li>• Pass: A Course in Networks and Markets: Game-theoretic Models and Reasoning, MIT Press, 2019</li> </ul>

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<b>Course L2716: Digital Economics</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Timo Heinrich
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	Students examine existing empirical studies on topics covered in the lecture and develop their own research questions and study designs.
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Parkes/Seuken: Algorithmic Economics: A Design Approach, Unpublished, 2020</li> <li>• Easley/Kleinberg: Networks, Crowds and Markets, Cambridge University Press, 2010</li> <li>• Weimann/Brosig-Koch: Methods in Experimental Economics, Springer, 2019</li> <li>• Pass: A Course in Networks and Markets: Game-theoretic Models and Reasoning, MIT Press, 2019</li> </ul>

Module M1683: Project and Negotiation Management			
Courses			
Title	Typ	Hrs/wk	CP
Open Project Exercise (L2798)	Recitation Section (small)	1	1
Project Management (L0709)	Lecture	2	2
Negotiation Management (L2669)	Project-/problem-based Learning	3	3
<b>Module Responsible</b>	Prof. Christian Lüthje		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	<p>Students will be familiar with...</p> <p>Project management</p> <ul style="list-style-type: none"> <li>• characteristics and critical success factors of projects,</li> <li>• typical phases in projects, corresponding tasks and challenges,</li> <li>• advanced methods and tools, which can be applied in special phases of a project (such as cost-benefit analyses, scheduling techniques, business process modeling techniques, change management approaches),</li> <li>• important soft factors influencing a project's success (such as cultural aspects, team dynamics, and leadership approaches),</li> <li>• different project management approaches (classic vs. agile vs. hybrid),</li> <li>• practical cases of international project management,</li> <li>• theories, strategies, and advanced methods of negotiation (such as game theory, decision theory, and negotiation analysis).</li> </ul> <p>Negotiation management</p> <ul style="list-style-type: none"> <li>• the theory basics of negotiations (e.g. game theory, behavioral theories)</li> <li>• the types and the pros and cons of different negotiation strategies</li> <li>• the process of negotiation including goal formulation, preparation/planning, execution and evaluation</li> <li>• about some key issues impacting negotiations (e.g. team building and roles, barriers to reaching a deal, cognitive biases, multi-phase negotiations)</li> </ul>		
<i>Skills</i>	<p>Students will be able to...</p> <p>Project Management</p> <ul style="list-style-type: none"> <li>• conduct stakeholder and industry analyses,</li> <li>• critically analyze industries and multinational firms (e.g., in terms of their competitive situation and their strengths and weaknesses),</li> <li>• systematically implement project management techniques to international projects (e.g., plan international projects, deal with uncertainty, and establish, harmonize and track quality, time, and cost objectives),</li> <li>• apply project management techniques to complex business cases (e.g., optimize the target setting process, develop work breakdown structures, schedules and action plans, monitor project progress, manage risk throughout the project, and do the project controlling),</li> <li>• apply strategies and methods of negotiation to complex business cases,</li> <li>• internalize the components of an effective negotiation and practice their use,</li> <li>• successfully apply strategies and methods of negotiation in business practice in an international context (e.g., expose and overcome typical barriers to an agreement, deal with typical hardball tactics, and avoid cognitive traps),</li> <li>• work target-oriented on exercises to solve case studies,</li> <li>• apply scientific standards to academic writing,</li> <li>• appropriately present results of their work to others.</li> </ul> <p>Negotiation Management</p> <ul style="list-style-type: none"> <li>• simultaneously considering multiple factors in negotiation situations and taking reasoned actions when preparing and conducting negotiations.</li> <li>• Analyzing and handling the key challenges of uncertainty, risk, intercultural differences, and time pressure in realistic negotiation situations.</li> <li>• 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).</li> <li>• reflecting on their decision-making in uncertain negotiation situations and derive actions for future decisions.</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	<p>The students will be able to...</p> <ul style="list-style-type: none"> <li>• lead fruitful group discussions,</li> <li>• provide appropriate feedback,</li> <li>• present their results in written form and by oral presentations,</li> <li>• collaborate respectfully in multicultural teams,</li> <li>• be reflective on their own behavior in negotiations.</li> </ul>		
<i>Autonomy</i>	<p>The students will be able to...</p> <ul style="list-style-type: none"> <li>• independently acquire further relevant information and critically evaluate this information,</li> <li>• independently gather knowledge,</li> <li>• improve management techniques and adapt these to new situations in international business practice.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		

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<b>Credit points</b>	6
<b>Course achievement</b>	None
<b>Examination</b>	Subject theoretical and practical work
<b>Examination duration and scale</b>	Negotiation Strategies: Preparation and reviewing problem-based learning sessions; Projektmanagement: tbd
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory

Course L2798: Open Project Exercise	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	In the lecture Project Management, the most important phases of a project and the use of the project management software Open Project are taught. In the group exercise, example projects are worked on in small groups and these project phases are run through. The project is planned and documented with Open Project.
<b>Literature</b>	

Course L0709: Project Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>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.</p> <p>The following topics will be covered in the lecture:</p> <ul style="list-style-type: none"> <li>• SMART, Work Breakdown Structure, Operationalization, Goals relation matrix</li> <li>• Metra-Potential Method (MPM), Critical-Path Method (CPM), Program evaluation and review technique (PERT)</li> <li>• Milestone Analysis, Earned Value Analysis (EVA)</li> <li>• Progress reporting, Tracing of project goals, deadlines and costs, Project Management Control Loop, Maturity Level Assurance (MLA)</li> <li>• Risk Management, Failure Mode and Effects Analysis (FMEA), Risk Matrix</li> </ul>
<b>Literature</b>	<p>Project Management Institute (2017): A Guide to the Project Management Body of Knowledge (PMBOK® Guide) 6. Aufl. Newtown Square, PA, USA: Project Management Institute.</p> <p>DeMarco, Tom (1997). The Deadline: A Novel About Project Management.</p> <p>DIN Deutsches Institut für Normung e.V. (2009). Projektmanagement - Projektmanagementsysteme - Teil 5: Begriffe. (DIN 69901-5)</p> <p>Frigenti, Enzo and Comminos, Dennis (2002). The Practice of Project Management.</p> <p>Haberfellner, Reinhard (2015). Systems Engineering: Grundlagen und Anwendung</p> <p>Harrison, Frederick and Lock, Dennis (2004). Advanced Project Management: A Structured Approach.</p> <p>Heyworth, Frank (2002). A Guide to Project Management.</p> <p>ISO - International Organization for Standardization (2012). Guidance on Project Management. (21500:2012(E))</p> <p>Kerzner, Harold (2013). Project Management: A Systems Approach to Planning, Scheduling, and Controlling.</p> <p>Lock, Dennis (2018). Project Management.</p> <p>Martinelli, Russ J. and Milošević, Dragan (2016). Project Management Toolbox: Tools and Techniques for the Practicing Project Manager.</p> <p>Murch, Richard (2011). Project Management: Best Practices for IT Professionals.</p> <p>Patzak, Gerold and Rattay, Günter (2009). Projektmanagement: Leitfaden zum Management von Projekten, Projektportfolios, Programmen und projektorientierten Unternehmen.</p>

Course L2669: Negotiation Management	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3

<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Christian Lüthje
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>General description of course content and course goals</b></p> <p>We negotiate everyday in private 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.</p> <p>The purpose of this interactive and problem-based course is to theoretically 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, preparation, execution, evaluation) and offer the students the opportunity to analyze their own behavior in negotiations in order to improve.</p> <p>The course structure is experiential and problem-based, combining lectures, class discussion, mini-cases and small exercises, 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.</p> <p><b>Content:</b></p> <p>The students will find answers to the following fundamental questions of negotiation strategies in theory and practice:</p> <ul style="list-style-type: none"> <li>• How do negotiations influence everyday life and business processes?</li> <li>• What are key features of negotiations?</li> <li>• What are different forms of negotiations? What kinds of negotiation can be distinguished?</li> <li>• Which theoretical approaches to a theory of negotiation can be distinguished?</li> <li>• How can game theory be applied to negotiation?</li> <li>• What makes an effective negotiator?</li> <li>• Which factors should be considered when planning negotiations?</li> <li>• What steps must be followed to reach a deal?</li> <li>• Are there specific negotiation tactics?</li> <li>• What are the typical barriers to an agreement and how to deal with them?</li> <li>• What are possible cognitive (mental) errors and how to correct them?</li> </ul> <p><b>Knowledge</b></p> <p>Students know...</p> <ul style="list-style-type: none"> <li>• the theory basics of negotiations (e.g. game theory, behavioral theories)</li> <li>• the types and the pros and cons of different negotiation strategies</li> <li>• the process of negotiation, including goal formulation, preparation/planning, execution and evaluation</li> <li>• about some key issues impacting negotiations (e.g. team building and roles, barriers to reaching a deal, cognitive biases, multi-phase negotiations)</li> </ul> <p><b>Skills</b></p> <p>Students are capable of...</p> <ul style="list-style-type: none"> <li>• simultaneously considering multiple factors in negotiation situations and taking reasoned actions when preparing and conducting negotiations.</li> <li>• Analyzing and handling the key challenges of uncertainty, risk, intercultural differences, and time pressure in realistic negotiation situations.</li> <li>• 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).</li> <li>• reflecting on their decision-making in uncertain negotiation situations and derive actions for future decisions.</li> </ul> <p><b>Social Competence</b></p> <p>Students can...</p> <ul style="list-style-type: none"> <li>• provide appropriate feedback and handle feedback on their own performance constructively.</li> <li>• constructively interact with their team members in role playing in negotiations sessions</li> <li>• develop joint solutions in mixed teams and present them to others in real-world negotiation situations</li> </ul> <p><b>Self-Reliance</b></p> <p>Students are able to...</p> <ul style="list-style-type: none"> <li>◦ assess possible consequences of their own negotiation behavior</li> <li>◦ define own positions and tasks in the negotiation preparation process.</li> <li>◦ justify and make elaborated decisions in authentic negotiation situations.</li> </ul>
<b>Literature</b>	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.

Module M0814: Technology Management			
Courses			
Title	Typ	Hrs/wk	CP
Technology Management (L0849)	Lecture	3	3
Technology Management Seminar (L0850)	Project-/problem-based Learning	2	3
<b>Module Responsible</b>	Prof. Cornelius Herstatt		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Bachelor knowledge in business management		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>Students will gain deep insights into:</p> <ul style="list-style-type: none"> <li>• International R&amp;D-Management</li> <li>• Technology Timing Strategies                             <ul style="list-style-type: none"> <li>◦ Technology Strategies and Lifecycle Management (I/II)</li> <li>◦ Technology Intelligence and Planning</li> </ul> </li> <li>• Technology Portfolio Management                             <ul style="list-style-type: none"> <li>◦ Technology Portfolio Methodology</li> <li>◦ Technology Acquisition and Exploitation</li> <li>◦ IP Management</li> </ul> </li> <li>• Organizing Technology Development                             <ul style="list-style-type: none"> <li>◦ Technology Organization &amp; Management</li> <li>◦ Technology Funding &amp; Controlling</li> </ul> </li> </ul> <p><i>Skills</i></p> <p>The course aims to:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of the importance of Technology Management - on a national as well as international level</li> <li>• Equip students with an understanding of important elements of Technology Management (strategic, operational, organizational and process-related aspects)</li> <li>• Foster a strategic orientation to problem-solving within the innovation process as well as Technology Management and its importance for corporate strategy</li> <li>• Clarify activities of Technology Management (e.g. technology sourcing, maintenance and exploitation)</li> <li>• Strengthen essential communication skills and a basic understanding of managerial, organizational and financial issues concerning Technology-, Innovation- and R&amp;D-management. Further topics to be discussed include:                             <ul style="list-style-type: none"> <li>• Basic concepts, models and tools, relevant to the management of technology, R&amp;D and innovation</li> <li>• Innovation as a process (steps, activities and results)</li> </ul> </li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <ul style="list-style-type: none"> <li>• Interact within a team</li> <li>• Raise awareness for globabl issues</li> </ul> <p><i>Autonomy</i></p> <ul style="list-style-type: none"> <li>• Gain access to knowledge sources</li> <li>• Discuss recent research debates in the context of Technology and Innovation Management</li> <li>• Develop presentation skills</li> <li>• Discussion of international cases in R&amp;D-Management</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 minutes		
<b>Assignment for the Following Curricula</b>	Global Innovation Management: Core Qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory		

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Course L0849: Technology Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Cornelius Herstatt
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	The role of technology for the competitive advantage of the firm and industries; Basic concepts, models and tools for the management of technology; managerial decision making regarding the identification, selection and protection of technology (make or buy, keep or sell, current and future technologies). Theories, practical examples (cases), lectures, interactive sessions and group study.  This lecture is part of the Module Technology Management and can not separately chosen.
<b>Literature</b>	Leiblein, M./Ziedonis, A.: Technology Strategy and Innoovation Management, Elgar Research Collection, Northhampton (MA) 2011

Course L0850: Technology Management Seminar	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Cornelius Herstatt
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	Beside the written exam at the end of the module, students have to give one presentation (RE) on a research paper and two presentations as part of a group discussion (GD) in the seminar in order to pass. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.
<b>Literature</b>	see lecture Technology Management.

**Specialization II. Civil Engineering**

**Module M0998: Statics and Dynamics of Structures**

**Courses**

Title	Typ	Hrs/wk	CP
Structural Dynamics (L1202)	Lecture	2	2
Structural Dynamics (L1203)	Recitation Section (large)	2	2
Fracture mechanics and fatigue in steel structures (L0564)	Lecture	1	1
Fracture mechanics and fatigue in steel structures (L0565)	Recitation Section (large)	1	1

<b>Module Responsible</b>	Prof. Uwe Starossek
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	Knowledge of linear structural analysis of statically determinate and indeterminate structures; Mechanics I/II, Mathematics I/II, Differential equations I
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
<i>Knowledge</i>	After successful completion of this module, the student can explain the basic aspects of dynamic effects on structures and the respective methods.
<i>Skills</i>	After successful completion of this module, the students will be able to predict the response of material and structures to dynamics loading using the appropriate computational approaches and methods.
<b>Personal Competence</b>	
<i>Social Competence</i>	Students can <ul style="list-style-type: none"> <li>• participate in subject-specific and interdisciplinary discussions,</li> <li>• defend their own work results in front of others</li> <li>• promote the scientific development of colleagues</li> <li>• Furthermore, they can give and accept professional constructive criticism</li> </ul>
<i>Autonomy</i>	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermore, they are able to structure the solution process for problems in the area of Structural Analysis.
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84
<b>Credit points</b>	6
<b>Course achievement</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	150 min
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory

Course L1202: Structural Dynamics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Uwe Starossek
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Single-degree-of-freedom systems: undamped and damped vibration, free vibration, forced vibrations due to harmonic, periodical or arbitrary loading, natural frequency, damping</li> <li>• vibration isolation</li> <li>• solution in the frequency-domain (Fourier transformation), solution in the time-domain</li> <li>• multi-degree-of-freedom systems: continuous or discrete systems, modelling with finite elements, generalisation</li> <li>• modal analysis</li> <li>• power iteration according to v.Mises</li> <li>• earthquake loading: seismological basics, response spectrum method</li> <li>• wind-induced vibrations: engineering meteorology, aerodynamic, classification of excitation mechanisms</li> </ul> <p>progressive collapse</p>
<b>Literature</b>	Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993.

Course L1203: Structural Dynamics	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Uwe Starossek
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L0564: Fracture mechanics and fatigue in steel structures	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Jürgen Priebe
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• basics of fatigue stress and fatigue resistance and determination of fatigue strength,</li> <li>• determination and use of S-N-curves and classification of notch effects,</li> <li>• set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,</li> <li>• set up of determination of fatigue strength in different examples,</li> <li>• basics of construction and design regarding the problem of material fatigue,</li> <li>• basics of linear elastic fracture mechanics under static and dynamic load,</li> <li>• determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009</li> <li>• Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst &amp; Sohn; Berlin 2003</li> <li>• Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 1996</li> <li>• Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993</li> <li>• DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsregeln, Bemessungsregeln für den Hochbau; 1993</li> <li>• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001</li> <li>• DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 2002</li> </ul>

Course L0565: Fracture mechanics and fatigue in steel structures	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Jürgen Priebe
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0723: Design of Prestressed Structures and Concrete Bridges			
Courses			
Title	Typ	Hrs/wk	CP
Design of Prestressed Structures and Concrete Bridges (L0603)	Lecture	3	4
Design of Prestressed Structures and Concrete Bridges (L0604)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Günter Rombach		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Detailed knowledge on the design of concrete structures. Modules: Reinforced Concrete Structures I+II, Structural Analysis I+II, Mechanics I+II, Concrete Structures		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students know the main bridge types, their applications and the various loads. They can explain the basic design methods. They can explain the design of a prestressed bridge.</p> <p><i>Skills</i> The students are able to design reinforced or prestressed concrete bridges.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> The students can design in teamwork a real concrete bridge.</p> <p><i>Autonomy</i> The students are able to design a prestressed concrete bridge and discuss the problems and results with other students.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 minutes		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory		

Course L0603: Design of Prestressed Structures and Concrete Bridges	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Günter Rombach
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>prestressed structures</p> <ul style="list-style-type: none"> <li>• basis of prestressed structures, field of application</li> <li>• differences between reinforced and prestressed concrete structures</li> <li>• history of prestressing</li> <li>• construction materials: concrete, tendons, ducts, anchorage systems</li> <li>• construction: prestressing methods</li> <li>• prestressing forces and member forces (friction, elongation)</li> <li>• tendon layout</li> <li>• time dependant prestressing losses</li> <li>• design of prestressed structures</li> <li>• design of anchorage region</li> <li>• non-bonded prestressing</li> <li>• prestressed flat slabs</li> </ul> <p>Concrete bridges</p> <ul style="list-style-type: none"> <li>• history of bridges</li> <li>• design of bridges</li> <li>• loads on bridges</li> <li>• member forces for slab, T-beam, hollow box, frame and arch bridges</li> <li>• precast bridges - precast segmental bridges</li> <li>• bearings</li> <li>• abutments, columns</li> <li>• construction methods</li> <li>• damages - checking of bridges</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Vorlesungsumdruckim STUDiP</li> <li>• Rombach, G. (2003): Spannbetonbau. Ernst &amp; Sohn, Berlin</li> <li>• Wicke, M. (2002): Anwendung des Spannbetons. Betonkalender 2002, Teil II, S. 113-180, Verlag Ernst &amp; Sohn, Berlin</li> <li>• Leonhardt, F. (1980): Vorlesungen über Massivbau. Teil 5: Spannbeton. Berlin</li> <li>• Mehlhorn, G. (2007): Handbuch Brücken, Springer Verlag</li> <li>• Schäfer, H.; Kaufeld, K. (1997): Massivbrücken. Betonkalender Teil II, S. 443ff, Ernst &amp; Sohn, Berlin</li> <li>• Menn, Ch. (1986): Stahlbetonbrücken. Springer Verlag, Wien</li> </ul>

Course L0604: Design of Prestressed Structures and Concrete Bridges	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Günter Rombach
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0977: Construction Logistics and Project Management			
Courses			
Title	Typ	Hrs/wk	CP
Construction Logistics (L1163)	Lecture	1	2
Construction Logistics (L1164)	Recitation Section (small)	1	2
Project Development and Management (L1161)	Lecture	1	1
Project Development and Management (L1162)	Project-/problem-based Learning	1	1
<b>Module Responsible</b>	Prof. Heike Flämig		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	none		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students can...</p> <ul style="list-style-type: none"> <li>• give definitions of the main terms of construction logistics and project development and management</li> <li>• name advantages and disadvantages of internal or external construction logistics</li> <li>• explain characteristics of products, demand and production of construction objects and their consequences for construction specific supply chains</li> <li>• differentiate constructions logistics from other logistics systems</li> </ul> <p><i>Skills</i> Students can...</p> <ul style="list-style-type: none"> <li>• carry out project life cycle assessments</li> <li>• apply methods and instruments of construction logistics</li> <li>• apply methods and instruments of project development and management</li> <li>• apply methods and instruments of conflict management</li> <li>• design supply and waste removal concepts for a construction project</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can...</p> <ul style="list-style-type: none"> <li>• hold presentations in and for groups</li> <li>• apply methods of conflict solving skills in group work and case studies</li> </ul> <p><i>Autonomy</i> Students can...</p> <ul style="list-style-type: none"> <li>• solve problems by holistic, systemic and flow oriented thinking</li> <li>• improve their creativity, negotiation skills, conflict and crises solution skills by applying methods of moderation in case studies</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written elaboration		
<b>Examination duration and scale</b>	Two written papers with presentations		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory International Management and Engineering: Specialisation II. Civil 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		

Course L1163: Construction Logistics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Heike Flämig
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The lecture gives deeper insight how important logistics are as a competitive factor for construction projects and which issues are to be addressed.</p> <p>The following topics are covered:</p> <ul style="list-style-type: none"> <li>• competitive factor logistics</li> <li>• the concept of systems, planning and coordination of logistics</li> <li>• material, equipment and reverse logistics</li> <li>• IT in construction logistics</li> <li>• elements of the planning model of construction logistics and their connections</li> <li>• flow oriented logistics systems for construction projects</li> <li>• logistics concepts for ready to use construction projects (especially procurement and waste removal logistics)</li> <li>• best practice examples (construction logistics Potsdamer Platz, recent case study of the region)</li> </ul> <p>Contents of the lecture are deepened in special exercises.</p>
<b>Literature</b>	<p>Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bd. 15.2. Wuppertal 2000.</p> <p>Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005.</p> <p>Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004.</p> <p>Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter: Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003.</p> <p>Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20)</p>

Course L1164: Construction Logistics	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Heike Flämig
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L1161: Project Development and Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Heike Flämig, Dr. Anton Worobei
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Within the lecture, the main aspects of project development and management are taught:</p> <ul style="list-style-type: none"> <li>• Terms and definitions of project management</li> <li>• Advantages and disadvantages of different ways of project handling</li> <li>• organization, information, coordination and documentation</li> <li>• cost and finance management in projects</li> <li>• time- and capacity management in projects</li> <li>• specific methods and instruments for successful team work</li> </ul> <p>Contents of the lecture are deepened in special exercises.</p>
<b>Literature</b>	Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.

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<b>Course L1162: Project Development and Management</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Heike Flämig, Dr. Anton Worobei
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0860: Harbour Engineering and Harbour Planning				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Harbour Engineering (L0809)		Lecture	2	2
Harbour Engineering (L1414)		Project-/problem-based Learning	1	2
Port Planning and Port Construction (L0378)		Lecture	2	2
<b>Module Responsible</b>	Prof. Peter Fröhle			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basics of coastal engineering			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students are able to define in details and to choose design approaches for the functional design of a port and apply them to design tasks. They can design the fundamental elements of a port.			
<i>Skills</i>	The students are able to select and apply appropriate approaches for the functional design of ports.			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to deploy their gained knowledge in applied problems such as the functional design of ports. Additionally, they will be able to work in team with engineers of other disciplines.			
<i>Autonomy</i>	The students will be able to independently extend their knowledge and apply it to new problems.			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	The duration of the examination is 150 min. The examination includes tasks with respect to the general understanding of the lecture contents and calculations tasks.			
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory			

Course L0809: Harbour Engineering	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Peter Fröhle
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Fundamentals of harbor engineering               <ul style="list-style-type: none"> <li>◦ Maritime transportation and waterways engineering</li> <li>◦ Ships</li> </ul> </li> <li>• Elements of harbors               <ul style="list-style-type: none"> <li>◦ Harbor approaches and water-side harbor areas</li> <li>◦ Terminal design and handling of cargo</li> <li>◦ Quay-walls and piers</li> <li>◦ Equipment of harbors</li> <li>◦ Sluices and other special constructions</li> </ul> </li> <li>• Connection to inland transportation / inland waterway transportation</li> <li>• Protection of harbors               <ul style="list-style-type: none"> <li>◦ Breakwaters and Jetties</li> <li>◦ Wave protection of harbors</li> </ul> </li> <li>• Fishery and other small harbors</li> </ul>
<b>Literature</b>	Brinkmann, B.: Seehäfen, Springer 2005

Course L1414: Harbour Engineering	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Peter Fröhle
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

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<b>Course L0378: Port Planning and Port Construction</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Frank Feindt
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Planning and implementation of major projects</li> <li>• Market analysis and traffic relations</li> <li>• Planning process and plan</li> <li>• Port planning in urban neighborhood</li> <li>• Development of the logistics center "Port of Hamburg" in the metropolis</li> <li>• Quays and waterfront structure</li> <li>• Special planning Law Harbor - securing of a flexible use of the port</li> <li>• Dimensioning of quays</li> <li>• Flood protection structures</li> <li>• Port of Hamburg - Infrastructure and development</li> <li>• Preparation of areas</li> <li>• Scour formation in front of shore structures</li> </ul>
<b>Literature</b>	Vorlesungsumdruck, s. <a href="http://www.tu-harburg.de/gbt">www.tu-harburg.de/gbt</a>

Module M0581: Water Protection			
Courses			
Title	Typ	Hrs/wk	CP
Water Protection and Wastewater Management (L0226)	Lecture	3	3
Water Protection and Wastewater Management (L2008)	Project Seminar	3	3
<b>Module Responsible</b>	Prof. Ralf Otterpohl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Basic knowledge in water management;</li> <li>• Good knowledge in urban drainage;</li> <li>• Good knowledge of wastewater treatment techniques;</li> <li>• Good knowledge of pollutants (e.g. COD, BOD, TS, N, P) and their properties;</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students can describe the basic principles of the regulatory framework related to the international and European water sector. They can explain limnological processes, substance cycles and water morphology in detail. They are able to assess complex problems related to water protection, such as ecosystem service and wastewater treatment with a special focus on innovative solutions, remediation measures as well as conceptual approaches.</p> <p><i>Skills</i> Students can accurately assess current problems and situations in a country-specific or local context. They can suggest concrete actions to contribute to the planning of tomorrow's urban water cycle. Furthermore, they can suggest appropriate technical, administrative and legislative solutions to solve these problems.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> The students can work together in international groups.</p> <p><i>Autonomy</i> Students are able to organize their work flow to prepare presentations and discussions. They can acquire appropriate knowledge by making enquiries independently.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Presentation		
<b>Examination duration and scale</b>	Term paper plus presentation		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Environmental Engineering: Specialisation Water: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Water: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Compulsory		

Course L0226: Water Protection and Wastewater Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Ralf Otterpohl
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The lecture focusses on:</p> <ul style="list-style-type: none"> <li>• Regulatory Framework (e.g. WFD)</li> <li>• Main instruments for the water management and protection</li> <li>• In depth knowledge of relevant measures of water pollution control</li> <li>• Urban drainage, treatment options in different regions on the world</li> <li>• Rainwater management, improved management of heavy rainfalls, downpours, rainwater harvesting, rainwater infiltration</li> <li>• Case Studies and Field Trips</li> </ul>
<b>Literature</b>	<p>The literature listed below is available in the library of the TUHH.</p> <ul style="list-style-type: none"> <li>• Water and wastewater technology Hammer, M. J. 1., &amp; . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International.</li> <li>• Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011). . New York, NY: McGraw-Hill.</li> <li>• Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.</li> </ul>

Course L2008: Water Protection and Wastewater Management	
<b>Typ</b>	Project Seminar
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Ralf Otterpohl
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	

Module M0595: Examination of Materials, Structural Condition and Damages			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Examination of Materials, Structural Condition and Damages (L0260)		Lecture	3
Examination of Materials, Structural Condition and Damages (L0261)		Recitation Section (small)	1
<b>CP</b>			
			4
			2
<b>Module Responsible</b>	Prof. Frank Schmidt-Döhl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge about building materials or material science, for example by the module Building Materials and Building Chemistry.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students are able to describe the rules for trading, use and marking of construction products in Germany. They know which methods for the testing of building material properties are usable and know the limitations and characteristics of the most important testing methods.		
<i>Skills</i>	The students are able to responsibly discover the rules for trading and using of building products in Germany. They are able to choose suitable methods for the testing and inspection of construction products, the examination of damages and the examination of the structural conditions of buildings. They are able to conclude from symptoms to the cause of damages. They are able to describe an examination in form of a test report or expert opinion.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students can describe the different roles of manufacturers as well as testing, supervisory and certification bodies within the framework of material testing. They can describe the different roles of the participants in legal proceedings.		
<i>Autonomy</i>	The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Materials Science: Specialisation Engineering Materials: Elective Compulsory		

Course L0260: Examination of Materials, Structural Condition and Damages	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Frank Schmidt-Döhl
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	Materials testing and marking process of construction products, testing methods for building materials and structures, testing reports and expert opinions, describing the condition of a structure, from symptoms to the cause of damages
<b>Literature</b>	Frank Schmidt-Döhl: Materialprüfung im Bauwesen. Fraunhofer irb-Verlag, Stuttgart, 2013.

Course L0261: Examination of Materials, Structural Condition and Damages	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Frank Schmidt-Döhl
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0603: Nonlinear Structural Analysis			
Courses			
Title	Typ	Hrs/wk	CP
Nonlinear Structural Analysis (L0277)	Lecture	3	4
Nonlinear Structural Analysis (L0279)	Recitation Section (small)	1	2
<b>Module Responsible</b>	Prof. Alexander Düster		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge of partial differential equations is recommended.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>+ give an overview of the different nonlinear phenomena in structural mechanics.</li> <li>+ explain the mechanical background of nonlinear phenomena in structural mechanics.</li> <li>+ to specify problems of nonlinear structural analysis, to identify them in a given situation and to explain their mathematical and mechanical background.</li> </ul> <p><i>Skills</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>+ model nonlinear structural problems.</li> <li>+ select for a given nonlinear structural problem a suitable computational procedure.</li> <li>+ apply finite element procedures for nonlinear structural analysis.</li> <li>+ critically verify and judge results of nonlinear finite elements.</li> <li>+ to transfer their knowledge of nonlinear solution procedures to new problems.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>+ solve problems in heterogeneous groups.</li> <li>+ present and discuss their results in front of others.</li> <li>+ give and accept professional constructive criticism.</li> </ul> <p><i>Autonomy</i></p> <p>Students are able to</p> <ul style="list-style-type: none"> <li>+ assess their knowledge by means of exercises and E-Learning.</li> <li>+ acquaint themselves with the necessary knowledge to solve research oriented tasks.</li> <li>+ to transform the acquired knowledge to similar problems.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory		

<b>Course L0277: Nonlinear Structural Analysis</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Alexander Düster
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Nonlinear phenomena</li> <li>3. Mathematical preliminaries</li> <li>4. Basic equations of continuum mechanics</li> <li>5. Spatial discretization with finite elements</li> <li>6. Solution of nonlinear systems of equations</li> <li>7. Solution of elastoplastic problems</li> <li>8. Stability problems</li> <li>9. Contact problems</li> </ol>
<b>Literature</b>	<p>[1] Alexander Düster, Nonlinear Structural Analysis, Lecture Notes, Technische Universität Hamburg-Harburg, 2014.</p> <p>[2] Peter Wriggers, Nonlinear Finite Element Methods, Springer 2008.</p> <p>[3] Peter Wriggers, Nichtlineare Finite-Elemente-Methoden, Springer 2001.</p> <p>[4] Javier Bonet and Richard D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge University Press, 2008.</p>

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

Module M0858: Coastal Hydraulic Engineering I			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Basics of Coastal Engineering (L0807)	Lecture	3	4
Basics of Coastal Engineering (L1413)	Project-/problem-based Learning	1	2
<b>Module Responsible</b>	Prof. Peter Fröhle		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of hydraulic engineering, hydrology and hydromechanics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	The students are able to define and explain the basic concepts of coastal engineering and port engineering. They are able to apply the concepts to selected practical problems of coastal engineering. Students can define and determine the basics for design and dimensioning of coastal engineering constructions.		
<i>Knowledge</i>			
<i>Skills</i>	The students are capable to apply basic design approaches to selected and pre-defined design tasks in coastal engineering.		
<b>Personal Competence</b>	The students are able to deploy their gained knowledge in applied problems such as the design of coastal protection structures. Additionally, they will be able to work in team with engineers of other disciplines, for instance designing of coastal breakwaters.		
<i>Social Competence</i>			
<i>Autonomy</i>	The students will be able to independently extend their knowledge and apply it to new problems.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	The duration of the examination is 2 hours. The examination includes tasks with respect to the general understanding of the lecture contents and calculations tasks.		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Compulsory Civil Engineering: Specialisation Coastal Engineering: Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory		

Course L0807: Basics of Coastal Engineering	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Peter Fröhle
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Basics of planning and design                             <ul style="list-style-type: none"> <li>◦ Water levels</li> <li>◦ Currents</li> <li>◦ Waves</li> <li>◦ Ice</li> </ul> </li> <li>• Planning and Design in Coastal Engineering                             <ul style="list-style-type: none"> <li>◦ Functional and constructional design</li> <li>◦ Determination of design parameters</li> <li>◦ Design-approaches                                     <ul style="list-style-type: none"> <li>▪ Filter</li> <li>▪ Rubble mound constructions</li> <li>▪ Piles</li> <li>▪ Vertical constructions</li> </ul> </li> </ul> </li> </ul>
<b>Literature</b>	Coastal Engineering Manual, CEM Vorlesungsumdruck

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<b>Course L1413: Basics of Coastal Engineering</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Peter Fröhle
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0699: Geotechnics III			
Courses			
Title	Typ	Hrs/wk	CP
Numerical Methods in Geotechnics (L0375)	Lecture	3	3
Advanced Foundation Engineering (L0497)	Lecture	2	2
Advanced Foundation Engineering (L0498)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Jürgen Grabe		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Geotechnics I and II, Mathematics I-III		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> After successfully completing the module, students will be able to</p> <ul style="list-style-type: none"> <li>• describe individual procedures for the geotechnical monitoring of civil engineering measures,</li> <li>• reproduce exploration and investigation methods of the subsoil,</li> <li>• select suitable types of field and laboratory tests for subsoil investigation and evaluate their results,</li> <li>• state the differences between various stress and deformation states and the physical significance of invariants of the stress and distortion tensor,</li> <li>• outline the standard and special soil mechanics tests used to determine the stress-strain behavior of soil,</li> <li>• describe continuum models and the resulting boundary value problems,</li> <li>• as well as define boundary value problems from the field of geotechnical engineering in such a way that they can be solved unambiguously.</li> </ul> <p><i>Skills</i> Students will be able to</p> <ul style="list-style-type: none"> <li>• dimension vertical drains for soil improvement of soft soils,</li> <li>• calculate depth compaction using various appropriate methods,</li> <li>• apply principles of horizontal bearing capacity of piles,</li> <li>• verify the internal and external stability of fluid-supported diaphragm walls,</li> <li>• evaluate the boundary conditions for the design of a deep excavation and design the individual components of the excavation,</li> <li>• perform, evaluate and interpret tests for the description and classification of soils according to applicable standards,</li> <li>• computationally implement numerical algorithms to solve boundary value problems,</li> <li>• select and apply the types of analyses depending on the degree of saturation, the impact, and the material behavior</li> <li>• determine appropriate model parameters for different possibilities and limitations of material models for the grain structure of soils.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can work in groups and support each other in finding solutions.</p> <p><i>Autonomy</i> Students are able to assess their own strengths and weaknesses and, based on this, organize their time and learning management and think in terms of processes.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Compulsory Civil Engineering: Specialisation Coastal Engineering: Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory		

Course L0375: Numerical Methods in Geotechnics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Dr. Hans Mathäus Stanford
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Topics:</p> <ul style="list-style-type: none"> <li>• numerical simulations</li> <li>• numerical algorithms</li> <li>• finite element method</li> <li>• application of finite element method in geomechanics</li> <li>• constitutive models for soils</li> <li>• contact models for soil structure interaction</li> <li>• selected applications</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden, Springer Verlag, Berlin</li> <li>• Bathe Klaus-Jürgen (2002): Finite-Elemente-Methoden. Springer Verlag, Berlin</li> </ul>

Course L0497: Advanced Foundation Engineering	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Jürgen Grabe
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Vertical drains</li> <li>• Piles</li> <li>• Ground improvement (Deep Compaction, Soil mixing)</li> <li>• Vibration driving</li> <li>• Jet grouting</li> <li>• Slurry wall</li> <li>• Deep excavation</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>• EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>• EAB (1988): Empfehlungen des Arbeitskreises Baugruben</li> <li>• Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst &amp; Sohn Verlag</li> </ul>

Course L0498: Advanced Foundation Engineering	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Jürgen Grabe
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0962: Sustainability and Risk Management			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Safety, Reliability and Risk Assessment (L1145)		Seminar	2
Environment and Sustainability (L0319)		Lecture	2
<b>CP</b>			3
<b>Module Responsible</b>	Prof. Kerstin Kuchta		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	none		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	Students are able to describe single techniques and to give an overview for the field of safety and risk assessment as well as environmental and sustainable engineering, in detail:		
<i>Knowledge</i>	<ul style="list-style-type: none"> <li>• basics in safety and reliability of technical facilities</li> <li>• safety and reliability analysis methods</li> <li>• risk assessment</li> <li>• Production and usage of bio-char</li> <li>• energy production and supply</li> <li>• sustainable product design</li> </ul>		
<i>Skills</i>	Students are able apply interdisciplinary system-oriented methods for risk assessment and sustainability reporting. They can evaluate the effort and costs for processes and select economically feasible treatment concepts.		
<b>Personal Competence</b>	Students can gain knowledge of the subject area from given sources and transform it to new questions. Furthermore, they can define targets for new application or research-oriented duties in for risk management and sustainability concepts accordance with the potential social, economic and cultural impact.		
<i>Social Competence</i>			
<i>Autonomy</i>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written elaboration		
<b>Examination duration and scale</b>	Elaboration and presentation (45 minutes in groups)		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Water and Environmental Engineering: Core Qualification: Compulsory		

Course L1145: Safety, Reliability and Risk Assessment	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Marco Ritzkowski
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	An introduction in safety and risk assessment is given and some typical problems of structural and environmental engineering are treated: <ul style="list-style-type: none"> <li>• basics in safety and reliability of technical facilities</li> <li>• safety and reliability analysis methods</li> <li>• risk assessment</li> <li>• practical examples and excursions</li> <li>• discussions and presentations</li> </ul>
<b>Literature</b>	- Vorlesungsunterlagen - Schneider, J., Schlatter, H.P.: Sicherheit und Zuverlässigkeit im Bauwesen. <a href="http://www.risksafety.ch/files/sicherheit_und_zuverlaessigkeit.pdf">www.risksafety.ch/files/sicherheit_und_zuverlaessigkeit.pdf</a>

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<b>Course L0319: Environment and Sustainability</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>This course presents actual methodologies and examples of environmental relevant, sustainable technologies, concepts and strategies in the field of energy supply, product design, water supply, waste water treatment or mobility. The following list show examples.</p> <ul style="list-style-type: none"> <li>Production and Usage of Bio-char</li> <li>Energy production with algae</li> <li>Environmental product design</li> <li>Clean Development mechanism (CDM)</li> <li>Democracy and Energy</li> <li>New Concepts for a sustainable Energy Supply</li> </ul> <ul style="list-style-type: none"> <li>Recycling of Wind Turbines</li> <li>Alternative Mobility</li> </ul> <ul style="list-style-type: none"> <li>Disposal of Nuclear Wastes</li> <li>Waste2Energy</li> <li>Offshore Wind energy</li> </ul>
<b>Literature</b>	Wird in der Veranstaltung bekannt gegeben.

Module M0963: Steel and Composite Structures			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Steel and Composite Structures (L1204)		Lecture	2
Steel and Composite Structures (L1205)		Recitation Section (large)	2
Steel Bridges (L1097)		Lecture	2
<b>Module Responsible</b>	Prof. Marcus Rütner		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of steel construction (i.e. Steel Structures I and II, BUBC)		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	After successful completion, students can		
	<ul style="list-style-type: none"> <li>describe the phenomenon of local buckling</li> <li>explain warping torsion</li> <li>illustrate the behaviour of composite structures</li> <li>specify the principles in design of composite structures</li> <li>sketch the constructions of steel and composite bridges</li> </ul>		
<i>Skills</i>	After successful participation students are able to		
	<ul style="list-style-type: none"> <li>check stiffened and unstiffened plated structures</li> <li>recognize and verify warping torsion in structures</li> <li>design composite structures</li> <li>design bridges and perform the detailing</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	--		
<i>Autonomy</i>	--		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory		

Course L1204: Steel and Composite Structures	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Marcus Rütner
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>Local-buckling of plated structures</li> <li>Warping torsion</li> <li>Composite-girders, -columns, -slabs, -bridges</li> <li>Principles in composite constructions</li> <li>Bridge-design and -construction</li> </ul>
<b>Literature</b>	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag  Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag

Course L1205: Steel and Composite Structures	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Marcus Rütner
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

<b>Course L1097: Steel Bridges</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Yves Freundt
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>Lecture Contents ,Steel Bridge Construction'</b>  <b>Dr.-Ing. Jörg Ahlgrimm</b></p> <ul style="list-style-type: none"> <li>- From tendering and contracting to completion - the development of a steel bridge</li> <li>- Contents of a bridge static - structural details, examples of analysis in detail: <ul style="list-style-type: none"> <li>-&gt; effective width in regard to the longitudinal stiffeners</li> <li>-&gt; Bearing point, bearing stiffener</li> <li>-&gt; Crossbeam breakthrough, crossbeam reinforcement</li> <li>-&gt; Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)</li> </ul> </li> <li>- Steel grades, -designation, testing methods and approval certificates</li> <li>- Nondestructive weld inspecting</li> <li>- Corrosion protection</li> <li>- Bridge bearing - types, format, function, dimensioning, installation</li> <li>- Expansion Joints</li> <li>- Oscillation of bridge hangers and cables - oscillation damper</li> <li>- Opening bridges- Detailed reviews to different assembling procedures and - implements</li> <li>- Selective damage events</li> </ul> <p>Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär: Ausführung von Stahlbauten</li> <li>• Petersen, Christian: Stahlbau, Abschnitt Brückenbau</li> <li>• Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S. 114</li> </ul>

Module M0964: Underground Constructions				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Applied Tunnel Constructions (L2407)		Lecture	2	3
Introduction to tunnel construction (L0707)		Lecture	1	2
Introduction to tunnel construction (L1811)		Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Jürgen Grabe			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Modules from Bachelor studies Civil and environmental engineering: <ul style="list-style-type: none"> <li>• Geotechnics I-II</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.			
<i>Skills</i>	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Capacity for teamwork concerning project management and design of tunnels.			
<i>Autonomy</i>	Promotion of independent and creative work flow in the framework of a design exercise.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	5 %	Excercises	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 minutes			
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Compulsory Civil Engineering: Specialisation Coastal Engineering: Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory			

Course L2407: Applied Tunnel Constructions	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Jürgen Grabe, Tim Babendererde
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	

Course L0707: Introduction to tunnel construction	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Marius Milatz
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Definitions</li> <li>• Historical development in tunneling</li> <li>• Geology for tunneling</li> <li>• Hard rock tunneling (construction composite and machines)</li> <li>• Tunnelung in temporarily stable soil with conventional construction methods</li> <li>• Tunneling in soft soils (form of supports, shield types, compressed air application)</li> <li>• Pipe jacking</li> <li>• Tunnel Lining, tunnel supporting structures</li> <li>• Calculation approaches for supporting structures in shield-driven tunnels</li> <li>• Surveying for tunneling</li> <li>• Safety requirements</li> <li>• Construction Contract</li> <li>• Literature and sources</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Vorlesung/Übung s. <a href="http://www.tu-harburg.de/gbt">www.tu-harburg.de/gbt</a></li> </ul>

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<b>Course L1811: Introduction to tunnel construction</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Marius Milatz
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0713: Concrete Structures				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Concrete Structures (L0579)		Seminar	1	1
Structural Concrete Members (L0577)		Lecture	2	3
Structural Concrete Members (L0578)		Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Günter Rombach			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basics of structural analysis, conception and dimensioning of structural concrete Modules: Reinforced Concrete Structures I+II, Structural Analysis I+II, Mechanics I+II			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students broaden their skills in structural engineering, especially in the field of buildings (houses, roofs, halls). They dispose of the knowledge for the conception and design of concrete buildings and structural members that are often used.			
<i>Skills</i>	The students are able to apply procedures of the conception and dimensioning to practical problems of structural engineering. They are capable to draft concrete buildings and to design them for general action effects and to plan their detailing and execution. Moreover, they can make design and construction sketches and draw up technical descriptions.			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to obtain results of high quality in teamwork.			
<i>Autonomy</i>	The students are able to carry out complex conception and dimensioning tasks of structures under the guidance of tutors.			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Presentation	Es werden 2 Referate ausgegeben
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 minutes			
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory			
Course L0579: Concrete Structures				
<b>Typ</b>	Seminar			
<b>Hrs/wk</b>	1			
<b>CP</b>	1			
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14			
<b>Lecturer</b>	Prof. Günter Rombach			
<b>Language</b>	DE			
<b>Cycle</b>	WiSe			
<b>Content</b>	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.			
<b>Literature</b>	- Projektbezogene Unterlagen werden abgegeben.			

Course L0577: Structural Concrete Members	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Günter Rombach
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• skyscrapers: structural elements</li> <li>• actions on structures</li> <li>• bracing systems</li> <li>• design of slabs (line and point supported plates and floor slabs)</li> <li>• membranes and deep beams</li> <li>• folded plates and shells</li> <li>• truss models</li> <li>• reinforced and prestressed members</li> </ul>
<b>Literature</b>	<p>Vorlesungsunterlagen können im STUDIIP heruntergeladen werden</p> <ul style="list-style-type: none"> <li>• Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010</li> <li>• König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst &amp; Sohn, Berlin 2003</li> <li>• Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005</li> <li>• Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012</li> <li>• Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken, Verlag Ernst &amp; Sohn, Berlin 1978</li> <li>• Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalender 1992, Teil I, 287-366, Verlag Ernst &amp; Sohn, Berlin 1992</li> <li>• Stiglat/Wippel: Platten. Verlag Ernst &amp; Sohn, Berlin, 1973</li> <li>• Schlaich J.; Schäfer K.: Konstruieren im Stahlbetonbau. Betonkalender 1998, Teil II, S. 721ff, Verlag Ernst &amp; Sohn, Berlin, 1998</li> <li>• Dames K.-H.: Rohbauzeichnungen Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997</li> </ul>

Course L0578: Structural Concrete Members	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Günter Rombach
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M1813: Agile learning with agile methods				
Courses				
Title	Typ	Hrs/wk	CP	
Agile Data Science for industrial Engineers (L3009)	Project-/problem-based Learning	3	6	
<b>Module Responsible</b>	Prof. Kathrin Fischer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Scientific Writing			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know: <ul style="list-style-type: none"> <li>• Basic principles of agile work</li> <li>• Roles within agile project management based on Scrum</li> <li>• Structure and workflows of agile project groups</li> <li>• Basic functions/classes/methods of data science in python</li> <li>• Selected libraries of data science in Python</li> </ul>			
<i>Skills</i>	The students are able to: <ul style="list-style-type: none"> <li>• Plan and carry out a project based on the Scrum philosophy, in detail:                             <ul style="list-style-type: none"> <li>◦ Define and allocate roles in Scrum</li> <li>◦ Plan Scrum sprints based on self-defined work packages (planning)</li> <li>◦ Carry out Scrum sprints</li> <li>◦ Complete, analyse and evaluate Scrum sprints (review and retrospective)</li> <li>◦ Present project results</li> </ul> </li> <li>• Use established tools of collaborative work</li> <li>• Writing simple scientific scripts for data science in Python collaboratively</li> <li>• Record the methods and results</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to: <ul style="list-style-type: none"> <li>• Work in heterogenic project groups and accept their defined roles based on the scrum philosophy</li> <li>• Commit to group intern time management necessities</li> <li>• Manage scope adjustments under time pressure</li> <li>• Realize and judge the importance of individual commitments for collaborative work</li> <li>• Communicate with stakeholders of their group project</li> </ul>			
<i>Autonomy</i>	The students are able to: <ul style="list-style-type: none"> <li>• Evaluate work packages regarding their practicability and commit to working on these individually</li> <li>• Evaluate their own skills regarding their contribution to a given project</li> <li>• Harmonize their own time management to the group intern time management</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Group discussion	
<b>Examination</b>	Written elaboration			
<b>Examination duration and scale</b>	Approx. 5 - 10 pages per person			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			

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<b>Course L3009: Agile Data Science for industrial Engineers</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Within this course, the fundamentals of Python for Data Science are taught and applied on a collaborative level.</p> <p>The course starts with an introduction to Python which is held in workshop format, and an introduction to collaborative work and agile project management.</p> <p>During this course different projects will be carried out in project groups, following the scrum philosophy.</p> <p>The course is dedicated to programming beginners, so no prior knowledge of Python is required. However, also students with programming experience are welcome to participate.</p> <p>For the exam, teams are required to write a report on the group projects and their results.</p>
<b>Literature</b>	Schwaber, K. & Sutherland, J. (2020): The Scrum Guide. Online Ressource

**Specialization II. Electrical Engineering**

**Module M0630: Robotics and Navigation in Medicine**

**Courses**

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

<b>Module Responsible</b>	Prof. Alexander Schlaefer
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<b>Admission Requirements</b>	None
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<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>principles of math (algebra, analysis/calculus)</li> <li>principles of programming, e.g., in Java or C++</li> <li>solid R or Matlab skills</li> </ul>
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<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
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<b>Professional Competence</b>	
<i>Knowledge</i>	The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.
<i>Skills</i>	The students are able to design and evaluate navigation systems and robotic systems for medical applications.
<b>Personal Competence</b>	
<i>Social Competence</i>	The students discuss the results of other groups, provide helpful feedback and can incorporate feedback into their work.
<i>Autonomy</i>	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.

<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70
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<b>Credit points</b>	6
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<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Written elaboration	
	Yes	10 %	Presentation	

<b>Examination</b>	Written exam
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<b>Examination duration and scale</b>	90 minutes
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<b>Assignment for the Following Curricula</b>	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory
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**Course L0335: Robotics and Navigation in Medicine**

<b>Typ</b>	Lecture
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<b>Hrs/wk</b>	2
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<b>CP</b>	3
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<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
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<b>Lecturer</b>	Prof. Alexander Schlaefer
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<b>Language</b>	EN
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<b>Cycle</b>	SoSe
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<b>Content</b>	- kinematics - calibration - tracking systems - navigation and image guidance - motion compensation The seminar extends and complements the contents of the lecture with respect to recent research results.
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<b>Literature</b>	Spong et al.: Robot Modeling and Control, 2005 Troccaz: Medical Robotics, 2012 Further literature will be given in the lecture.
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<b>Course L0338: Robotics and Navigation in Medicine</b>	
<b>Typ</b>	Project Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Schlaefer
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

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

Module M0673: Information Theory and Coding			
Courses			
Title	Typ	Hrs/wk	CP
Information Theory and Coding (L0436)	Lecture	3	4
Information Theory and Coding (L0438)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Gerhard Bauch		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Mathematics 1-3</li> <li>• Probability theory and random processes</li> <li>• Basic knowledge of communications engineering (e.g. from lecture "Fundamentals of Communications and Random Processes")</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students know the basic definitions for quantification of information in the sense of information theory. They know Shannon's source coding theorem and channel coding theorem and are able to determine theoretical limits of data compression and error-free data transmission over noisy channels. They understand the principles of source coding as well as error-detecting and error-correcting channel coding. They are familiar with the principles of decoding, in particular with modern methods of iterative decoding. They know fundamental coding schemes, their properties and decoding algorithms.</p> <p><i>Skills</i> The students are able to determine the limits of data compression as well as of data transmission through noisy channels and based on those limits to design basic parameters of a transmission scheme. They can estimate the parameters of an error-detecting or error-correcting channel coding scheme for achieving certain performance targets. They are able to compare the properties of basic channel coding and decoding schemes regarding error correction capabilities, decoding delay, decoding complexity and to decide for a suitable method. They are capable of implementing basic coding and decoding schemes in software.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students can jointly solve specific problems.</p> <p><i>Autonomy</i> The students are able to acquire relevant information from appropriate literature sources. They can control their level of knowledge during the lecture period by solving tutorial problems, software tools, clicker system.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Information and Communication Systems: Elective Compulsory Computational Science and Engineering: Specialisation II. Engineering Science: Elective Compulsory Information and Communication Systems: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory		

Course L0436: Information Theory and Coding	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Gerhard Bauch
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Fundamentals of information theory                             <ul style="list-style-type: none"> <li>◦ Self information, entropy, mutual information</li> <li>◦ Source coding theorem, channel coding theorem</li> <li>◦ Channel capacity of various channels</li> </ul> </li> <li>• Fundamental source coding algorithms:                             <ul style="list-style-type: none"> <li>◦ Huffman Code, Lempel Ziv Algorithm</li> </ul> </li> <li>• Fundamentals of channel coding                             <ul style="list-style-type: none"> <li>◦ Basic parameters of channel coding and respective bounds</li> <li>◦ Decoding principles: Maximum-A-Posteriori Decoding, Maximum-Likelihood Decoding, Hard-Decision-Decoding and Soft-Decision-Decoding</li> <li>◦ Error probability</li> </ul> </li> <li>• Block codes</li> <li>• Low Density Parity Check (LDPC) Codes and iterative Ddecoding</li> <li>• Convolutional codes and Viterbi-Decoding</li> <li>• Turbo Codes and iterative decoding</li> <li>• Coded Modulation</li> </ul>
<b>Literature</b>	Bossert, M.: Kanalcodierung. Oldenbourg. Friedrichs, B.: Kanalcodierung. Springer. Lin, S., Costello, D.: Error Control Coding. Prentice Hall. Roth, R.: Introduction to Coding Theory. Johnson, S.: Iterative Error Correction. Cambridge. Richardson, T., Urbanke, R.: Modern Coding Theory. Cambridge University Press. Gallager, R. G.: Information theory and reliable communication. Wiley-VCH Cover, T., Thomas, J.: Elements of information theory. Wiley.

Course L0438: Information Theory and Coding	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Gerhard Bauch
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0712: Microwave Semiconductor Devices and Circuits I			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Microwave Semiconductor Devices and Circuits I (L0580)		Lecture	3
Microwave Semiconductor Devices and Circuits I (L0581)		Recitation Section (large)	2
<b>Module Responsible</b>	Prof. Alexander Kölpin		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Electrical Engineering IV, Microwave Engineering, Fundamentals of Semiconductor Technology		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students are capable of explaining the functionality of amplifier, mixer, and oscillator in detail. They can present theories, concepts, and reasonable assumptions for description and synthesis of these devices. They are able to apply thorough knowledge of semiconductor physics of selected microwave devices to amplifier, mixer, and oscillator. They can compare different devices with respect to various parameters (such as frequency range, power und efficiency).		
<i>Skills</i>	The students can assess occurring linear and nonlinear effects in active microwave circuits and are capable of analyzing and evaluating them. They are able to develop passive and active linear microwave circuits with the help of modern software-tools, taking application requirements into account.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to carry out subject-specific tasks in small groups, and to adequately present solutions (e.g. in CAD-Exercises).		
<i>Autonomy</i>	The students are able to obtain additional information from given literature sources and set the content in context with the lecture. They can link and deepen their knowledge of other courses, e.g., Electrical Engineering IV, Theoretical Engineering, Microwave Engineering, Semiconductor Devices. The students acquire the ability to communicate problems and solutions in the field of microwave semiconductor devices and circuits in English.		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Oral exam		
<b>Examination duration and scale</b>	30 min		
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory		

Course L0580: Microwave Semiconductor Devices and Circuits I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Alexander Kölpin
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- Amplifier: S-Parameters, stability, gain definitions; Bipolar Junction Transistor and HBT, MESFET and HEMT; Circuit applications, nonlinear distortions, low noise and power amplifier</li> <li>- Mixer: Conversion matrix analysis; pn- and Schottky-diode, FET; Circuit applications, conversion gain and noise figure</li> <li>- Oszillator: Oscillation start-up, steady state operation, stability; IMPATT-diode, Gunn-element, FET; oscillator stabilization</li> <li>- Linear passive circuits: Planar microwave circuits, quarterwave matching circuits and discontinuities, lowpass-filter and bandpass-filter synthesis</li> <li>- Design of active circuits</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>- E. Voges, „Hochfrequenztechnik“, Hüthig (2004)</li> <li>- H.-G. Unger, W. Harth, „Hochfrequenz-Halbleiterelektronik“, S. Hirzel Verlag (1972)</li> <li>- S.M. Sze, „Physics of Semiconductor Devices“, John Wiley &amp; Sons (1981)</li> <li>- A. Jacob, „Lecture Notes Microwave Semiconductor Devices and Circuits Part I“</li> </ul>

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<b>Course L0581: Microwave Semiconductor Devices and Circuits I</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Kölpin
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

**Module M0925: Digital Circuit Design**

Courses			
Title	Typ	Hrs/wk	CP
Digital Circuit Design (L0698)	Lecture	2	3
Advanced Digital Circuit Design (L0699)	Lecture	2	3
<b>Module Responsible</b>	Prof. Matthias Kuhl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i> <i>Skills</i>			
<b>Personal Competence</b> <i>Social Competence</i> <i>Autonomy</i>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Oral exam		
<b>Examination duration and scale</b>	40 min		
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Nanoelectronics and Microsystems Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Microelectronics and Microsystems: Specialisation Microelectronics Complements: Elective Compulsory Microelectronics and Microsystems: Specialisation Embedded Systems: Elective Compulsory		

**Course L0698: Digital Circuit Design**

<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Volkhard Klinger
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	

**Course L0699: Advanced Digital Circuit Design**

<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Volkhard Klinger
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	
<b>Literature</b>	

Module M0746: Microsystem Engineering				
Courses				
Title	Typ	Hrs/wk	CP	
Microsystem Engineering (L0680)	Lecture	2	4	
Microsystem Engineering (L0682)	Project-/problem-based Learning	2	2	
<b>Module Responsible</b>	Dr. rer. nat. Thomas Kusserow			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic courses in physics, mathematics and electric engineering			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know about the most important technologies and materials of MEMS as well as their applications in sensors and actuators.			
<i>Skills</i>	Students are able to analyze and describe the functional behaviour of MEMS components and to evaluate the potential of microsystems.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to solve specific problems alone or in a group and to present the results accordingly.			
<i>Autonomy</i>	Students are able to acquire particular knowledge using specialized literature and to integrate and associate this knowledge with other fields.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Presentation	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	2h			
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Microelectronics and Microsystems: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory			

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

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

Module M0676: Digital Communications				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Digital Communications (L0444)		Lecture	2	3
Digital Communications (L0445)		Recitation Section (large)	2	2
Laboratory Digital Communications (L0646)		Practical Course	1	1
<b>Module Responsible</b>	Prof. Gerhard Bauch			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Mathematics 1-3</li> <li>• Signals and Systems</li> <li>• Fundamentals of Communications and Random Processes</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> The students are able to understand, compare and design modern digital information transmission schemes. They are familiar with the properties of linear and non-linear digital modulation methods. They can describe distortions caused by transmission channels and design and evaluate detectors including channel estimation and equalization. They know the principles of single carrier transmission and multi-carrier transmission as well as the fundamentals of basic multiple access schemes.</p> <p>The students are familiar with the contents of lecture and tutorials. They can explain and apply them to new problems.</p> <p><i>Skills</i> The students are able to design and analyse a digital information transmission scheme including multiple access. They are able to choose a digital modulation scheme taking into account transmission rate, required bandwidth, error probability, and further signal properties. They can design an appropriate detector including channel estimation and equalization taking into account performance and complexity properties of suboptimum solutions. They are able to set parameters of a single carrier or multi carrier transmission scheme and trade the properties of both approaches against each other.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students can jointly solve specific problems.</p> <p><i>Autonomy</i> The students are able to acquire relevant information from appropriate literature sources. They can control their level of knowledge during the lecture period by solving tutorial problems, software tools, clicker system.</p>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Written elaboration	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 min			
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Core Qualification: Compulsory Computer Science in Engineering: Specialisation II. Engineering Science: Elective Compulsory Information and Communication Systems: Specialisation Communication Systems: Compulsory Information and Communication Systems: Specialisation Secure and Dependable IT Systems, Focus Networks: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Microelectronics and Microsystems: Core Qualification: Elective Compulsory			

Course L0444: Digital Communications	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Gerhard Bauch
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Repetition: Baseband Transmission                             <ul style="list-style-type: none"> <li>◦ Pulse shaping: Non-return to zero (NRZ) rectangular pulses, raised-cosine pulses, square-root raised-cosine pulses</li> <li>◦ Power spectral density (psd) of baseband signals</li> <li>◦ Intersymbol interference (ISI)</li> <li>◦ First and second Nyquist criterion</li> <li>◦ AWGN channel</li> <li>◦ Matched filter</li> <li>◦ Matched-filter receiver and correlation receiver</li> <li>◦ Noise whitening matched filter</li> <li>◦ Discrete-time AWGN channel model</li> </ul> </li> <li>• Representation of bandpass signals and systems in the equivalent baseband                             <ul style="list-style-type: none"> <li>◦ Quadrature amplitude modulation (QAM)</li> <li>◦ Equivalent baseband signal and system</li> <li>◦ Analytical signal</li> <li>◦ Equivalent baseband random process, equivalent baseband white Gaussian noise process</li> <li>◦ Equivalent baseband AWGN channel</li> <li>◦ Equivalent baseband channel model with frequency-offset and phase noise</li> </ul> </li> </ul>

- Equivalent baseband Rayleigh fading and Rice fading channel models
- Equivalent baseband frequency-selective channel model
- Discrete memoryless channels (DMC)
- Bandpass transmission via carrier modulation
  - Amplitude modulation, frequency modulation, phase modulation
  - Linear digital modulation methods
    - On-off keying, M-ary amplitude shift keying (M-ASK), M-ary phase shift keying (M-PSK), M-ary quadrature amplitude modulation (M-QAM), offset-QPSK
    - Signal space representation of transmit signal constellations and signals
    - Energy of linear digital modulated signals, average energy per symbol
    - Power spectral density of linear digital modulated signals
    - Bandwidth efficiency
    - Correlation coefficient of elementary signals
    - Error probabilities of linear digital modulation methods
      - Error functions
      - Gray mapping and natural mapping
      - Bit error probabilities, symbol error probabilities, pairwise symbol error probabilities
      - Euclidean distance and Hamming distance
      - Exact and approximate computation of error probabilities
      - Performance comparison of modulation schemes in terms of per bit SNR vs. per symbol SNR
    - Hierarchical modulation, multilevel modulation
    - Effects of carrier phase offset and carrier frequency offset
    - Differential modulation
      - M-ary differential phase shift keying (M-PSK)
      - Coherent and non-coherent detection of DPSK
      - p/M-differential phase shift keying (p/M-DPSK)
      - Differential amplitude and phase shift keying (DAPSK)
  - Non-linear digital modulation methods
    - Frequency shift keying (FSK)
    - Modulation index
    - Minimum shift keying (MSK)
      - Offset-QPSK representation of MSK
      - MSK with differential precoding and rotation
      - Bit error probabilities of MSK
      - Gaussian minimum shift keying (GMSK)
      - Power spectral density of MSK and GMSK
    - Continuous phase modulation (CPM)
      - General description of CPM signals
      - Frequency pulses and phase pulses
    - Coherent and non-coherent detection of FSK
  - Performance comparison of linear and non-linear digital modulation methods
- Frequency-selective channels, ISI channels
  - Intersymbol interference and frequency-selectivity
  - RMS delay spread
  - Narrowband and broadband channels
  - Equivalent baseband transmission model for frequency-selective channels
  - Receive filter design
- Equalization
  - Symbol-spaced and fractionally-spaced equalizers
  - Inverse system
  - Non-recursive linear equalizers
    - Linear zero-forcing (ZF) equalizer
    - Linear minimum mean squared error (MMSE) equalizer
  - Non-linear equalization:
    - Decision feedback equalizer (DFE)
    - Tomlinson-Harashima precoding
  - Maximum a posteriori probability (MAP) and maximum likelihood equalizer, Viterbi algorithm
- Single-carrier vs. multi-carrier transmission
- Multi-carrier transmission
  - General multicarrier transmission
  - Orthogonal frequency division multiplex (OFDM)
    - OFDM implementation using the Fast Fourier Transform (FFT)
    - Cyclic guard interval
    - Power spectral density of OFDM
    - Peak-to-average power ratio (PAPR)
- Multiple access
  - Principles of time division multiple access (TDMA), frequency division multiple access (FDMA), code division multiple access (CDMA), non-orthogonal multiple access (NOMA), hybrid multiple access
- Spread spectrum communications
  - Direct sequence spread spectrum communications
  - Frequency hopping
  - Protection against eavesdropping
  - Protection against narrowband jammers
  - Short vs. long spreading codes
  - Direct sequence spread spectrum communications in frequency-selective channels

	<ul style="list-style-type: none"> <li>▪ Rake receiver</li> <li>◦ Code division multiple access (CDMA) <ul style="list-style-type: none"> <li>▪ Design criteria of spreading sequences, autocorrelation function and crosscorrelation function of spreading sequences</li> <li>▪ Intersymbol interference (ISI) and multiple access interference (MAI)</li> <li>▪ Pseudo noise (PN) sequences, maximum length sequences (m-sequences), Gold codes, Walsh-Hadamard codes, orthogonal variable spreading factor (OVSF) codes</li> <li>▪ Multicode transmission</li> <li>▪ CDMA in uplink and downlink of a wireless communications system</li> <li>▪ Single-user detection vs. multi-user detection</li> </ul> </li> </ul>
<b>Literature</b>	<p>K. Kammeyer: Nachrichtenübertragung, Teubner</p> <p>P.A. Höher: Grundlagen der digitalen Informationsübertragung, Teubner.</p> <p>J.G. Proakis, M. Salehi: Digital Communications. McGraw-Hill.</p> <p>S. Haykin: Communication Systems. Wiley</p> <p>R.G. Gallager: Principles of Digital Communication. Cambridge</p> <p>A. Goldsmith: Wireless Communication. Cambridge.</p> <p>D. Tse, P. Viswanath: Fundamentals of Wireless Communication. Cambridge.</p>

Course L0445: Digital Communications	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Gerhard Bauch
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L0646: Laboratory Digital Communications	
<b>Typ</b>	Practical Course
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Gerhard Bauch
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- DSL transmission</li> <li>- Random processes</li> <li>- Digital data transmission</li> </ul>
<b>Literature</b>	<p>K. Kammeyer: Nachrichtenübertragung, Teubner</p> <p>P.A. Höher: Grundlagen der digitalen Informationsübertragung, Teubner.</p> <p>J.G. Proakis, M. Salehi: Digital Communications. McGraw-Hill.</p> <p>S. Haykin: Communication Systems. Wiley</p> <p>R.G. Gallager: Principles of Digital Communication. Cambridge</p> <p>A. Goldsmith: Wireless Communication. Cambridge.</p> <p>D. Tse, P. Viswanath: Fundamentals of Wireless Communication. Cambridge.</p>

Module M1048: Integrated Circuit Design			
Courses			
Title	Typ	Hrs/wk	CP
Integrated Circuit Design (L0691)	Lecture	3	4
Integrated Circuit Design (L0998)	Recitation Section (small)	1	2
<b>Module Responsible</b>	Prof. Matthias Kuhl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge of (solid-state) physics and mathematics. Knowledge in fundamentals of electrical engineering and electrical networks.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i>	<ul style="list-style-type: none"> <li>• Students can explain basic concepts of electron transport in semiconductor devices (energy bands, generation/recombination, carrier concentrations, drift and diffusion current densities, semiconductor device equations).</li> <li>• Students are able to explain functional principles of pn-diodes, MOS capacitors, and MOSFETs using energy band diagrams.</li> <li>• Students can present and discuss current-voltage relationships and small-signal equivalent circuits of these devices.</li> <li>• Students can explain the physics and current-voltage behavior transistors based on charged carrier flow.</li> <li>• Students are able to explain the basic concepts for static and dynamic logic gates for integrated circuits</li> <li>• Students can exemplify approaches for low power consumption on the device and circuit level</li> <li>• Students can describe the potential and limitations of analytical expression for device and circuit analysis.</li> <li>• Students can explain characterization techniques for MOS devices.</li> </ul>		
<i>Skills</i>	<ul style="list-style-type: none"> <li>• Students can qualitatively construct energy band diagrams of the devices for varying applied voltages.</li> <li>• Students are able to qualitatively determine electric field, carrier concentrations, and charge flow from energy band diagrams.</li> <li>• Students can understand scientific publications from the field of semiconductor devices.</li> <li>• Students can calculate the dimensions of MOS devices in dependence of the circuits properties</li> <li>• Students can design complex electronic circuits and anticipate possible problems.</li> <li>• Students know procedure for optimization regarding high performance and low power consumption</li> </ul>		
<b>Personal Competence</b> <i>Social Competence</i>	<ul style="list-style-type: none"> <li>• Students can team up with other experts in the field to work out innovative solutions.</li> <li>• Students are able to work by their own or in small groups for solving problems and answer scientific questions.</li> <li>• Students have the ability to critically question the value of their contributions to working groups.</li> </ul>		
<i>Autonomy</i>	<ul style="list-style-type: none"> <li>• Students are able to assess their knowledge in a realistic manner.</li> <li>• Students are able to define their personal approaches to solve challenging problems</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Nanoelectronics and Microsystems Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Microelectronics and Microsystems: Core Qualification: Elective Compulsory		

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Course L0691: Integrated Circuit Design	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Matthias Kuhl
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Electron transport in semiconductors</li> <li>• Electronic operating principles of diodes, MOS capacitors, and MOS field-effect transistors</li> <li>• MOS transistor as four terminal device</li> <li>• Performance degradation due to short channel effects</li> <li>• Scaling-down of MOS technology</li> <li>• Digital logic circuits</li> <li>• Basic analog circuits</li> <li>• Operational amplifiers</li> <li>• Bipolar and BiCMOS circuits</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Yuan Taur, Tak H. Ning: Fundamentals of Modern VLSI Devices, Cambridge University Press 1998</li> <li>• R. Jacob Baker: CMOS, Circuit Design, Layout and Simulation, IEEE Press, Wiley Interscience, 3rd Edition, 2010</li> <li>• Neil H.E. Weste and David Money Harris, Integrated Circuit Design, Pearson, 4th International Edition, 2013</li> <li>• John E. Ayers, Digital Integrated Circuits: Analysis and Design, CRC Press, 2009</li> <li>• Richard C. Jaeger and Travis N. Blalock: Microelectronic Circuit Design, Mc Graw-Hill, 4rd. Edition, 2010</li> </ul>

Course L0998: Integrated Circuit Design	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Matthias Kuhl
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0548: Bioelectromagnetics: Principles and Applications				
Courses				
Title	Typ	Hrs/wk	CP	
Bioelectromagnetics: Principles and Applications (L0371)	Lecture	3	5	
Bioelectromagnetics: Principles and Applications (L0373)	Recitation Section (small)	2	1	
<b>Module Responsible</b>	Prof. Christian Schuster			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic principles of physics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Students can explain the basic principles, relationships, and methods of bioelectromagnetics, i.e. the quantification and application of electromagnetic fields in biological tissue. They can define and exemplify the most important physical phenomena and order them corresponding to wavelength and frequency of the fields. They can give an overview over measurement and numerical techniques for characterization of electromagnetic fields in practical applications. They can give examples for therapeutic and diagnostic utilization of electromagnetic fields in medical technology.			
<i>Skills</i>	Students know how to apply various methods to characterize the behavior of electromagnetic fields in biological tissue. In order to do this they can relate to and make use of the elementary solutions of Maxwell's Equations. They are able to assess the most important effects that these models predict for biological tissue, they can order the effects corresponding to wavelength and frequency, respectively, and they can analyze them in a quantitative way. They are able to develop validation strategies for their predictions. They are able to evaluate the effects of electromagnetic fields for therapeutic and diagnostic applications and make an appropriate choice.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to work together on subject related tasks in small groups. They are able to present their results effectively in English (e.g. during small group exercises).			
<i>Autonomy</i>	Students are capable to gather information from subject related, professional publications and relate that information to the context of the lecture. They are able to make a connection between their knowledge obtained in this lecture with the content of other lectures (e.g. theory of electromagnetic fields, fundamentals of electrical engineering / physics). They can communicate problems and effects in the field of bioelectromagnetics in English.			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Presentation	
<b>Examination</b>	Oral exam			
<b>Examination duration and scale</b>	45 min			
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Microwave Engineering, Optics, and Electromagnetic Compatibility: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory			

Course L0371: Bioelectromagnetics: Principles and Applications	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	5
<b>Workload in Hours</b>	Independent Study Time 108, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Christian Schuster
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- Fundamental properties of electromagnetic fields (phenomena)</li> <li>- Mathematical description of electromagnetic fields (Maxwell's Equations)</li> <li>- Electromagnetic properties of biological tissue</li> <li>- Principles of energy absorption in biological tissue, dosimetry</li> <li>- Numerical methods for the computation of electromagnetic fields (especially FDTD)</li> <li>- Measurement techniques for characterization of electromagnetic fields</li> <li>- Behavior of electromagnetic fields of low frequency in biological tissue</li> <li>- Behavior of electromagnetic fields of medium frequency in biological tissue</li> <li>- Behavior of electromagnetic fields of high frequency in biological tissue</li> <li>- Behavior of electromagnetic fields of very high frequency in biological tissue</li> <li>- Diagnostic applications of electromagnetic fields in medical technology</li> <li>- Therapeutic applications of electromagnetic fields in medical technology</li> <li>- The human body as a generator of electromagnetic fields</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>- C. Furse, D. Christensen, C. Durney, "Basic Introduction to Bioelectromagnetics", CRC (2009)</li> <li>- A. Vorst, A. Rosen, Y. Kotsuka, "RF/Microwave Interaction with Biological Tissues", Wiley (2006)</li> <li>- S. Grimnes, O. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008)</li> <li>- F. Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnetic Fields", CRC (2006)</li> </ul>

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

<b>Module M0846: Control Systems Theory and Design</b>			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Control Systems Theory and Design (L0656)	Lecture	2	4
Control Systems Theory and Design (L0657)	Recitation Section (small)	2	2
<b>Module Responsible</b>	Prof. Herbert Werner		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Introduction to Control Systems		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<ul style="list-style-type: none"> <li>• Students can explain how linear dynamic systems are represented as state space models; they can interpret the system response to initial states or external excitation as trajectories in state space</li> <li>• They can explain the system properties controllability and observability, and their relationship to state feedback and state estimation, respectively</li> <li>• They can explain the significance of a minimal realisation</li> <li>• They can explain observer-based state feedback and how it can be used to achieve tracking and disturbance rejection</li> <li>• They can extend all of the above to multi-input multi-output systems</li> <li>• They can explain the z-transform and its relationship with the Laplace Transform</li> <li>• They can explain state space models and transfer function models of discrete-time systems</li> <li>• They can explain the experimental identification of ARX models of dynamic systems, and how the identification problem can be solved by solving a normal equation</li> <li>• They can explain how a state space model can be constructed from a discrete-time impulse response</li> </ul>		
<i>Knowledge</i>			
<i>Skills</i>	<ul style="list-style-type: none"> <li>• Students can transform transfer function models into state space models and vice versa</li> <li>• They can assess controllability and observability and construct minimal realisations</li> <li>• They can design LQG controllers for multivariable plants</li> <li>• They can carry out a controller design both in continuous-time and discrete-time domain, and decide which is appropriate for a given sampling rate</li> <li>• They can identify transfer function models and state space models of dynamic systems from experimental data</li> <li>• They can carry out all these tasks using standard software tools (Matlab Control Toolbox, System Identification Toolbox, Simulink)</li> </ul>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students can work in small groups on specific problems to arrive at joint solutions.</p> <p><i>Autonomy</i> Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it when solving given problems.</p> <p>They can assess their knowledge in weekly on-line tests and thereby control their learning progress.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory Computer Science in Engineering: Specialisation II. Engineering Science: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory		

Course L0656: Control Systems Theory and Design	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Herbert Werner
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>State space methods (single-input single-output)</p> <ul style="list-style-type: none"> <li>• State space models and transfer functions, state feedback</li> <li>• Coordinate basis, similarity transformations</li> <li>• Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem</li> <li>• Controllability and pole placement</li> <li>• State estimation, observability, Kalman decomposition</li> <li>• Observer-based state feedback control, reference tracking</li> <li>• Transmission zeros</li> <li>• Optimal pole placement, symmetric root locus</li> </ul> <p>Multi-input multi-output systems</p> <ul style="list-style-type: none"> <li>• Transfer function matrices, state space models of multivariable systems, Gilbert realization</li> <li>• Poles and zeros of multivariable systems, minimal realization</li> <li>• Closed-loop stability</li> <li>• Pole placement for multivariable systems, LQR design, Kalman filter</li> </ul> <p>Digital Control</p> <ul style="list-style-type: none"> <li>• Discrete-time systems: difference equations and z-transform</li> <li>• Discrete-time state space models, sampled data systems, poles and zeros</li> <li>• Frequency response of sampled data systems, choice of sampling rate</li> </ul> <p>System identification and model order reduction</p> <ul style="list-style-type: none"> <li>• Least squares estimation, ARX models, persistent excitation</li> <li>• Identification of state space models, subspace identification</li> <li>• Balanced realization and model order reduction</li> </ul> <p>Case study</p> <ul style="list-style-type: none"> <li>• Modelling and multivariable control of a process evaporator using Matlab and Simulink</li> </ul> <p>Software tools</p> <ul style="list-style-type: none"> <li>• Matlab/Simulink</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Werner, H., Lecture Notes „Control Systems Theory and Design“</li> <li>• T. Kailath "Linear Systems", Prentice Hall, 1980</li> <li>• K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997</li> <li>• L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999</li> </ul>

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

Module M0710: Microwave Engineering				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Microwave Engineering (L0573)		Lecture	2	3
Microwave Engineering (L0574)		Recitation Section (large)	2	2
Microwave Engineering (L0575)		Practical Course	1	1
<b>Module Responsible</b>	Prof. Alexander Kölpin			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Fundamentals of communication engineering, semiconductor devices and circuits. Basics of Wave propagation from transmission line theory and theoretical electrical engineering.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Students can explain the propagation of electromagnetic waves and related phenomena. They can describe transmission systems and components. They can name different types of antennas and describe the main characteristics of antennas. They can explain noise in linear circuits, compare different circuits using characteristic numbers and select the best one for specific scenarios.			
<i>Skills</i>	Students are able to calculate the propagation of electromagnetic waves. They can analyze complete transmission systems und configure simple receiver circuits. They can calculate the characteristic of simple antennas and arrays based on the geometry. They can calculate the noise of receivers and the signal-to-noise-ratio of transmission systems. They can apply their theoretical knowledge to the practical courses.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students work together in small groups during the practical courses. Together they document, evaluate and discuss their results.			
<i>Autonomy</i>	Students are able to relate the knowledge gained in the course to contents of previous lectures. With given instructions they can extract data needed to solve specific problems from external sources. They are able to apply their knowledge to the laboratory courses using the given instructions.			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Subject	theoretical and practical work
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 min			
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Core Qualification: Compulsory Information and Communication Systems: Specialisation Communication Systems: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Microelectronics and Microsystems: Specialisation Communication and Signal Processing: Elective Compulsory			

Course L0573: Microwave Engineering	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Kölpin
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- Antennas: Analysis - Characteristics - Realizations</li> <li>- Radio Wave Propagation</li> <li>- Transmitter: Power Generation with Vacuum Tubes and Transistors</li> <li>- Receiver: Preamplifier - Heterodyning - Noise</li> <li>- Selected System Applications</li> </ul>
<b>Literature</b>	<p>H.-G. Unger, „Elektromagnetische Theorie für die Hochfrequenztechnik, Teil I“, Hüthig, Heidelberg, 1988</p> <p>H.-G. Unger, „Hochfrequenztechnik in Funk und Radar“, Teubner, Stuttgart, 1994</p> <p>E. Voges, „Hochfrequenztechnik - Teil II: Leistungsrohren, Antennen und Funkübertragung, Funk- und Radartechnik“, Hüthig, Heidelberg, 1991</p> <p>E. Voges, „Hochfrequenztechnik“, Hüthig, Bonn, 2004</p> <p>C.A. Balanis, „Antenna Theory“, John Wiley and Sons, 1982</p> <p>R. E. Collin, „Foundations for Microwave Engineering“, McGraw-Hill, 1992</p> <p>D. M. Pozar, „Microwave and RF Design of Wireless Systems“, John Wiley and Sons, 2001</p> <p>D. M. Pozar, „Microwave Engineerin“, John Wiley and Sons, 2005</p>

Course L0574: Microwave Engineering	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Kölpin
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L0575: Microwave Engineering	
<b>Typ</b>	Practical Course
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Alexander Kölpin
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

**Specialization II. Energy and Environmental Engineering**

**Module M0511: Electrical Energy from Solar Radiation and Wind Power**

<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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
<b>Module Responsible</b>	Dr. Isabel Höfer		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Module: Technical Thermodynamics I, Module: Technical Thermodynamics II, Module: Fundamentals of Fluid Mechanics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p>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.</p> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can discuss scientific tasks subject-specificly and multidisciplinary within a seminar.</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	2.5 hours written exam + written elaboration (incl. presentation) in sustainability management		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Anne Rödl
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• What is "sustainability"?</li> <li>• Why is this concept an important topic for companies?</li> <li>• What opportunities and business risks are addressed or are associated with it?</li> <li>• 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?</li> <li>• What concepts or frameworks exist for the implementation of sustainability management in companies?</li> <li>• Which sustainability labels exist for products or companies? What do they have in common, and where do they differ?</li> </ul> <p>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.</p> <p>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.</p>
<b>Literature</b>	<p>Die folgenden Bücher bieten einen Überblick:</p> <p>Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage</p> <p>Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.</p>

Course L0013: Hydro Power Use	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Stefan Achleitner
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction, importance of water power in the national and global context</li> <li>• Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies</li> <li>• Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems</li> <li>• Construction of hydroelectric power plants: description of the individual components and their technical system interaction</li> <li>• Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc.</li> <li>• Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection</li> <li>• Hydropower and the Environment</li> <li>• Examples from practice</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage</li> <li>• Quaschnig, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage</li> <li>• Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage</li> <li>• von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage</li> <li>• Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006</li> </ul>

Course L0011: Wind Turbine Plants	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Rudolf Zelleremann
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Historical development</li> <li>• Wind: origins, geographic and temporal distribution, locations</li> <li>• Power coefficient, rotor thrust</li> <li>• Aerodynamics of the rotor</li> <li>• Operating performance</li> <li>• Power limitation, partial load, pitch and stall control</li> <li>• Plant selection, yield prediction, economy</li> <li>• Excursion</li> </ul>
<b>Literature</b>	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005

Course L0012: Wind Energy Use - Focus Offshore	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Martin Skiba
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering</li> <li>• Physical fundamentals for utilization of wind energy</li> <li>• 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</li> <li>• Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures</li> <li>• Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection</li> <li>• Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics</li> <li>• Development and planning of offshore wind farms</li> <li>• Operation and optimization of offshore wind farms</li> <li>• Day excursion</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage</li> <li>• Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidelberg, 1997, 3. Auflage</li> <li>• Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4. Auflage</li> <li>• Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage</li> <li>• Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage</li> </ul>

Module M0874: Wastewater Systems			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Wastewater Systems - Collection, Treatment and Reuse (L0934)		Lecture	2                  2
Wastewater Systems - Collection, Treatment and Reuse (L0943)		Recitation Section (large)	1                  1
Advanced Wastewater Treatment (L0357)		Lecture	2                  2
Advanced Wastewater Treatment (L0358)		Recitation Section (large)	1                  1
<b>Module Responsible</b>	Prof. Ralf Otterpohl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge of wastewater management and the key processes involved in wastewater treatment.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students are able to outline key areas of the full range of treatment systems in waste water management, as well as their mutual dependence for sustainable water protection. They can describe relevant economic, environmental and social factors.		
<i>Skills</i>	Students are able to pre-design and explain the available wastewater treatment processes and the scope of their application in municipal and for some industrial treatment plants.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Social skills are not targeted in this module.		
<i>Autonomy</i>	Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject.		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Environmental Engineering: Specialisation Water: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Compulsory		

Course L0934: Wastewater Systems - Collection, Treatment and Reuse	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Ralf Otterpohl
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Understanding the global situation with water and wastewater</li> <li>• Regional planning and decentralised systems</li> <li>• Overview on innovative approaches</li> <li>• In depth knowledge on advanced wastewater treatment options for different situations, for end-of-pipe and reuse</li> <li>• Mathematical Modelling of Nitrogen Removal</li> <li>• Exercises with calculations and design</li> </ul>
<b>Literature</b>	Henze, Mogens: Wastewater Treatment: Biological and Chemical Processes, Springer 2002, 430 pages  George Tchobanoglous, Franklin L. Burton, H. David Stensel: Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy McGraw-Hill, 2004 - 1819 pages

Course L0943: Wastewater Systems - Collection, Treatment and Reuse	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Ralf Otterpohl
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L0357: Advanced Wastewater Treatment	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Joachim Behrendt
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Survey on advanced wastewater treatment</p> <p>reuse of reclaimed municipal wastewater</p> <p>Precipitation</p> <p>Flocculation</p> <p>Depth filtration</p> <p>Membrane Processes</p> <p>Activated carbon adsorption</p> <p>Ozonation</p> <p>"Advanced Oxidation Processes"</p> <p>Disinfection</p>
<b>Literature</b>	<p>Metcalf &amp; Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003</p> <p>Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987</p> <p>Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007</p> <p>Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006</p> <p>Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003</p>

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<b>Course L0358: Advanced Wastewater Treatment</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Joachim Behrendt
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Aggregate organic compounds (sum parameters)</p> <p>Industrial wastewater</p> <p>Processes for industrial wastewater treatment</p> <p>Precipitation</p> <p>Flocculation</p> <p>Activated carbon adsorption</p> <p>Recalcitrant organic compounds</p>
<b>Literature</b>	<p>Metcalf &amp; Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003</p> <p>Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987</p> <p>Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007</p> <p>Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006</p> <p>Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003</p>

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
<b>Module Responsible</b>	Prof. Martin Kaltschmitt		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	none		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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 evaluate 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.</p> <p><i>Skills</i> 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 evaluate the economic and ecologic conditions of these systems. They can select calculation methods within the radiation theory for these topics.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module.</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	3 hours written exam		
<b>Assignment for the Following Curricula</b>	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		

<b>Course L0016: Energy Meteorology</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Volker Matthias, Dr. Beate Geyer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction: radiation source Sun, Astronomical Foundations, Fundamentals of radiation</li> <li>• Structure of the atmosphere</li> <li>• Properties and laws of radiation                             <ul style="list-style-type: none"> <li>◦ Polarization</li> <li>◦ Radiation quantities</li> <li>◦ Planck's radiation law</li> <li>◦ Wien's displacement law</li> <li>◦ Stefan-Boltzmann law</li> <li>◦ Kirchhoff's law</li> <li>◦ Brightness temperature</li> <li>◦ Absorption, reflection, transmission</li> </ul> </li> <li>• Radiation balance, global radiation, energy balance</li> <li>• Atmospheric extinction</li> <li>• Mie and Rayleigh scattering</li> <li>• Radiative transfer</li> <li>• Optical effects in the atmosphere</li> <li>• Calculation of the sun and calculate radiation on inclined surfaces</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Helmut Kraus: Die Atmosphäre der Erde</li> <li>• Hans Häckel: Meteorologie</li> <li>• Grant W. Petty: A First Course in Atmospheric Radiation</li> <li>• Martin Kaltschmitt, Wolfgang Streicher, Andreas Wiese: Renewable Energy</li> <li>• Alexander Löw, Volker Matthias: Skript Optik Strahlung Fernerkundung</li> </ul>

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

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<b>Course L0018: Collector Technology</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Agis Papadopoulos
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction: Energy demand and application of solar energy.</li> <li>• Heat transfer in the solar thermal energy: conduction, convection, radiation.</li> <li>• Collectors: Types, structure, efficiency, dimensioning, concentrated systems.</li> <li>• Energy storage: Requirements, types.</li> <li>• Passive solar energy: components and systems.</li> <li>• Solar thermal low temperature systems: collector variants, construction, calculation.</li> <li>• Solar thermal high temperature systems: Classification of solar power plants construction.</li> <li>• Solar air conditioning.</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Vorlesungsskript.</li> <li>• Kaltschmitt, Streicher und Wiese (Hrsg.). Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte, 5. Auflage, Springer, 2013.</li> <li>• Stieglitz und Heinzel .Thermische Solarenergie: Grundlagen, Technologie, Anwendungen. Springer, 2012.</li> <li>• Von Böckh und Wetzel. Wärmeübertragung: Grundlagen und Praxis, Springer, 2011.</li> <li>• Baehr und Stephan. Wärme- und Stoffübertragung. Springer, 2009.</li> <li>• de Vos. Thermodynamics of solar energy conversion. Wiley-VCH, 2008.</li> <li>• Mohr, Svoboda und Unger. Praxis solarthermischer Kraftwerke. Springer, 1999.</li> </ul>

Course L0015: Solar Power Generation	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Martin Schlecht, Prof. Alf Mews, Roman Fritsches-Baguhl, Paola Pignatelli
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Photovoltaics:</p> <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Primary energies and consumption, available solar energy</li> <li>3. Physics of the ideal solar cell</li> <li>4. Light absorption, PN transition, characteristic sizes of the solar cell, efficiency</li> <li>5. Physics of the real solar cell</li> <li>6. Charge carrier recombination, characteristic curves, barrier layer recombination, equivalent circuit diagram</li> <li>7. Increasing efficiency</li> <li>8. Methods for increasing the quantum yield and reducing recombination</li> <li>9. Hetero- and tandem structures</li> <li>10. Heterojunction, Schottky, electrochemical, MIS and SIS cell, tandem cell</li> <li>11. Concentrator cells</li> <li>12. Concentrator optics and tracking systems, concentrator cells</li> <li>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)</li> <li>14. Modules</li> <li>15. Switches</li> </ol> <p>Concentrating solar power plants:</p> <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Point focused technologies</li> <li>3. Line focused technologies</li> <li>4. Design of CSP projects</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• A. Götzberger, B. Voß, J. Knobloch: Sonnenenergie: Photovoltaik, Teubner Studienskripten, Stuttgart, 1995</li> <li>• A. Götzberger: Sonnenenergie: Photovoltaik : Physik und Technologie der Solarzelle, Teubner Stuttgart, 1994</li> <li>• H.-J. Lewerenz, H. Jungblut: Photovoltaik, Springer, Berlin, Heidelberg, New York, 1995</li> <li>• A. Götzberger: Photovoltaic solar energy generation, Springer, Berlin, 2005</li> <li>• C. Hu, R. M. White: Solar Cells, Mc Graw Hill, New York, 1983</li> <li>• H.-G. Wagemann: Grundlagen der photovoltaischen Energiewandlung: Solarstrahlung, Halbleitereigenschaften und Solarzellenkonzepte, Teubner, Stuttgart, 1994</li> <li>• R. J. van Overstraeten, R.P. Mertens: Physics, technology and use of photovoltaics, Adam Hilger Ltd, Bristol and Boston, 1986</li> <li>• B. O. Seraphin: Solar energy conversion Topics of applied physics V 01 31, Springer, Berlin, Heidelberg, New York, 1995</li> <li>• P. Würfel: Physics of Solar cells, Principles and new concepts, Wiley-VCH, Weinheim 2005</li> <li>• U. Rindelhardt: Photovoltaische Stromversorgung, Teubner-Reihe Umwelt, Stuttgart 2001</li> <li>• V. Quaschnig: Regenerative Energiesysteme, Hanser, München, 2003</li> <li>• G. Schmitz: Regenerative Energien, Ringvorlesung TU Hamburg-Harburg 1994/95, Institut für Energietechnik</li> </ul>

Module M0513: System Aspects of Renewable Energies				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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
<b>Module Responsible</b>	Prof. Martin Kaltschmitt			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Module: Technical Thermodynamics I Module: Technical Thermodynamics II			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p><i>Skills</i> 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.</p> <p>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.</p>			
<b>Personal Competence</b>				
<i>Social Competence</i>				
<i>Autonomy</i>	Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module. Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions.			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	3 hours written exam			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Fröba
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction to electrochemical energy conversion</li> <li>2. Function and structure of electrolyte</li> <li>3. Low-temperature fuel cell               <ul style="list-style-type: none"> <li>◦ Types</li> <li>◦ Thermodynamics of the PEM fuel cell</li> <li>◦ Cooling and humidification strategy</li> </ul> </li> <li>4. High-temperature fuel cell               <ul style="list-style-type: none"> <li>◦ The MCFC</li> <li>◦ The SOFC</li> <li>◦ Integration Strategies and partial reforming</li> </ul> </li> <li>5. Fuels               <ul style="list-style-type: none"> <li>◦ Supply of fuel</li> <li>◦ Reforming of natural gas and biogas</li> <li>◦ Reforming of liquid hydrocarbons</li> </ul> </li> <li>6. Energetic Integration and control of fuel cell systems</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Hamann, C.; Vielstich, W.: Elektrochemie 3. Aufl.; Weinheim: Wiley - VCH, 2003</li> </ul>

Course L0019: Energy Trading	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Michael Sagorje, Dr. Sven Orłowski
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Basic concepts and tradable products in energy markets</li> <li>• Primary energy markets</li> <li>• Electricity Markets</li> <li>• European Emissions Trading Scheme</li> <li>• Influence of renewable energy</li> <li>• Real options</li> <li>• Risk management</li> </ul> <p>Within the exercise the various tasks are actively discussed and applied to various cases of application.</p>
<b>Literature</b>	

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

<b>Course L0025: Deep Geothermal Energy</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Ben Norden
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction to the deep geothermal use</li> <li>2. Geological Basics I</li> <li>3. Geological Basics II</li> <li>4. Geology and thermal aspects</li> <li>5. Rock Physical Aspects</li> <li>6. Geochemical aspects</li> <li>7. Exploration of deep geothermal reservoirs</li> <li>8. Drilling technologies, piping and expansion</li> <li>9. Borehole Geophysics</li> <li>10. Underground system characterization and reservoir engineering</li> <li>11. Microbiology and Upper-day system components</li> <li>12. Adapted investment concepts, cost and environmental aspect</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012)</li> <li>• <a href="http://www.geo-energy.org">www.geo-energy.org</a></li> <li>• Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2012.</li> <li>• Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013.</li> <li>• Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001)</li> <li>• Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH &amp; Co. KGaA; Auflage: 1. Auflage (19. April 2010)</li> </ul>

Module M0721: Air Conditioning			
Courses			
Title	Typ	Hrs/wk	CP
Air Conditioning (L0594)	Lecture	3	5
Air Conditioning (L0595)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Dr. Arne Speerforck		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students know the different kinds of air conditioning systems for buildings and mobile applications and how these systems are controlled. They are familiar with the change of state of humid air and are able to draw the state changes in a $h_1+x,x$ -diagram. They are able to calculate the minimum airflow needed for hygienic conditions in rooms and can choose suitable filters. They know the basic flow pattern in rooms and are able to calculate the air velocity in rooms with the help of simple methods. They know the principles to calculate an air duct network. They know the different possibilities to produce cold and are able to draw these processes into suitable thermodynamic diagrams. They know the criteria for the assessment of refrigerants.		
<i>Skills</i>	Students are able to configure air condition systems for buildings and mobile applications. They are able to calculate an air duct network and have the ability to perform simple planning tasks, regarding natural heat sources and heat sinks. They can transfer research knowledge into practice. They are able to perform scientific work in the field of air conditioning.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to discuss in small groups and develop an approach.		
<i>Autonomy</i>	Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 min		
<b>Assignment for the Following Curricula</b>	Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory		

Course L0594: Air Conditioning	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	5
<b>Workload in Hours</b>	Independent Study Time 108, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Dr. Arne Speerforck, Prof. Gerhard Schmitz
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>1. Overview</p> <p>1.1 Kinds of air conditioning systems</p> <p>1.2 Ventilating</p> <p>1.3 Function of an air condition system</p> <p>2. Thermodynamic processes</p> <p>2.1 Psychrometric chart</p> <p>2.2 Mixer preheater, heater</p> <p>2.3 Cooler</p> <p>2.4 Humidifier</p> <p>2.5 Air conditioning process in a Psychrometric chart</p> <p>2.6 Desiccant assisted air conditioning</p> <p>3. Calculation of heating and cooling loads</p> <p>3.1 Heating loads</p> <p>3.2 Cooling loads</p> <p>3.3 Calculation of inner cooling load</p> <p>3.4 Calculation of outer cooling load</p> <p>4. Ventilating systems</p> <p>4.1 Fresh air demand</p> <p>4.2 Air flow in rooms</p> <p>4.3 Calculation of duct systems</p> <p>4.4 Fans</p> <p>4.5 Filters</p> <p>5. Refrigeration systems</p> <p>5.1. compression chillers</p> <p>5.2 Absorption chillers</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Schmitz, G.: Klimaanlage, Skript zur Vorlesung</li> <li>• VDI Wärmeatlas, 11. Auflage, Springer Verlag, Düsseldorf 2013</li> <li>• Herwig, H.; Moschallski, A.: Wärmeübertragung, Vieweg+Teubner Verlag, Wiesbaden 2009</li> <li>• Recknagel, H.; Sprenger, E.; Schrammek, E.-R.: Taschenbuch für Heizung- und Klimatechnik 2013/2014, 76. Auflage, Deutscher Industrieverlag, 2013</li> </ul>

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

Module M0641: Steam Generators				
Courses				
Title	Typ	Hrs/wk	CP	
Steam Generators (L0213)	Lecture	3	5	
Steam Generators (L0214)	Recitation Section (large)	1	1	
<b>Module Responsible</b>	Dr. Kristin Abel-Günther			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• "Technical Thermodynamics I and II"</li> <li>• "Heat Transfer"</li> <li>• "Fluid Mechanics"</li> <li>• "Steam Power Plants"</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>The students know the thermodynamic base principles for steam generators and their types. They are able to describe the basic principles of steam generators and sketch the combustion and fuel supply aspects of fossil-fuelled power plants. They can perform thermal design calculations and conceive the water-steam side, as well as they are able to define the constructive details of the steam generator. The students can describe and evaluate the operational behaviour of steam generators and explain these in the context of related disciplines.</p> <p><i>Skills</i></p> <p>The students will be able, using detailed knowledge on the calculation, design, and construction of steam generators, linked with a wide theoretical and methodical foundation, to understand the main design and construction aspects of steam generators. Through problem definition and formalisation, modelling of processes, and training in the solution methodology for partial problems a good overview of this key component of the power plant will be obtained.</p> <p>Within the framework of the exercise the students obtain the ability to draw the balances, and design the steam generator and its components. For this purpose small but close to lifelike tasks are solved, to highlight aspects of the design of steam generators.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>Especially during the exercises the focus is placed on communication with the tutor. This animates the students to reflect on their existing knowledge and ask specific questions to further improve their understanding.</p> <p><i>Autonomy</i></p> <p>The students will be able to perform basic calculations covering aspects of the steam generator, with only the help of smaller clues, on their own. This way the theoretical and practical knowledge from the lecture is consolidated and the potential effects from different process schemata and boundary conditions are highlighted.</p>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	5 %	Exercises	Den Studierenden wird eine kleine Aufgabe (in ca. 5 min lösbar) zur Vorlesung der Vorwoche gestellt. Die Antworten müssen üblicherweise als Freitext gegeben werden, aber auch Zeichnungen, Stichpunkte oder, in seltenen Fällen, Multiple Choice sind möglich.
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory			

Course L0213: Steam Generators	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	5
<b>Workload in Hours</b>	Independent Study Time 108, Study Time in Lecture 42
<b>Lecturer</b>	Dr. Kristin Abel-Günther
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Thermodynamics of steam</li> <li>• Basic principles of steam generators</li> <li>• Types of steam generators</li> <li>• Fuels and combustion systems</li> <li>• Coal pulverisers and coal drying</li> <li>• Modes of operation</li> <li>• Thermal analysis and design</li> <li>• Fluid dynamics in steam generators</li> <li>• Design of the water-steam side</li> <li>• Construction aspects</li> <li>• Stress analysis</li> <li>• Feed water for steam generators</li> <li>• Operating behaviour of steam Generators</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Dolezal, R.: Dampferzeugung. Springer-Verlag, 1985</li> <li>• Thomas, H.J.: Thermische Kraftanlagen. Springer-Verlag, 1985</li> <li>• Steinmüller-Taschenbuch: Dampferzeuger-Technik. Vulkan-Verlag, Essen, 1992</li> <li>• Kakaç, Sadık: Boilers, Evaporators and Condensers. John Wiley &amp; Sons, New York, 1991</li> <li>• Stultz, S.C. and Kitto, J.B. (Ed.): Steam - its generation and use. 40<sup>th</sup> edition, The Babcock &amp; Wilcox Company, Barberton, Ohio, USA, 1992</li> </ul>

Course L0214: Steam Generators	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Kristin Abel-Günther
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M1000: Combined Heat and Power and Combustion Technology				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Combined Heat and Power and Combustion Technology (L0216)		Lecture	3	5
Combined Heat and Power and Combustion Technology (L0220)		Recitation Section (large)	1	1
<b>Module Responsible</b>	Dr. Kristin Abel-Günther			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• "Gas-Steam Power Plants"</li> <li>• "Technical Thermodynamics I and II"</li> <li>• "Heat Transfer"</li> <li>• "Fluid Mechanics"</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p><b>VBT/Combustion Engineering</b></p> <p>The students outline the thermodynamic and chemical fundamentals of combustion processes and the main characteristics of various fuels. They gain basic knowledge in reaction kinetics and fundamentals of furnace design. The students are able to describe the formation of emissions and the primary reduction measures, and evaluate the impact of regulations and allowable limit levels.</p> <p><b>KWK/Combined Heat and Power</b></p> <p>The students present the layout, design and operation of Combined Heat and Power plants and are in a position to compare with each other district heating plants with back-pressure steam turbine or condensing turbine with pressure-controlled extraction tapping, CHP plants with gas turbine or with combined steam and gas turbine, or even district heating plants with an internal combustion engine. They can explain and analyse aspects of combined heat, power and cooling (CCHP) and describe the layout of the key components needed. Through this specialised knowledge they are able to evaluate the ecological significance of district CHP generation, as well as its economics.</p> <p><b>Storage Technologies</b></p> <p>The students present the layout, design and operation of electrical and heat storage technologies and are able to classify these in regards of their optimum operating range and conditions in power plants and complex energy systems. They evaluate the environmental effects of the storage technologies.</p> <p><i>Skills</i></p> <p>The students will be able to identify optimization possibilities due to combined power and heat production and the usage of short, medium and long-term storage technologies. The detailed understanding of the complete energy conversion chain, starting with the combustion of a fuel, the conversion of the primary energy into heat and power, storage and discharge of the storage enables the students to evaluate the efficiency and economies of the processes and to holistically consider energy utilisation. Examples from practical experience, such as the CHP energy supply facility of the TUHH and the district heating network of Hamburg will be used, to highlight the potential from electricity generation plants with simultaneous heat extraction and storage.</p> <p>Within the framework of the exercises the students deepen their knowledge based on examples from the industries.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>Especially during the exercises the focus is placed on communication with the tutor. This animates the students to reflect on their existing knowledge and ask specific questions for improving further this knowledge level.</p> <p><i>Autonomy</i></p> <p>The students assisted by the tutors will be able to perform estimating calculations. In this manner the theoretical and practical knowledge from the lecture is consolidated and the potential impact of different process arrangements and boundary conditions highlighted.</p>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Written elaboration	Am Ende jeder Vorlesung wird schriftlich eine zu auswertende Kurzfrage (5-10 min) zu der Vorlesung der Vorwoche gestellt. In den Kurzfragen werden kleine Rechenaufgaben, Skizzen oder auch kleine Freitexte zur Beantwortung gestellt.
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory			

Course L0216: Combined Heat and Power and Combustion Technology	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	5
<b>Workload in Hours</b>	Independent Study Time 108, Study Time in Lecture 42
<b>Lecturer</b>	Dr. Kristin Abel-Günther
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p><b>Part 1: Combustion Engineering</b></p> <ul style="list-style-type: none"> <li>• Thermodynamic and chemical fundamentals</li> <li>• Fuels</li> <li>• Reaction kinetics</li> <li>• Premixed flames</li> <li>• Systematik of flames and combustion chambers</li> <li>• Combustion Chamber design</li> <li>• Reduction of Emissions</li> </ul> <p><b>Part 2: Energy Storage</b></p> <p>1.Motivation: Why is Energy storage essential ?</p> <p>2.Storage of electrical energy</p> <ul style="list-style-type: none"> <li>• Condensers</li> <li>• Akkumulators</li> <li>• Hydro power stations</li> <li>• Short term storage with fly wheels</li> <li>• Compressed air energy storage CAES</li> <li>• Economics</li> </ul> <p>3.Heat Storage</p> <ul style="list-style-type: none"> <li>• Sensible heat storage</li> <li>• Latent heat storage</li> <li>• Thermocheical heat storage</li> <li>• Economics</li> </ul> <p>4.Sector coupling and Power to X</p> <ul style="list-style-type: none"> <li>• PtG</li> <li>• PtL</li> <li>• Research on PTX</li> </ul> <p><b>Part 3: "Combined Heat and Power":</b></p> <ul style="list-style-type: none"> <li>• Layout, design and operation of Combined Heat and Power plants</li> <li>• District heating plants with back-pressure steam turbine and condensing turbine with pressure-controlled extraction tapping</li> <li>• District heating plants with gas turbine</li> <li>• District heating plants with combined steam and gas turbine</li> <li>• District heating plants with motor engine</li> <li>• Combined cooling heat and power (CCHP)</li> <li>• Layout of the key components</li> <li>• Regulatory framework and allowable limits</li> <li>• Economic significance and calculation of the profitability of district CHP plant</li> </ul>
<b>Literature</b>	<p>Bezüglich des Themenbereichs "Kraft-Wärme-Kopplung":</p> <ul style="list-style-type: none"> <li>• W. Piller, M. Rudolph: Kraft-Wärme-Kopplung, VWEW Verlag</li> <li>• Kehlhofer, Kunze, Lehmann, Schüller: Handbuch Energie, Band 7, Technischer Verlag Resch</li> <li>• W. Suttor: Praxis Kraft-Wärme-Kopplung, C.F. Müller Verlag</li> <li>• K.W. Schmitz, G. Koch: Kraft-Wärme-Kopplung, VDI Verlag</li> <li>• K.-H. Suttor, W. Suttor: Die KWK Fibel, Resch Verlag</li> </ul> <p>und für die Grundlagen der "Verbrennungstechnik":</p> <ul style="list-style-type: none"> <li>• J. Warnatz, U. Maas, R.W. Dibble; Technische Verbrennung: physikalisch-chemische Grundlagen, Modellbildung, Schadstoffentstehung. Springer, Berlin [u. a.], 2001</li> </ul>

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<b>Course L0220: Combined Heat and Power and Combustion Technology</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Kristin Abel-Günther
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0801: Water Resources and -Supply			
Courses			
Title	Typ	Hrs/wk	CP
Chemistry of Drinking Water Treatment (L0311)	Lecture	2	1
Chemistry of Drinking Water Treatment (L0312)	Recitation Section (large)	1	2
Water Resource Management (L0402)	Lecture	2	2
Water Resource Management (L0403)	Recitation Section (small)	1	1
<b>Module Responsible</b>	Prof. Mathias Ernst		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge of water management and the key processes involved in water treatment.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students will be able to outline key areas of conflict in water management, as well as their mutual dependence for sustainable water supply. They will understand relevant economic, environmental and social factors. Students will be able to explain and outline the organisational structures of water companies. They will be able to explain the available water treatment processes and the scope of their application.</p> <p><i>Skills</i> Students will be able to assess complex problems in drinking water production and establish solutions involving water management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students will be able to carry out chemical calculations for selected treatment processes and apply generally accepted technical rules and standards to these processes.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Working in a diverse group of specialists, students will be able to develop and document complex solutions for the management and treatment of drinking water. They will be able to take an appropriate professional position, for example representing user interests. They will be able to develop joint solutions in teams of diverse experts and present these solutions to others.</p> <p><i>Autonomy</i> Students will be in a position to work on a subject independently and present on this subject.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 min (chemistry) + presentation		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory		

Course L0311: Chemistry of Drinking Water Treatment	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Klaus Johannsen
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The topic of this course is water chemistry with respect to drinking water treatment and water distribution</p> <p>Major topics are solubility of gases, carbonic acid system and calcium carbonate, blending, softening, redox processes, materials and legal requirements on drinking water treatment. Focus is put on generally accepted rules of technology (DVGW- and DIN-standards).</p> <p>Special emphasis is put on calculations using realistic analysis data (e.g. calculation of pH or calcium carbonate dissolution potential) in exercises. Students can get a feedback and gain extra points for exam by solving problems for homework.</p> <p>Knowledge of drinking water treatment processes is vital for this lecture. Therefore the most important processes are explained coordinated with the course "Water resources management" in the beginning of the semester.</p>
<b>Literature</b>	<p><b>MHW (rev. by Crittenden, J. et al.):</b> Water treatment principles and design. John Wiley &amp; Sons, Hoboken, 2005.</p> <p><b>Stumm, W., Morgan, J.J.:</b> Aquatic chemistry. John Wiley &amp; Sons, New York, 1996.</p> <p><b>DVGW (Hrsg.):</b> Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004.</p> <p><b>Jensen, J. N.:</b> A Problem Solving Approach to Aquatic Chemistry. John Wiley &amp; Sons, Inc., New York, 2003.</p>

Course L0312: Chemistry of Drinking Water Treatment	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Klaus Johannsen
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L0402: Water Resource Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Mathias Ernst
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The lecture provides comprehensive knowledge on interaction of water resource management and drinking water supply. Content overview:</p> <ul style="list-style-type: none"> <li>• Current situation of global water resources</li> <li>- User and Stakeholder conflicts</li> <li>- Wasserressourcenmanagement in urbane Gebieten</li> <li>- Rechtliche Aspekte, Organisationsformen Trinkwasserversorgungsunternehmen.</li> <li>- Ökobilanzierung, Benchmarking in der Wasserversorgung</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Aktuelle UN World Water Development Reports</li> <li>• Branchenbild der deutschen Wasserwirtschaft, VKU (2011)</li> <li>• Aktuelle Artikel wissenschaftlicher Zeitschriften</li> <li>• Ppt der Vorlesung</li> </ul>

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<b>Course L0403: Water Resource Management</b>	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Mathias Ernst
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0949: Rural Development and Resources Oriented Sanitation for different Climate Zones				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Rural Development and Resources Oriented Sanitation for different Climate Zones (L0942)		Seminar	2	3
Rural Development and Resources Oriented Sanitation for different Climate Zones (L0941)		Lecture	2	3
<b>Module Responsible</b>	Prof. Ralf Otterpohl			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic knowledge of the global situation with rising poverty, soil degradation, lack of water resources and sanitation			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Students can describe resources oriented wastewater systems mainly based on source control in detail. They can comment on techniques designed for reuse of water, nutrients and soil conditioners.  Students are able to discuss a wide range of proven approaches in Rural Development from and for many regions of the world.			
<i>Skills</i>	Students are able to design low-tech/low-cost sanitation, rural water supply, rainwater harvesting systems, measures for the rehabilitation of top soil quality combined with food and water security. Students can consult on the basics of soil building through "Holistic Planned Grazing" as developed by Allan Savory.			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to develop a specific topic in a team and to work out milestones according to a given plan.			
<i>Autonomy</i>	Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Subject theoretical and practical work			
<b>Examination duration and scale</b>	During the course of the semester, the students work towards mile stones. The work includes presentations and papers. Detailed information will be provided at the beginning of the semester.			
<b>Assignment for the Following Curricula</b>	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 Water: 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 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 Water and Environmental Engineering: Specialisation Cities: Elective Compulsory			

Course L0942: Rural Development and Resources Oriented Sanitation for different Climate Zones	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Ralf Otterpohl
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>Central part of this module is a group work on a subtopic of the lectures. The focus of these projects will be based on an interview with a target audience, practitioners or scientists.</li> <li>The group work is divided into several Milestones and Assignments. The outcome will be presented in a final presentation at the end of the semester.</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>J. Lange, R. Otterpohl 2000: Abwasser - Handbuch zu einer zukunftsfähigen Abwasserwirtschaft. Mallbeton Verlag (TUHH Bibliothek)</li> <li>Winblad, Uno and Simpson-Hébert, Mayling 2004: Ecological Sanitation, EcoSanRes, Sweden (free download)</li> <li>Schober, Sabine: WTO/TUHH Award winning Terra Preta Toilet Design: <a href="http://youtu.be/w_R09cYq6ys">http://youtu.be/w_R09cYq6ys</a></li> </ul>

Course L0941: Rural Development and Resources Oriented Sanitation for different Climate Zones	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Ralf Otterpohl
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Living Soil - THE key element of Rural Development</li> <li>• Participatory Approaches</li> <li>• Rainwater Harvesting</li> <li>• Ecological Sanitation Principles and practical examples</li> <li>• Permaculture Principles of Rural Development</li> <li>• Performance and Resilience of Organic Small Farms</li> <li>• Going Further: The TUHH Toolbox for Rural Development</li> <li>• EMAS Technologies, Low cost drinking water supply</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation: <a href="http://youtu.be/9hmkgn0nBgk">http://youtu.be/9hmkgn0nBgk</a></li> <li>• Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press</li> </ul>

Module M1125: Bioresources and Biorefineries			
Courses			
Title	Typ	Hrs/wk	CP
Biorefinery Technology (L0895)	Lecture	2	2
Biorefinery Technologie (L0974)	Recitation Section (small)	1	1
Bioresource Management (L0892)	Lecture	2	2
Bioresource Management (L0893)	Recitation Section (small)	1	1
<b>Module Responsible</b>	Dr. Ina Körner		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics on engineering; Basics of waste and energy management		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students can give an overview on principles and theories in the field's bioresource management and biorefinery technology and can explain specialized terms and technologies.		
<i>Skills</i>	Students are capable of applying knowledge and know-how in the field's bioresource management and biorefinery technology in order to perform technical and regional-planning tasks. They are also able to discuss the links to waste management, energy management and biotechnology.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students can work goal-oriented with others and communicate and document their interests and knowledge in an acceptable way.		
<i>Autonomy</i>	Students are able to solve independently, with the aid of pointers, practice-related tasks bearing in mind possible societal consequences.		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	Chemical and Bioprocess Engineering: Specialisation Bioprocess Engineering: Elective Compulsory Environmental Engineering: Specialisation Waste and Energy: Elective Compulsory Environmental Engineering: Specialisation Biotechnology: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Energy: Elective Compulsory		

Course L0895: Biorefinery Technology	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Ina Körner
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The Europe 2020 strategy calls for bioeconomy as the key for smart and green growth of today. Biorefineries are the fundamental part on the way to convert the use of fossil-based society to bio-based society. For this reason, agriculture and forestry sectors are increasingly deliver bioresources. It is not only for their traditional applications in the food and feed sectors such as pulp or paper and construction material productions, but also to produce bioenergy and bio-based products such as bio-plastics. However although bioresources are renewable, they are considered as limited resources as well. The bioeconomy's limitation factor is the availability land on our world. In the context of the development of the bioeconomy, the sustainable and reliable supply of non-food biomass feedstock is a critical success factor for the long-term perspective of bioenergy and other bio-based products production. Biorefineries are complex of technologies and process cascades using the available primary, secondary and tertiary bioresources to produce a multitude of products - a product mix from material and energy products.</p> <p>The lecture gives an overview on biorefinery technology and shall contribute to promotion of international biorefinery developments.</p> <p>Lectures:</p> <ul style="list-style-type: none"> <li>• What is a biorefinery: Overview on basic organic substrates and processes which lead to material and energy products</li> <li>• The way from a fossil based to a biobased economy in the 21st century</li> <li>• The worlds most advanced biorefinery</li> <li>• Presentation of various biorefinery systems and their products (e.g. lignocellulose biorefinery, green biorefinery, whole plant biorefinery, civilization biorefinery)</li> <li>• Example projects (e.g. combination of anaerobic digestion and composting in practice; demonstration project in Hamburgs city quarter Jenfelder Au)</li> </ul> <p>The lectures will be accompanied by technical tours. Optional it is also possible to visit more biorefinery lectures in the University of Hamburg (lectures in German only).</p> <p>In the exercise students have the possibility to work in groups on a biorefinery project or to work on a student-specific task.</p>
<b>Literature</b>	<p>Biorefineries - Industrial Process and Products - Status Qua and Future directions by Kamm, Gruber and Kamm (2010); Wiley VCH, available on-line in TUHH-library</p> <p>Powerpoint-Präsentations / selected Publications / further recommendations depending on the actual developments</p> <p>Industrial Biorefineries and White Biorefinery, by Pandey, Höfer, Larroche, Taherzadeh, Nampoothiri (Eds.); (2014 book development in progress)</p>

Course L0974: Biorefinery Technologie	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Ina Körner
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>1.) Selection of a topic within the thematic area "Biorefinery Technologie" from a given list or self-selected.</p> <p>2.) Self-dependent recherches to the topic.</p> <p>3.) Preparation of a written elaboration.</p> <p>4.) Presentation of the results in the group.</p>
<b>Literature</b>	<p>Vom Thema abhängig. Eigene Recherchen nötig.</p> <p>Depending on the topic. Own recheches necessary.</p>

Course L0892: Bioresource Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Ina Körner
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>In the context of limited fossil resources, climate change mitigation and increasing population growth, Bioresources has a special role. They have to feed the population and in the same time they are important for material production such as pulp and paper or construction materials. Moreover they become more and more important in chemical industry and in energy provision as fossil substitution. Although Bioresources are renewable, they are also considered as limited resources. The availability of land on our planet is the main limitation factor. The sustainable and reliable supply of non-food biomass feedstock is a critical for successful and long term perspective on production of bioenergy and other bio-based products. As the consequence, the increasing competition and shortages continue to happen at the traditional sectors. On the other side, huge unused but potentials residue on waste and wastewater sector exist. Nowadays, a lot of activities to develop better processes, to create new bio-based products in order to become more efficient, the inclusion of secondary and tertiary bio-resources in the valorisation chain are going on.</p> <p>The lecture deals with the current state-of-the-art of bioresource management. It shows deficits and potentials for improvement especially in the sector of utilization of organic residues for material and energy generation:</p> <p><i>Lectures on:</i></p> <ul style="list-style-type: none"> <li>• Bioresource generation and utilization including lost potentials today</li> <li>• Basic biological, mechanical, physico-chemical and logistical processes</li> <li>• The conflict of material vs. energy generation from wood / waste wood</li> <li>• The basics of pulp &amp; paper production including waste paper recycling</li> <li>• The Pros and Cons from biogas and compost production</li> </ul> <p><i>Special lectures by invited guests from research and practice:</i></p> <ul style="list-style-type: none"> <li>• Pathways of waste organics on the example of Hamburg`s City Cleaning Company</li> <li>• Utilization options of landscaping materials on the example of grass</li> <li>• Increase of process efficiency of anaerobic digestions</li> <li>• Decision support tools on the example of an municipality in Indonesia</li> </ul> <p><i>Optional: Technical visits</i></p>
<b>Literature</b>	Power-Point presentations in STUD-IP

Course L0893: Bioresource Management	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Ina Körner
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0902: Wastewater Treatment and Air Pollution Abatement			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Biological Wastewater Treatment (L0517)		Lecture	2
Air Pollution Abatement (L0203)		Lecture	2
<b>Module Responsible</b>	Dr. Swantje Pietsch-Braune		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge of biology and chemistry Basic knowledge of solids process engineering and separation technology		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> After successful completion of the module students are able to</p> <ul style="list-style-type: none"> <li>name and explain biological processes for waste water treatment,</li> <li>characterize waste water and sewage sludge,</li> <li>discuss legal regulations in the area of emissions and air quality</li> <li>explain the effects of air pollutants on the environment,</li> <li>name and explain off gas treatment processes and to define their area of application</li> </ul> <p><i>Skills</i> Students are able to</p> <ul style="list-style-type: none"> <li>choose and design process steps for the biological waste water treatment</li> <li>combine processes for cleaning of off-gases depending on the pollutants contained in the gases</li> </ul> <p><b>Personal Competence</b> <i>Social Competence</i> <i>Autonomy</i></p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Joachim Behrendt
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	Charaterisation of Wastewater Metobolism of Microorganisms Kinetic of microbiotic processes Calculation of bioreactor for wastewater treatment Concepts of Wastewater treatment Design of WWTP Excursion to a WWTP Biofilms Biofim Reactors Anaerobic Wastewater and sludge treatment resources oriented sanitation technology Future challenges of wastewater treatment
<b>Literature</b>	<b>Gujer, Willi</b> Siedlungswasserwirtschaft : mit 84 Tabellen ISBN: 3540343296 (Gb.) URL: <a href="http://www.gbv.de/dms/bs/toc/516261924.pdf">http://www.gbv.de/dms/bs/toc/516261924.pdf</a> URL: <a href="http://deposit.d-nb.de/cgi-bin/dokserv?">http://deposit.d-nb.de/cgi-bin/dokserv?</a>

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-Pföhren : 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](http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf) URL:  
[http://www.gbv.de/dms/weimar/abs/513989765\\_abs.pdf](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](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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Swantje Pietsch-Braune, Christian Eichler
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	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 from 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.
<b>Literature</b>	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 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
<b>Module Responsible</b>	Prof. Michael Schlüter		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	All lectures from the undergraduate studies, especially mathematics, chemistry, thermodynamics, fluid mechanics, heat- and mass transfer.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to:</p> <ul style="list-style-type: none"> <li>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.</li> <li>explain the main transport laws and their application as well as the limits of application.</li> <li>describe how transport coefficients for heat- and mass transfer can be derived experimentally.</li> <li>compare different multiphase reactors like trickle bed reactors, pipe reactors, stirring tanks and bubble column reactors.</li> <li>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.</li> </ul> <p><i>Skills</i> The students are able to:</p> <ul style="list-style-type: none"> <li>optimize multiphase reactors by using mass- and energy balances,</li> <li>use transport processes for the design of technical processes,</li> <li>to choose a multiphase reactor for a specific application.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students are able to discuss in international teams in english and develop an approach under pressure of time.</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	15 min Presentation + 90 min multiple choice written examen		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Interfaces in MPF (boundary layers, surfactants)</li> <li>• Hydrodynamics &amp; pressure drop in Film Flows</li> <li>• Hydrodynamics &amp; pressure drop in Gas-Liquid Pipe Flows</li> <li>• Hydrodynamics &amp; pressure drop in Bubbly Flows</li> <li>• Mass Transfer in Film Flows</li> <li>• Mass Transfer in Gas-Liquid Pipe Flows</li> <li>• Mass Transfer in Bubbly Flows</li> <li>• Reactive mass Transfer in Multiphase Flows</li> <li>• Film Flow: Application Trickle Bed Reactors</li> <li>• Pipe Flow: Application Tubular Reactors</li> <li>• Bubbly Flow: Application Bubble Column Reactors</li> </ul>
<b>Literature</b>	<p>Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.</p> <p>Clift, R.; Grace, J.R.; Weber, M.E.: Bubbles, Drops and Particles, Academic Press, New York, 1978.</p> <p>Fan, L.-S.; Tsuchiya, K.: Bubble Wake Dynamics in Liquids and Liquid-Solid Suspensions, Butterworth-Heinemann Series in Chemical Engineering, Boston, USA, 1990.</p> <p>Hewitt, G.F.; Delhay, J.M.; Zuber, N. (Ed.): Multiphase Science and Technology. Hemisphere Publishing Corp, Vol. 1/1982 bis Vol. 6/1992.</p> <p>Kolev, N.I.: Multiphase flow dynamics. Springer, Vol. 1 and 2, 2002.</p> <p>Levy, S.: Two-Phase Flow in Complex Systems. Verlag John Wiley &amp; Sons, Inc, 1999.</p> <p>Crowe, C.T.: Multiphase Flows with Droplets and Particles. CRC Press, Boca Raton, Fla, 1998.</p>

Course L0105: Reactor Design Using Local Transport Processes	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>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.</p> <p>The four students in each team have to:</p> <ul style="list-style-type: none"> <li>• collect and discuss material properties and equations for design from the literature,</li> <li>• calculate the optimal hydrodynamic design,</li> <li>• check the plausibility of the results critically,</li> <li>• write an exposé with the results.</li> </ul> <p>This exposé will be used as basis for the discussion within the oral group examen of each team.</p>
<b>Literature</b>	see actual literature list in StudIP with recent published papers

Module Manual M.Sc. "International Management and Engineering"

<b>Course L0103: Heat &amp; Mass Transfer in Process Engineering</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction - Transport Processes in Chemical Engineering</li> <li>• Molecular Heat- and Mass Transfer: Applications of Fourier's and Fick's Law</li> <li>• Convective Heat and Mass Transfer: Applications in Process Engineering</li> <li>• Unsteady State Transport Processes: Cooling &amp; Drying</li> <li>• Transport at fluidic Interfaces: Two Film, Penetration, Surface Renewal</li> <li>• Transport Laws &amp; Balance Equations with turbulence, sinks and sources</li> <li>• Experimental Determination of Transport Coefficients</li> <li>• Design and Scale Up of Reactors for Heat- and Mass Transfer</li> <li>• Reactive Mass Transfer</li> <li>• Processes with Phase Changes - Evaporization and Condensation</li> <li>• Radiative Heat Transfer - Fundamentals</li> <li>• Radiative Heat Transfer - Solar Energy</li> </ul>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Baehr, Stephan: Heat and Mass Transfer, Wiley 2002.</li> <li>2. Bird, Stewart, Lightfoot: Transport Phenomena, Springer, 2000.</li> <li>3. John H. Lienhard: A Heat Transfer Textbook, Phlogiston Press, Cambridge Massachusetts, 2008.</li> <li>4. Myers: Analytical Methods in Conduction Heat Transfer, McGraw-Hill, 1971.</li> <li>5. Incropera, De Witt: Fundamentals of Heat and Mass Transfer, Wiley, 2002.</li> <li>6. Beek, Muttzall: Transport Phenomena, Wiley, 1983.</li> <li>7. Crank: The Mathematics of Diffusion, Oxford, 1995.</li> <li>8. Madhusudana: Thermal Contact Conductance, Springer, 1996.</li> <li>9. Treybal: Mass-Transfer-Operation, McGraw-Hill, 1987.</li> </ol>

Module M0542: Fluid Mechanics in Process Engineering			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Applications of Fluid Mechanics in Process Engineering (L0106)		Recitation Section (large)	2
Fluid Mechanics II (L0001)		Lecture	2
<b>CP</b>			4
<b>Module Responsible</b>	Prof. Michael Schlüter		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Mathematics I-III</li> <li>• Fundamentals in Fluid Mechanics</li> <li>• Technical Thermodynamics I-II</li> <li>• Heat- and Mass Transfer</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students are able to describe different applications of fluid mechanics in Process Engineering, Bioprocess Engineering, Energy- and Environmental Process Engineering and Renewable Energies. They are able to use the fundamentals of fluid mechanics for calculations of certain engineering problems. 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 in an example of free jets, empirical solutions in an example with the Forchheimer equation, numerical methods in an example of Large Eddy Simulation).		
<i>Skills</i>	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.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to discuss a given problem in small groups and to develop an approach.		
<i>Autonomy</i>	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.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: 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 Process Engineering: Core Qualification: Compulsory		

Course L0106: Applications of Fluid Mechanics in Process Engineering	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	The Exercise-Lecture will bridge the gap between the theoretical content from the lecture and practical calculations. For this aim a special exercise is calculated at the blackboard that shows how the theoretical knowledge from the lecture can be used to solve real problems in Process Engineering.
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.</li> <li>2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.</li> <li>3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>4. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994.</li> <li>6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006.</li> <li>7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008.</li> <li>8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007</li> <li>9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009.</li> <li>10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.</li> <li>11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008.</li> <li>12. Schlichting, H. : Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.</li> <li>13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>14. White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011.</li> </ol>

Course L0001: Fluid Mechanics II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Differential equations for momentum-, heat and mass transfer</li> <li>• Examples for simplifications of the Navier-Stokes Equations</li> <li>• Unsteady momentum transfer</li> <li>• Free shear layer, turbulence and free jets</li> <li>• Flow around particles - Solids Process Engineering</li> <li>• Coupling of momentum and heat transfer - Thermal Process Engineering</li> <li>• Rheology – Bioprocess Engineering</li> <li>• Coupling of momentum- and mass transfer – Reactive mixing, Chemical Process Engineering</li> <li>• Flow threwn porous structures - heterogeneous catalysis</li> <li>• Pumps and turbines - Energy- and Environmental Process Engineering</li> <li>• Wind- and Wave-Turbines - Renewable Energy</li> <li>• Introduction into Computational Fluid Dynamics</li> </ul>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.</li> <li>2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.</li> <li>3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>4. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994.</li> <li>6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006.</li> <li>7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008.</li> <li>8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007</li> <li>9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009.</li> <li>10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.</li> <li>11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008.</li> <li>12. Schlichting, H. : Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.</li> <li>13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> </ol>

Module M0619: Waste Treatment Technologies				
Courses				
Title	Typ	Hrs/wk	CP	
Waste and Environmental Chemistry (L0328)	Practical Course	2	2	
Biological Waste Treatment (L0318)	Project-/problem-based Learning	3	4	
<b>Module Responsible</b>	Prof. Kerstin Kuchta			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	chemical and biological basics			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The module aims possess knowledge concerning the planning of biological waste treatment plants. Students are able to explain the design and layout of anaerobic and aerobic waste treatment plants in detail, describe different techniques for waste gas treatment plants for biological waste treatment plants and explain different methods for waste analytics.			
<i>Skills</i>	The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques and quality control measurements. The students can recherché and evaluate literature and date connected to the tasks given in der module and plan additional tests. They are capable of reflecting and evaluating findings in the group.			
<b>Personal Competence</b>				
<i>Social Competence</i>	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 in front of colleagues. Furthermore, they can give and accept professional constructive criticism.			
<i>Autonomy</i>	Students can independently tap knowledge from literature, business or test reports and transform it to the course projects. They are capable, in consultation with supervisors as well as in the interim presentation, 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.			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Subject	theoretical and practical work
<b>Examination</b>	Presentation			
<b>Examination duration and scale</b>	Elaboration and Presentation (15-25 minutes in groups)			
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Environmental Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Energy: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory			

<b>Course L0328: Waste and Environmental Chemistry</b>	
<b>Typ</b>	Practical Course
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The participants are divided into groups. Each group prepares a transcript on the experiment performed, which is then used as basis for discussing the results and to evaluate the performance of the group and the individual student.</p> <p>In some experiments the test procedure and the results are presented in seminar form, accompanied by discussion and results evaluation.</p> <p>Experiments ar e.g.</p> <p>Screening and particle size determination</p> <p>Fos/Tac</p> <p>AAS</p> <p>Chalorific value</p>
<b>Literature</b>	Scripte

<b>Course L0318: Biological Waste Treatment</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. biological basics</li> <li>3. determination process specific material characterization</li> <li>4. aerobic degradation ( Composting, stabilization)</li> <li>5. anaerobic degradation (Biogas production, fermentation)</li> <li>6. Technical layout and process design</li> <li>7. Flue gas treatment</li> <li>8. Plant design practical phase</li> </ol>
<b>Literature</b>	

Module M0742: Thermal Energy Systems			
Courses			
Title	Typ	Hrs/wk	CP
Thermal Energy Systems (L0023)	Lecture	3	5
Thermal Energy Systems (L0024)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Dr. Arne Speerforck		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> 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.</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 min		
<b>Assignment for the Following Curricula</b>	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 Energy Systems	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	5
<b>Workload in Hours</b>	Independent Study Time 108, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Dr. Arne Speerforck, Prof. Gerhard Schmitz
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>1. Introduction</p> <p>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</p> <p>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</p> <p>4. Thermal treatment 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</p> <p>5. Laws and standards 5.1 Buildings 5.2 Industrial plants</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Schmitz, G.: Klimateanlagen, Skript zur Vorlesung</li> <li>• VDI Wärmeatlas, 11. Auflage, Springer Verlag, Düsseldorf 2013</li> <li>• Herwig, H.; Moschallski, A.: Wärmeübertragung, Vieweg+Teubner Verlag, Wiesbaden 2009</li> <li>• Recknagel, H.; Sprenger, E.; Schrammek, E.-R.: Taschenbuch für Heizung- und Klimatechnik 2013/2014, 76. Auflage, Deutscher Industrieverlag, 2013</li> </ul>

Course L0024: Thermal Energy Systems	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Dr. Arne Speerforck
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M1813: Agile learning with agile methods				
Courses				
Title	Typ	Hrs/wk	CP	
Agile Data Science for industrial Engineers (L3009)	Project-/problem-based Learning	3	6	
<b>Module Responsible</b>	Prof. Kathrin Fischer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Scientific Writing			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know: <ul style="list-style-type: none"> <li>• Basic principles of agile work</li> <li>• Roles within agile project management based on Scrum</li> <li>• Structure and workflows of agile project groups</li> <li>• Basic functions/classes/methods of data science in python</li> <li>• Selected libraries of data science in Python</li> </ul>			
<i>Skills</i>	The students are able to: <ul style="list-style-type: none"> <li>• Plan and carry out a project based on the Scrum philosophy, in detail:                             <ul style="list-style-type: none"> <li>◦ Define and allocate roles in Scrum</li> <li>◦ Plan Scrum sprints based on self-defined work packages (planning)</li> <li>◦ Carry out Scrum sprints</li> <li>◦ Complete, analyse and evaluate Scrum sprints (review and retrospective)</li> <li>◦ Present project results</li> </ul> </li> <li>• Use established tools of collaborative work</li> <li>• Writing simple scientific scripts for data science in Python collaboratively</li> <li>• Record the methods and results</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to: <ul style="list-style-type: none"> <li>• Work in heterogenic project groups and accept their defined roles based on the scrum philosophy</li> <li>• Commit to group intern time management necessities</li> <li>• Manage scope adjustments under time pressure</li> <li>• Realize and judge the importance of individual commitments for collaborative work</li> <li>• Communicate with stakeholders of their group project</li> </ul>			
<i>Autonomy</i>	The students are able to: <ul style="list-style-type: none"> <li>• Evaluate work packages regarding their practicability and commit to working on these individually</li> <li>• Evaluate their own skills regarding their contribution to a given project</li> <li>• Harmonize their own time management to the group intern time management</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Group discussion	
<b>Examination</b>	Written elaboration			
<b>Examination duration and scale</b>	Approx. 5 - 10 pages per person			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			

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<b>Course L3009: Agile Data Science for industrial Engineers</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Within this course, the fundamentals of Python for Data Science are taught and applied on a collaborative level.</p> <p>The course starts with an introduction to Python which is held in workshop format, and an introduction to collaborative work and agile project management.</p> <p>During this course different projects will be carried out in project groups, following the scrum philosophy.</p> <p>The course is dedicated to programming beginners, so no prior knowledge of Python is required. However, also students with programming experience are welcome to participate.</p> <p>For the exam, teams are required to write a report on the group projects and their results.</p>
<b>Literature</b>	Schwaber, K. & Sutherland, J. (2020): The Scrum Guide. Online Ressource

**Specialization II. Information Technology**

**Module M0837: Simulation of Communication Networks**

**Courses**

<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Simulation of Communication Networks (L0887)	Project-/problem-based Learning	5	6
<b>Module Responsible</b>	Prof. Andreas Timm-Giel		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Knowledge of computer and communication networks</li> <li>• Basic programming skills</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to explain the necessary stochastics, the discrete event simulation technology and modelling of networks for performance evaluation.</p> <p><i>Skills</i> Students are able to apply the method of simulation for performance evaluation to different, also not practiced, problems of communication networks. The students can analyse the obtained results and explain the effects observed in the network. They are able to question their own results.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to acquire expert knowledge in groups, present the results, and discuss solution approaches and results. They are able to work out solutions for new problems in small teams.</p> <p><i>Autonomy</i> Students are able to transfer independently and in discussion with others the acquired method and expert knowledge to new problems. They can identify missing knowledge and acquire this knowledge independently.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Oral exam		
<b>Examination duration and scale</b>	30 min		
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Information and Communication Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory Information and Communication Systems: Specialisation Communication Systems: Elective Compulsory Information and Communication Systems: Specialisation Secure and Dependable IT Systems, Focus Networks: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory		

**Course L0887: Simulation of Communication Networks**

<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	5
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70
<b>Lecturer</b>	Prof. Andreas Timm-Giel
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	In the course necessary basic stochastics and the discrete event simulation are introduced. Also simulation models for communication networks, for example, traffic models, mobility models and radio channel models are presented in the lecture. Students work with a simulation tool, where they can directly try out the acquired skills, algorithms and models. At the end of the course increasingly complex networks and protocols are considered and their performance is determined by simulation.
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Skript des Instituts für Kommunikationsnetze</li> </ul> Further literature is announced at the beginning of the lecture.

Module M0627: Machine Learning and Data Mining			
Courses			
Title	Typ	Hrs/wk	CP
Machine Learning and Data Mining (L0340)	Lecture	2	4
Machine Learning and Data Mining (L0510)	Recitation Section (small)	2	2
<b>Module Responsible</b>	NN		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Calculus</li> <li>• Stochastics</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i>	<p>Students can explain the difference between instance-based and model-based learning approaches, and they can enumerate basic machine learning technique for each of the two basic approaches, either on the basis of static data, or on the basis of incrementally incoming data . For dealing with uncertainty, students can describe suitable representation formalisms, and they explain how axioms, features, parameters, or structures used in these formalisms can be learned automatically with different algorithms. Students are also able to sketch different clustering techniques. They depict how the performance of learned classifiers can be improved by ensemble learning, and they can summarize how this influences computational learning theory. Algorithms for reinforcement learning can also be explained by students.</p>		
<b>Professional Competence</b> <i>Skills</i>	<p>Student derive decision trees and, in turn, propositional rule sets from simple and static data tables and are able to name and explain basic optimization techniques. They present and apply the basic idea of first-order inductive learning. Students apply the BME, MAP, ML, and EM algorithms for learning parameters of Bayesian networks and compare the different algorithms. They also know how to carry out Gaussian mixture learning. They can contrast kNN classifiers, neural networks, and support vector machines, and name their basic application areas and algorithmic properties. Students can describe basic clustering techniques and explain the basic components of those techniques. Students compare related machine learning techniques, e.g., k-means clustering and nearest neighbor classification. They can distinguish various ensemble learning techniques and compare the different goals of those techniques.</p>		
<b>Personal Competence</b> <i>Social Competence</i> <i>Autonomy</i>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 minutes		
<b>Assignment for the Following Curricula</b>	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory		

Course L0340: Machine Learning and Data Mining	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Rainer Marrone
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Decision trees</li> <li>• First-order inductive learning</li> <li>• Incremental learning: Version spaces</li> <li>• Uncertainty</li> <li>• Bayesian networks</li> <li>• Learning parameters of Bayesian networks BME, MAP, ML, EM algorithm</li> <li>• Learning structures of Bayesian networks</li> <li>• Gaussian Mixture Models</li> <li>• kNN classifier, neural network classifier, support vector machine (SVM) classifier</li> <li>• Clustering <ul style="list-style-type: none"> <li>Distance measures, k-means clustering, nearest neighbor clustering</li> </ul> </li> <li>• Kernel Density Estimation</li> <li>• Ensemble Learning</li> <li>• Reinforcement Learning</li> <li>• Computational Learning Theory</li> </ul>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russel, Peter Norvig, Prentice Hall, 2010, Chapters 13, 14, 18-21</li> <li>2. Machine Learning: A Probabilistic Perspective, Kevin Murphy, MIT Press 2012</li> </ol>

Course L0510: Machine Learning and Data Mining	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Rainer Marrone
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0556: Computer Graphics			
Courses			
Title	Typ	Hrs/wk	CP
Computer Graphics (L0145)	Lecture	2	3
Computer Graphics (L0768)	Recitation Section (small)	2	3
<b>Module Responsible</b>	Prof. Tobias Knopp		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Linear Algebra (in particular matrix/vector computation)</li> <li>• Basic programming skills in C/C++</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students can explain and describe basic algorithms in 3D computer graphics.</p> <p><i>Skills</i> Students are capable of</p> <ul style="list-style-type: none"> <li>• implementing a basic 3D rendering pipeline. This consists of projecting simple 3D structures (e.g. cube, spheres) onto a 2D surface using a virtual camera.</li> <li>• apply geometric transformations (e.g. rotation, scaling) in 2D and 3D computer graphics.</li> <li>• using well-known 2D/3D APIs (OpenGL, Cairo) for solving a given problem statement.</li> </ul>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students can collaborate in a small team on the realization and validation of a 3D computer graphics pipeline.</p> <p><i>Autonomy</i></p> <ul style="list-style-type: none"> <li>• Students are able to solve simple tasks independently with reference to the contents of the lectures and the exercise sets.</li> <li>• Students are able to solve detailed problems independently with the aid of the tutorial's programming task.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory Information and Communication Systems: Specialisation Communication Systems, Focus Signal Processing: Elective Compulsory Information and Communication Systems: Specialisation Secure and Dependable IT Systems, Focus Software and Signal Processing: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory		

Course L0145: Computer Graphics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Tobias Knopp
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Computer graphics and animation are leading to an unprecedented visual revolution. The course deals with its technological foundations:</p> <ul style="list-style-type: none"> <li>• Object-oriented Computer Graphics</li> <li>• Projections and Transformations</li> <li>• Polygonal and Parametric Modelling</li> <li>• Illuminating, Shading, Rendering</li> <li>• Computer Animation Techniques</li> <li>• Kinematics and Dynamics Effects</li> </ul> <p>Students will be working on a series of mini-projects which will eventually evolve into a final project. Learning computer graphics and animation resembles learning a musical instrument. Therefore, doing your projects well and in time is essential for performing well on this course.</p>
<b>Literature</b>	<p>Alan H. Watt: 3D Computer Graphics. Harlow: Pearson (3rd ed., repr., 2009).</p> <p>Dariush Derakhshani: Introducing Autodesk Maya 2014. New York, NY : Wiley (2013).</p>

Course L0768: Computer Graphics	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Tobias Knopp
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0676: Digital Communications				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Digital Communications (L0444)		Lecture	2	3
Digital Communications (L0445)		Recitation Section (large)	2	2
Laboratory Digital Communications (L0646)		Practical Course	1	1
<b>Module Responsible</b>	Prof. Gerhard Bauch			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Mathematics 1-3</li> <li>• Signals and Systems</li> <li>• Fundamentals of Communications and Random Processes</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> The students are able to understand, compare and design modern digital information transmission schemes. They are familiar with the properties of linear and non-linear digital modulation methods. They can describe distortions caused by transmission channels and design and evaluate detectors including channel estimation and equalization. They know the principles of single carrier transmission and multi-carrier transmission as well as the fundamentals of basic multiple access schemes.</p> <p>The students are familiar with the contents of lecture and tutorials. They can explain and apply them to new problems.</p> <p><i>Skills</i> The students are able to design and analyse a digital information transmission scheme including multiple access. They are able to choose a digital modulation scheme taking into account transmission rate, required bandwidth, error probability, and further signal properties. They can design an appropriate detector including channel estimation and equalization taking into account performance and complexity properties of suboptimum solutions. They are able to set parameters of a single carrier or multi carrier transmission scheme and trade the properties of both approaches against each other.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students can jointly solve specific problems.</p> <p><i>Autonomy</i> The students are able to acquire relevant information from appropriate literature sources. They can control their level of knowledge during the lecture period by solving tutorial problems, software tools, clicker system.</p>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Written elaboration	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 min			
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Core Qualification: Compulsory Computer Science in Engineering: Specialisation II. Engineering Science: Elective Compulsory Information and Communication Systems: Specialisation Communication Systems: Compulsory Information and Communication Systems: Specialisation Secure and Dependable IT Systems, Focus Networks: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory Microelectronics and Microsystems: Core Qualification: Elective Compulsory			

Course L0444: Digital Communications	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Gerhard Bauch
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Repetition: Baseband Transmission                             <ul style="list-style-type: none"> <li>◦ Pulse shaping: Non-return to zero (NRZ) rectangular pulses, raised-cosine pulses, square-root raised-cosine pulses</li> <li>◦ Power spectral density (psd) of baseband signals</li> <li>◦ Intersymbol interference (ISI)</li> <li>◦ First and second Nyquist criterion</li> <li>◦ AWGN channel</li> <li>◦ Matched filter</li> <li>◦ Matched-filter receiver and correlation receiver</li> <li>◦ Noise whitening matched filter</li> <li>◦ Discrete-time AWGN channel model</li> </ul> </li> <li>• Representation of bandpass signals and systems in the equivalent baseband                             <ul style="list-style-type: none"> <li>◦ Quadrature amplitude modulation (QAM)</li> <li>◦ Equivalent baseband signal and system</li> <li>◦ Analytical signal</li> <li>◦ Equivalent baseband random process, equivalent baseband white Gaussian noise process</li> <li>◦ Equivalent baseband AWGN channel</li> <li>◦ Equivalent baseband channel model with frequency-offset and phase noise</li> </ul> </li> </ul>

- Equivalent baseband Rayleigh fading and Rice fading channel models
- Equivalent baseband frequency-selective channel model
- Discrete memoryless channels (DMC)
- Bandpass transmission via carrier modulation
  - Amplitude modulation, frequency modulation, phase modulation
  - Linear digital modulation methods
    - On-off keying, M-ary amplitude shift keying (M-ASK), M-ary phase shift keying (M-PSK), M-ary quadrature amplitude modulation (M-QAM), offset-QPSK
    - Signal space representation of transmit signal constellations and signals
    - Energy of linear digital modulated signals, average energy per symbol
    - Power spectral density of linear digital modulated signals
    - Bandwidth efficiency
    - Correlation coefficient of elementary signals
    - Error probabilities of linear digital modulation methods
      - Error functions
      - Gray mapping and natural mapping
      - Bit error probabilities, symbol error probabilities, pairwise symbol error probabilities
      - Euclidean distance and Hamming distance
      - Exact and approximate computation of error probabilities
      - Performance comparison of modulation schemes in terms of per bit SNR vs. per symbol SNR
    - Hierarchical modulation, multilevel modulation
    - Effects of carrier phase offset and carrier frequency offset
    - Differential modulation
      - M-ary differential phase shift keying (M-PSK)
      - Coherent and non-coherent detection of DPSK
      - p/M-differential phase shift keying (p/M-DPSK)
      - Differential amplitude and phase shift keying (DAPSK)
  - Non-linear digital modulation methods
    - Frequency shift keying (FSK)
    - Modulation index
    - Minimum shift keying (MSK)
      - Offset-QPSK representation of MSK
      - MSK with differential precoding and rotation
      - Bit error probabilities of MSK
      - Gaussian minimum shift keying (GMSK)
      - Power spectral density of MSK and GMSK
    - Continuous phase modulation (CPM)
      - General description of CPM signals
      - Frequency pulses and phase pulses
    - Coherent and non-coherent detection of FSK
  - Performance comparison of linear and non-linear digital modulation methods
- Frequency-selective channels, ISI channels
  - Intersymbol interference and frequency-selectivity
  - RMS delay spread
  - Narrowband and broadband channels
  - Equivalent baseband transmission model for frequency-selective channels
  - Receive filter design
- Equalization
  - Symbol-spaced and fractionally-spaced equalizers
  - Inverse system
  - Non-recursive linear equalizers
    - Linear zero-forcing (ZF) equalizer
    - Linear minimum mean squared error (MMSE) equalizer
  - Non-linear equalization:
    - Decision feedback equalizer (DFE)
    - Tomlinson-Harashima precoding
  - Maximum a posteriori probability (MAP) and maximum likelihood equalizer, Viterbi algorithm
- Single-carrier vs. multi-carrier transmission
- Multi-carrier transmission
  - General multicarrier transmission
  - Orthogonal frequency division multiplex (OFDM)
    - OFDM implementation using the Fast Fourier Transform (FFT)
    - Cyclic guard interval
    - Power spectral density of OFDM
    - Peak-to-average power ratio (PAPR)
- Multiple access
  - Principles of time division multiple access (TDMA), frequency division multiple access (FDMA), code division multiple access (CDMA), non-orthogonal multiple access (NOMA), hybrid multiple access
- Spread spectrum communications
  - Direct sequence spread spectrum communications
  - Frequency hopping
  - Protection against eavesdropping
  - Protection against narrowband jammers
  - Short vs. long spreading codes
  - Direct sequence spread spectrum communications in frequency-selective channels

	<ul style="list-style-type: none"> <li>▪ Rake receiver</li> <li>◦ Code division multiple access (CDMA) <ul style="list-style-type: none"> <li>▪ Design criteria of spreading sequences, autocorrelation function and crosscorrelation function of spreading sequences</li> <li>▪ Intersymbol interference (ISI) and multiple access interference (MAI)</li> <li>▪ Pseudo noise (PN) sequences, maximum length sequences (m-sequences), Gold codes, Walsh-Hadamard codes, orthogonal variable spreading factor (OVSF) codes</li> <li>▪ Multicode transmission</li> <li>▪ CDMA in uplink and downlink of a wireless communications system</li> <li>▪ Single-user detection vs. multi-user detection</li> </ul> </li> </ul>
<b>Literature</b>	<p>K. Kammeyer: Nachrichtenübertragung, Teubner</p> <p>P.A. Höher: Grundlagen der digitalen Informationsübertragung, Teubner.</p> <p>J.G. Proakis, M. Salehi: Digital Communications. McGraw-Hill.</p> <p>S. Haykin: Communication Systems. Wiley</p> <p>R.G. Gallager: Principles of Digital Communication. Cambridge</p> <p>A. Goldsmith: Wireless Communication. Cambridge.</p> <p>D. Tse, P. Viswanath: Fundamentals of Wireless Communication. Cambridge.</p>

Course L0445: Digital Communications	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Gerhard Bauch
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L0646: Laboratory Digital Communications	
<b>Typ</b>	Practical Course
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Gerhard Bauch
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- DSL transmission</li> <li>- Random processes</li> <li>- Digital data transmission</li> </ul>
<b>Literature</b>	<p>K. Kammeyer: Nachrichtenübertragung, Teubner</p> <p>P.A. Höher: Grundlagen der digitalen Informationsübertragung, Teubner.</p> <p>J.G. Proakis, M. Salehi: Digital Communications. McGraw-Hill.</p> <p>S. Haykin: Communication Systems. Wiley</p> <p>R.G. Gallager: Principles of Digital Communication. Cambridge</p> <p>A. Goldsmith: Wireless Communication. Cambridge.</p> <p>D. Tse, P. Viswanath: Fundamentals of Wireless Communication. Cambridge.</p>

Module M0753: Software Verification			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Software Verification (L0629)	Lecture	2	3
Software Verification (L0630)	Recitation Section (small)	2	3
<b>Module Responsible</b>	Prof. Sibylle Schupp		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>Automata theory and formal languages</li> <li>Computational logic</li> <li>Object-oriented programming, algorithms, and data structures</li> <li>Functional programming or procedural programming</li> <li>Concurrency</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i>	Students apply the major verification techniques in model checking and deductive verification. They explain in formal terms syntax and semantics of the underlying logics, and assess the expressivity of different logics as well as their limitations. They classify formal properties of software systems. They find flaws in formal arguments, arising from modeling artifacts or underspecification.		
<i>Skills</i>	Students formulate provable properties of a software system in a formal language. They develop logic-based models that properly abstract from the software under verification and, where necessary, adapt model or property. They construct proofs and property checks by hand or using tools for model checking or deductive verification, and reflect on the scope of the results. Presented with a verification problem in natural language, they select the appropriate verification technique and justify their choice.		
<b>Personal Competence</b> <i>Social Competence</i>	Students discuss relevant topics in class. They defend their solutions orally. They communicate in English.		
<i>Autonomy</i>	Using accompanying on-line material for self study, students can assess their level of knowledge continuously and adjust it appropriately. Working on exercise problems, they receive additional feedback. Within limits, they can set their own learning goals. Upon successful completion, students can identify and precisely formulate new problems in academic or applied research in the field of software verification. Within this field, they can conduct independent studies to acquire the necessary competencies and compile their findings in academic reports. They can devise plans to arrive at new solutions or assess existing ones.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>
	Yes	15 %	Excercises
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	Computer Science: Specialisation I. Computer and Software Engineering: Elective Compulsory Computer Science in Engineering: Specialisation I. Computer Science: Elective Compulsory Information and Communication Systems: Specialisation Secure and Dependable IT Systems: Compulsory Information and Communication Systems: Specialisation Communication Systems, Focus Software: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory		

Course L0629: Software Verification	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Sibylle Schupp
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>Model checking (bounded model checking, CTL, LTL)</li> <li>Real-time model checking (TCTL, timed automata)</li> <li>Deductive verification (Hoare logic)</li> <li>Tool support</li> <li>Recent developments of verification techniques and applications</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>C. Baier and J-P. Katoen, Principles of Model Checking, MIT Press 2007.</li> <li>M. Huth and M. Bryan, Logic in Computer Science. Modelling and Reasoning about Systems, 2nd Edition, 2004.</li> <li>Selected Research Papers</li> </ul>

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<b>Course L0630: Software Verification</b>	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Sibylle Schupp
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0836: Communication Networks				
Courses				
Title	Typ	Hrs/wk	CP	
Selected Topics of Communication Networks (L0899)	Project-/problem-based Learning	2	2	
Communication Networks (L0897)	Lecture	2	2	
Communication Networks Exercise (L0898)	Project-/problem-based Learning	1	2	
<b>Module Responsible</b>	Prof. Andreas Timm-Giel			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>Fundamental stochastics</li> <li>Basic understanding of computer networks and/or communication technologies is beneficial</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to describe the principles and structures of communication networks in detail. They can explain the formal description methods of communication networks and their protocols. They are able to explain how current and complex communication networks work and describe the current research in these examples.</p> <p><i>Skills</i> Students are able to evaluate the performance of communication networks using the learned methods. They are able to work out problems themselves and apply the learned methods. They can apply what they have learned autonomously on further and new communication networks.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to define tasks themselves in small teams and solve these problems together using the learned methods. They can present the obtained results. They are able to discuss and critically analyse the solutions.</p> <p><i>Autonomy</i> Students are able to obtain the necessary expert knowledge for understanding the functionality and performance capabilities of new communication networks independently.</p>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	None			
<b>Examination</b>	Presentation			
<b>Examination duration and scale</b>	1.5 hours colloquium with three students, therefore about 30 min per student. Topics of the colloquium are the posters from the previous poster session and the topics of the module.			
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Information and Communication Systems: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory Computer Science in Engineering: Specialisation I. Computer Science: Elective Compulsory Information and Communication Systems: Specialisation Communication Systems: Elective Compulsory Information and Communication Systems: Specialisation Secure and Dependable IT Systems, Focus Networks: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Microelectronics and Microsystems: Specialisation Communication and Signal Processing: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory			
Course L0899: Selected Topics of Communication Networks				
<b>Typ</b>	Project-/problem-based Learning			
<b>Hrs/wk</b>	2			
<b>CP</b>	2			
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28			
<b>Lecturer</b>	Prof. Andreas Timm-Giel			
<b>Language</b>	EN			
<b>Cycle</b>	WiSe			
<b>Content</b>	Example networks selected by the students will be researched on in a PBL course by the students in groups and will be presented in a poster session at the end of the term.			
<b>Literature</b>	<ul style="list-style-type: none"> <li>see lecture</li> </ul>			

<b>Course L0897: Communication Networks</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Andreas Timm-Giel, Dr.-Ing. Koojana Kuladinithi
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Skript des Instituts für Kommunikationsnetze</li> <li>• Tannenbaum, Computernetzwerke, Pearson-Studium</li> </ul> <p>Further literature is announced at the beginning of the lecture.</p>

<b>Course L0898: Communication Networks Exercise</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Andreas Timm-Giel
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	Part of the content of the lecture Communication Networks are reflected in computing tasks in groups, others are motivated and addressed in the form of a PBL exercise.
<b>Literature</b>	<ul style="list-style-type: none"> <li>• announced during lecture</li> </ul>

Module M0733: Software Analysis			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Software Analysis (L0631)		Lecture	2
Software Analysis (L0632)		Recitation Section (small)	2
<b>CP</b>			3
<b>Module Responsible</b>	Prof. Sibylle Schupp		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Basic knowledge of software-engineering activities</li> <li>• Discrete algebraic structures</li> <li>• Object-oriented programming, algorithms, and data structures</li> <li>• Functional programming or Procedural programming</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students apply the major approaches to data-flow analysis, control-flow analysis, and type-based analysis, along with their classification schemes, and employ abstract interpretation. They explain the standard forms of internal representations and models, including their mathematical structure and properties, and evaluate their suitability for a particular analysis. They explain and categorize the major analysis algorithms. They distinguish precise solutions from approximative approaches, and show termination and soundness properties.</p> <p><i>Skills</i> Presented with an analytical task for a software artifact, students select appropriate approaches from software analysis, and justify their choice. They design suitable representations by modifying standard representations. They develop customized analyses and devise them as safe overapproximations. They formulate analyses in a formal way and construct arguments for their correctness, behavior, and precision.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students discuss relevant topics in class. They defend their solutions orally. They communicate in English.</p> <p><i>Autonomy</i> Using accompanying on-line material for self study, students can assess their level of knowledge continuously and adjust it appropriately. Working on exercise problems, they receive additional feedback. Within limits, they can set their own learning goals. Upon successful completion, students can identify and precisely formulate new problems in academic or applied research in the field of software analysis. Within this field, they can conduct independent studies to acquire the necessary competencies and compile their findings in academic reports. They can devise plans to arrive at new solutions or assess existing ones.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	software artifacts/mathematical write-ups; short presentation		
<b>Assignment for the Following Curricula</b>	Information and Communication Systems: Specialisation Secure and Dependable IT Systems, Focus Software and Signal Processing: Elective Compulsory Information and Communication Systems: Specialisation Communication Systems, Focus Software: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory		

Course L0631: Software Analysis	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Sibylle Schupp
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Modeling: Control-Flow Modeling, Data Dependences, Intermediate Languages)</li> <li>• Classical Bit-Vector Analyses (Reaching Definition, Very Busy Expressions, Liveness, Available Expressions, May/Must, Forward/Backward)</li> <li>• Monotone Frameworks (Lattices, Transfer Functions, Ascending Chain Condition, Distributivity, Constant Propagation)</li> <li>• Theory of Data-Flow Analysis (TarSKI's Fixed Point Theorem, Data-Flow Equations, MFP Solution, MOP Solution, Worklist Algorithm)</li> <li>• Non-Classical Data-Flow Analyses</li> <li>• Abstract Interpretation (Galois Connections, Approximating Fixed Points, Construction Techniques)</li> <li>• Type Systems (Type Derivation, Inference Trees, Algorithm W, Unification)</li> <li>• Recent Developments of Analysis Techniques and Applications</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Flemming Nielsen, Hanne Nielsen, and Chris Hankin. Principles of Program Analysis. Springer, 2nd. ed. 2005.</li> <li>• Uday Khedker, Amitabha Sanyal, and Bageshri Karkara. Data Flow Analysis: Theory and Practice. CRC Press, 2009.</li> <li>• Benjamin Pierce, Types and Programming Languages, MIT Press.</li> <li>• Selected research papers</li> </ul>

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Course L0632: Software Analysis	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Sibylle Schupp
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M1598: Image Processing			
Courses			
Title	Typ	Hrs/wk	CP
Image Processing (L2443)	Lecture	2	4
Image Processing (L2444)	Recitation Section (small)	2	2
<b>Module Responsible</b>	Prof. Tobias Knopp		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Signal and Systems		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students know about <ul style="list-style-type: none"> <li>• visual perception</li> <li>• multidimensional signal processing</li> <li>• sampling and sampling theorem</li> <li>• filtering</li> <li>• image enhancement</li> <li>• edge detection</li> <li>• multi-resolution procedures: Gauss and Laplace pyramid, wavelets</li> <li>• image compression</li> <li>• image segmentation</li> <li>• morphological image processing</li> </ul>		
<i>Skills</i>	The students can <ul style="list-style-type: none"> <li>• analyze, process, and improve multidimensional image data</li> <li>• implement simple compression algorithms</li> <li>• design custom filters for specific applications</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students can work on complex problems both independently and in teams. They can exchange ideas with each other and use their individual strengths to solve the problem.		
<i>Autonomy</i>	Students are able to independently investigate a complex problem and assess which competencies are required to solve it.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	Data Science: Core Qualification: Elective Compulsory Data Science: Specialisation I. Mathematics/Computer Science: Elective Compulsory Electrical Engineering: Specialisation Information and Communication Systems: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory Information and Communication Systems: Specialisation Secure and Dependable IT Systems, Focus Software and Signal Processing: Elective Compulsory Information and Communication Systems: Specialisation Communication Systems, Focus Signal Processing: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Microelectronics and Microsystems: Specialisation Communication and Signal Processing: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory		

Course L2443: Image Processing	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Tobias Knopp
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Visual perception</li> <li>• Multidimensional signal processing</li> <li>• Sampling and sampling theorem</li> <li>• Filtering</li> <li>• Image enhancement</li> <li>• Edge detection</li> <li>• Multi-resolution procedures: Gauss and Laplace pyramid, wavelets</li> <li>• Image Compression</li> <li>• Segmentation</li> <li>• Morphological image processing</li> </ul>
<b>Literature</b>	Bredies/Lorenz, Mathematische Bildverarbeitung, Vieweg, 2011 Pratt, Digital Image Processing, Wiley, 2001 Bernd Jähne: Digitale Bildverarbeitung - Springer, Berlin 2005

Course L2444: Image Processing	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Tobias Knopp
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0629: Intelligent Autonomous Agents and Cognitive Robotics			
Courses			
Title	Typ	Hrs/wk	CP
Intelligent Autonomous Agents and Cognitive Robotics (L0341)	Lecture	2	4
Intelligent Autonomous Agents and Cognitive Robotics (L0512)	Recitation Section (small)	2	2
<b>Module Responsible</b>	Rainer Marrone		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Vectors, matrices, Calculus		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students can explain the agent abstraction, define intelligence in terms of rational behavior, and give details about agent design (goals, utilities, environments). They can describe the main features of environments. The notion of adversarial agent cooperation can be discussed in terms of decision problems and algorithms for solving these problems. For dealing with uncertainty in real-world scenarios, students can summarize how Bayesian networks can be employed as a knowledge representation and reasoning formalism in static and dynamic settings. In addition, students can define decision making procedures in simple and sequential settings, with and with complete access to the state of the environment. In this context, students can describe techniques for solving (partially observable) Markov decision problems, and they can recall techniques for measuring the value of information. Students can identify techniques for simultaneous localization and mapping, and can explain planning techniques for achieving desired states. Students can explain coordination problems and decision making in a multi-agent setting in term of different types of equilibria, social choice functions, voting protocol, and mechanism design techniques.</p> <p><i>Skills</i> Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent application students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesian networks/dynamic Bayesian networks and apply bayesian reasoning for simple queries. Students can also name and apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situations students will apply techniques for finding different equilibria states, e.g., Nash equilibria. For multi-agent decision making students will apply different voting protocols and compare and explain the results.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to discuss their solutions to problems with others. They communicate in English</p> <p><i>Autonomy</i> Students are able of checking their understanding of complex concepts by solving variants of concrete problems</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 minutes		
<b>Assignment for the Following Curricula</b>	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory		

Course L0341: Intelligent Autonomous Agents and Cognitive Robotics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Rainer Marrone
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Definition of agents, rational behavior, goals, utilities, environment types</li> <li>• Adversarial agent cooperation: Agents with complete access to the state(s) of the environment, games, Minimax algorithm, alpha-beta pruning, elements of chance</li> <li>• Uncertainty: Motivation: agents with no direct access to the state(s) of the environment, probabilities, conditional probabilities, product rule, Bayes rule, full joint probability distribution, marginalization, summing out, answering queries, complexity, independence assumptions, naive Bayes, conditional independence assumptions</li> <li>• Bayesian networks: Syntax and semantics of Bayesian networks, answering queries revised (inference by enumeration), typical-case complexity, pragmatics: reasoning from effect (that can be perceived by an agent) to cause (that cannot be directly perceived).</li> <li>• Probabilistic reasoning over time: Environmental state may change even without the agent performing actions, dynamic Bayesian networks, Markov assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation, special cases: hidden Markov models, Kalman filters, Exact inferences and approximations</li> <li>• Decision making under uncertainty: Simple decisions: utility theory, multivariate utility functions, dominance, decision networks, value of information Complex decisions: sequential decision problems, value iteration, policy iteration, MDPs Decision-theoretic agents: POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks</li> <li>• Simultaneous Localization and Mapping</li> <li>• Planning</li> <li>• Game theory (Golden Balls: Split or Share) Decisions with multiple agents, Nash equilibrium, Bayes-Nash equilibrium</li> <li>• Social Choice Voting protocols, preferences, paradoxes, Arrow's Theorem,</li> <li>• Mechanism Design Fundamentals, dominant strategy implementation, Revelation Principle, Gibbard-Satterthwaite Impossibility Theorem, Direct mechanisms, incentive compatibility, strategy-proofness, Vickrey-Groves-Clarke mechanisms, expected externality mechanisms, participation constraints, individual rationality, budget balancedness, bilateral trade, Myerson-Satterthwaite Theorem</li> </ul>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Artificial Intelligence: A Modern Approach (Third Edition), Stuart Russell, Peter Norvig, Prentice Hall, 2010, Chapters 2-5, 10-11, 13-17</li> <li>2. Probabilistic Robotics, Thrun, S., Burgard, W., Fox, D. MIT Press 2005</li> <li>3. Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham, Kevin Leyton-Brown, Cambridge University Press, 2009</li> </ol>

Course L0512: Intelligent Autonomous Agents and Cognitive Robotics	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Rainer Marrone
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0550: Digital Image Analysis			
Courses			
Title	Typ	Hrs/wk	CP
Digital Image Analysis (L0126)	Lecture	4	6
<b>Module Responsible</b>	Prof. Tobias Knopp		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	System theory of one-dimensional signals (convolution and correlation, sampling theory, interpolation and decimation, Fourier transform, linear time-invariant systems), linear algebra (Eigenvalue decomposition, SVD), basic stochastics and statistics (expectation values, influence of sample size, correlation and covariance, normal distribution and its parameters), basics of Matlab, basics in optics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students can</p> <ul style="list-style-type: none"> <li>• Describe imaging processes</li> <li>• Depict the physics of sensorics</li> <li>• Explain linear and non-linear filtering of signals</li> <li>• Establish interdisciplinary connections in the subject area and arrange them in their context</li> <li>• Interpret effects of the most important classes of imaging sensors and displays using mathematical methods and physical models.</li> </ul> <p><i>Skills</i> Students are able to</p> <ul style="list-style-type: none"> <li>• Use highly sophisticated methods and procedures of the subject area</li> <li>• Identify problems and develop and implement creative solutions.</li> </ul> <p>Students can solve simple arithmetical problems relating to the specification and design of image processing and image analysis systems.</p> <p>Students are able to assess different solution approaches in multidimensional decision-making areas.</p> <p>Students can undertake a prototypical analysis of processes in Matlab.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> k.A.</p> <p><i>Autonomy</i> Students can solve image analysis tasks independently using the relevant literature.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 Minutes, Content of Lecture and materials in StudIP		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Information Technology: Elective Compulsory		

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Course L0126: Digital Image Analysis	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Tobias Knopp
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Image representation, definition of images and volume data sets, illumination, radiometry, multispectral imaging, reflectivities, shape from shading</li> <li>• Perception of luminance and color, color spaces and transforms, color matching functions, human visual system, color appearance models</li> <li>• imaging sensors (CMOS, CCD, HDR, X-ray, IR), sensor characterization(EMVA1288), lenses and optics</li> <li>• spatio-temporal sampling (interpolation, decimation, aliasing, leakage, moiré, flicker, apertures)</li> <li>• features (filters, edge detection, morphology, invariance, statistical features, texture)</li> <li>• optical flow ( variational methods, quadratic optimization, Euler-Lagrange equations)</li> <li>• segmentation (distance, region growing, cluster analysis, active contours, level sets, energy minimization and graph cuts)</li> <li>• registration (distance and similarity, variational calculus, iterative closest points)</li> </ul>
<b>Literature</b>	<p>Bredies/Lorenz, Mathematische Bildverarbeitung, Vieweg, 2011</p> <p>Wedel/Cremers, Stereo Scene Flow for 3D Motion Analysis, Springer 2011</p> <p>Handels, Medizinische Bildverarbeitung, Vieweg, 2000</p> <p>Pratt, Digital Image Processing, Wiley, 2001</p> <p>Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989</p>

**Specialization II. Logistics**

Module M0978: Mobility of Goods and Logistics Systems			
Courses			
Title	Typ	Hrs/wk	CP
Mobility of Goods, Logistics, Traffic (L1165)	Lecture	2	2
International Logistics and Transport Systems (L1168)	Project-/problem-based Learning	3	4
<b>Module Responsible</b>	Prof. Heike Flämig		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Introduction to Logistics and Mobility</li> <li>• Foundations of Management</li> <li>• Legal Foundations of Transportation and Logistics</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to...</p> <ul style="list-style-type: none"> <li>• give definitions of system theory, (international) transport chains and logistics in the context of supply chain management</li> <li>• explain trends and strategies for mobility of goods and logistics</li> <li>• describe elements of integrated and multi-modal transport chains and their advantages and disadvantages</li> <li>• deduce impacts of management decisions on logistics system and traffic system and explain how stakeholders influence them</li> <li>• explain the correlations between economy and logistics systems, mobility of goods, space-time-structures and the traffic system as well as ecology and politics</li> </ul> <p><i>Skills</i> Students are able to...</p> <ul style="list-style-type: none"> <li>• Design intermodal transport chains and logistic concepts</li> <li>• apply the commodity chain theory and case study analysis</li> <li>• evaluate different international transport chains</li> <li>• cope with differences in cultures that influence international transport chains</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to...</p> <ul style="list-style-type: none"> <li>• develop a feeling of social responsibility for their future jobs</li> <li>• give constructive feedback to others about their presentation skills</li> <li>• plan and execute teamwork tasks</li> </ul> <p><i>Autonomy</i> Students are able to improve presentation skills by feedback of others</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b> <b>Description</b>
	Yes	None	Participation in excursions
	Yes	None	Excercises
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	written exam (60 minutes), excercises in groups (min. 80% attendance), one-day excursion with short presentations		
<b>Assignment for the Following Curricula</b>	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 Mechanical Engineering and Management: Specialisation Management: Elective Compulsory		

Course L1165: Mobility of Goods, Logistics, Traffic	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Heike Flämig
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The intention of this lecture is to provide a general system analysis-based overview of how transportation chains emerge and how they are developed. The respective advantages and disadvantages of different international transportation chains of goods are to be pointed out from a micro- and a macroeconomic point of view. The effects on the traffic system as well as the ecological and social consequences of a spatial deviation of economical activities are to be discussed.</p> <p>The overview of current international transportation chains is carried out on the basis of concrete material- and appendant information flows. Established transportation chains and some of their individual elements are to become transparent to the students by a number of practical examples.</p> <ol style="list-style-type: none"> <li>1. A conceptual systems model</li> <li>2. Elements of integrated and multi-modal transportation chains</li> <li>3. interaction of transport and traffic, demand and supply on different layers of the transport system</li> <li>4. Global Issues in Supply Chain Management</li> <li>5. Global Players and networks</li> <li>6. Logistics and corporate social responsibility (CSR)</li> <li>7. Methods and data for assessment of international transport chains</li> <li>8. Influence of cultural aspects on international transport chains</li> <li>9. New solutions using different focuses of the transport and logistics system</li> </ol>
<b>Literature</b>	<p>David, Pierre A.; Stewart, Richard D.: International Logistics: The Management of International Trade Operations, 3rd Edition, Mason, 2010</p> <p>Schieck, Arno: Internationale Logistik: Objekte, Prozesse und Infrastrukturen grenzüberschreitender Güterströme, München, 2009</p> <p>BLOECH, J., IHDE, G. B. (1997) Vahlens Großes Logistikleikon, München, Verlag C.H. Beck</p> <p>IHDE, G. B. (1991) Transport, Verkehr, Logistik, München, Verlag Franz Vahlen, 2. völlig überarbeitete und erweiterte Auflage</p> <p>NUHN, H., HESSE, M. (2006) Verkehrsgeographie, Paderborn, München, Wien, Zürich, Verlage Ferdinand Schöningh</p> <p>PFOHL, H.-C. (2000) Logistiksysteme - Betriebswirtschaftliche Grundlagen, Berlin, Heidelberg, New York, Springer-Verlag, 6. Auflage</p>

Course L1168: International Logistics and Transport Systems	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Heike Flämig
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The problem-oriented-learning lecture consists of case studies and complex problems concerning the systemic characteristics of different modes of transport as well as the organization and realization of transport chains. Students get to know specific issues from practice of logistics and mobility of goods and work out recommendations for solutions.</p>
<b>Literature</b>	<p>David, Pierre A.; Stewart, Richard D.: International Logistics: The Management of International Trade Operations, 3rd Edition, Mason, 2010</p> <p>Schieck, Arno: Internationale Logistik: Objekte, Prozesse und Infrastrukturen grenzüberschreitender Güterströme, München, 2009</p>

Module M1089: Integrated Maintenance and Spare Part Logistics	
<b>Courses</b>	
<b>Title</b>	<b>Typ</b> <b>Hrs/wk</b> <b>CP</b>
Spare Part Logistics (L1403)	Lecture 1 2
Maintenance Logistics (L1401)	Lecture 2 2
Exercises to Integrated Maintenance and Spare Part Logistics (L1405)	Recitation Section (small) 1 2
<b>Module Responsible</b>	Prof. Kathrin Fischer
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	Basic knowledge of logistical processes
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b> <i>Knowledge</i>	<ul style="list-style-type: none"> <li>Students can explain basic concepts of maintenance and spare parts logistics and distinguish between them.</li> <li>Students can explain key approaches and concepts of maintenance and spare parts logistics, locate them in a theoretical context and present practical applications.</li> </ul>
<i>Skills</i>	<ul style="list-style-type: none"> <li>Students can plan and evaluate processes, techniques and organizational forms in the field of maintenance and spare parts logistics.</li> <li>Students can apply planning methods in maintenance and spare parts logistics to practical examples.</li> <li>Students can develop and apply key performance indicator systems and carry out current status analyses.</li> </ul>
<b>Personal Competence</b> <i>Social Competence</i>	<ul style="list-style-type: none"> <li>Students can present and argue their own expert opinions and work results in front of teachers and other students in an appropriate manner.</li> <li>Students can achieve accurate work results as members of a team.</li> </ul>
<i>Autonomy</i>	<ul style="list-style-type: none"> <li>Students can access specialist knowledge independently and transfer the knowledge acquired to new problems.</li> </ul>
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Credit points</b>	6
<b>Course achievement</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	2 hours
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory

Course L1403: Spare Part Logistics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Ingo Martens
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>Introduction: Logistical spare parts management, factors influencing need for spare parts, spare logistics requirements, integration of spare parts logistics and maintenance logistics.</li> <li>Methoda: Analysis of spare parts stocks, differentiation of spare parts strategy, forecasting need for spare parts, process chains</li> <li>Planning: preliminary planning, concept planning and realisation, planning instruments and tools.</li> <li>Practical examples for: optimization of spare parts centers, optimization of international spare parts distribution, performance-based logistics, new business models in spare parts logistics.</li> </ul>
<b>Literature</b>	Scripts and text documents to be handed out during the course.

<b>Course L1401: Maintenance Logistics</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Ingo Martens
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction: developments and trends in integrated maintenance and spare parts logistics, components of integrated maintenance, the terms maintenance and maintenance logistics, need for action and the "maintenance dilemma," maintenance planning measures.</li> <li>• Basics of integrated maintenance: maintenance technology, organisational structures and workflows, maintenance controlling, integration of employees and management.</li> <li>• Knowledge-based business management and maintenance: Production and maintenance, condition knowledge and diagnosis, business management strategy, management, motivation and success.</li> <li>• Target and key performance indicator systems: developing target systems, performance indicator requirements, performance indicator analysis, strengths and weaknesses analysis, potential analysis, performance indicator models, monitoring (IH Cockpit)</li> <li>• Maintenance methods: make or buy versus outsourcing, total productive maintenance, differentiating between logistics strategies.</li> <li>• Maintenance planning: concept planning and realization, concept planning tasks and steps, supplementing planning basics, technology and organisation sub-concepts, overall concept of integrated maintenance and spare parts logistics.</li> <li>• Practical examples, including for: energy-efficient asset management, maintenance strategies in highly automated goods distribution centers, remote diagnosis and service management in wind energy plants, value stream analysis in maintenance.</li> </ul>
<b>Literature</b>	<p>Skripte und Textdokumente, die während der Vorlesung herausgegeben werden.</p> <p>Scripts and text documents to be handed out during the course.</p>

<b>Course L1405: Exercises to Integrated Maintenance and Spare Part Logistics</b>	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Ingo Martens
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	
<b>Literature</b>	Es wird die in den Vorlesungen "Instandhaltungslogistik" und "Ersatzteillogistik" verwendete Literatur empfohlen.

Module M1132: Maritime Transport				
Courses				
Title	Typ	Hrs/wk	CP	
Maritime Transport (L0063)	Lecture	2	3	
Maritime Transport (L0064)	Recitation Section (small)	2	3	
<b>Module Responsible</b>	Prof. Carlos Jahn			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>				
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students are able to...			
	<ul style="list-style-type: none"> <li>• present the actors involved in the maritime transport chain with regard to their typical tasks;</li> <li>• name common cargo types in shipping and classify cargo to the corresponding categories;</li> <li>• explain operating forms in maritime shipping, transport options and management in transport networks;</li> <li>• weigh the advantages and disadvantages of the various modes of hinterland transport and apply them in practice;</li> <li>• present relevant factors for the location planning of ports and seaport terminals and discuss them in a problem-oriented way;</li> <li>• estimate the potential of digitisation in maritime shipping.</li> </ul>			
<i>Skills</i>	The students are able to...			
	<ul style="list-style-type: none"> <li>• determine the mode of transport, actors and functions of the actors in the maritime supply chain;</li> <li>• identify possible cost drivers in a transport chain and recommend appropriate proposals for cost reduction;</li> <li>• record, map and systematically analyse material and information flows of a maritime logistics chain, identify possible problems and recommend solutions;</li> <li>• perform risk assessments of human disruptions to the supply chain;</li> <li>• analyse accidents in the field of maritime logistics and evaluating their relevance in everyday life;</li> <li>• deal with current research topics in the field of maritime logistics in a differentiated way;</li> <li>• apply different process modelling methods in a hitherto unknown field of activity and to work out the respective advantages.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to...			
	<ul style="list-style-type: none"> <li>• discuss and organise extensive work packages in groups;</li> <li>• document and present the elaborated results.</li> </ul>			
<i>Autonomy</i>	The students are capable to...			
	<ul style="list-style-type: none"> <li>• research and select technical literature, including standards and guidelines;</li> <li>• submit own shares in an extensive written elaboration in small groups in due time.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	15 %	Subject theoretical and practical work	and Teilnahme an einem Planspiel und anschließende schriftliche Ausarbeitung
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 minutes			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>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.</p> <p>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.</p> <p>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.</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005.</li> <li>• Schönknecht, Axel. Maritime Containerlogistik: Leistungsvergleich von Containerschiffen in intermodalen Transportketten. Berlin Heidelberg: Springer-Verlag, 2009.</li> <li>• Stopford, Martin. Maritime Economics Routledge, 2009</li> </ul>

Course L0064: Maritime Transport	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>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.</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Stopford, Martin. Maritime Economics Routledge, 2009</li> <li>• Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005.</li> <li>• Schönknecht, Axel. Maritime Containerlogistik: Leistungsvergleich von Containerschiffen in intermodalen Transportketten. Berlin Heidelberg: Springer-Verlag, 2009.</li> </ul>

Module M0977: Construction Logistics and Project Management			
Courses			
Title	Typ	Hrs/wk	CP
Construction Logistics (L1163)	Lecture	1	2
Construction Logistics (L1164)	Recitation Section (small)	1	2
Project Development and Management (L1161)	Lecture	1	1
Project Development and Management (L1162)	Project-/problem-based Learning	1	1
<b>Module Responsible</b>	Prof. Heike Flämig		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	none		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i>	Students can... <ul style="list-style-type: none"> <li>• give definitions of the main terms of construction logistics and project development and management</li> <li>• name advantages and disadvantages of internal or external construction logistics</li> <li>• explain characteristics of products, demand and production of construction objects and their consequences for construction specific supply chains</li> <li>• differentiate constructions logistics from other logistics systems</li> </ul>		
<i>Skills</i>	Students can... <ul style="list-style-type: none"> <li>• carry out project life cycle assessments</li> <li>• apply methods and instruments of construction logistics</li> <li>• apply methods and instruments of project development and management</li> <li>• apply methods and instruments of conflict management</li> <li>• design supply and waste removal concepts for a construction project</li> </ul>		
<b>Personal Competence</b> <i>Social Competence</i>	Students can... <ul style="list-style-type: none"> <li>• hold presentations in and for groups</li> <li>• apply methods of conflict solving skills in group work and case studies</li> </ul>		
<i>Autonomy</i>	Students can... <ul style="list-style-type: none"> <li>• solve problems by holistic, systemic and flow oriented thinking</li> <li>• improve their creativity, negotiation skills, conflict and crises solution skills by applying methods of moderation in case studies</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written elaboration		
<b>Examination duration and scale</b>	Two written papers with presentations		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory International Management and Engineering: Specialisation II. Civil 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		

Course L1163: Construction Logistics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Heike Flämig
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The lecture gives deeper insight how important logistics are as a competitive factor for construction projects and which issues are to be addressed.</p> <p>The following topics are covered:</p> <ul style="list-style-type: none"> <li>• competitive factor logistics</li> <li>• the concept of systems, planning and coordination of logistics</li> <li>• material, equipment and reverse logistics</li> <li>• IT in construction logistics</li> <li>• elements of the planning model of construction logistics and their connections</li> <li>• flow oriented logistics systems for construction projects</li> <li>• logistics concepts for ready to use construction projects (especially procurement and waste removal logistics)</li> <li>• best practice examples (construction logistics Potsdamer Platz, recent case study of the region)</li> </ul> <p>Contents of the lecture are deepened in special exercises.</p>
<b>Literature</b>	<p>Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bd. 15.2. Wuppertal 2000.</p> <p>Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005.</p> <p>Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004.</p> <p>Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter: Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003.</p> <p>Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20)</p>

Course L1164: Construction Logistics	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Heike Flämig
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L1161: Project Development and Management	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Heike Flämig, Dr. Anton Worobei
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Within the lecture, the main aspects of project development and management are taught:</p> <ul style="list-style-type: none"> <li>• Terms and definitions of project management</li> <li>• Advantages and disadvantages of different ways of project handling</li> <li>• organization, information, coordination and documentation</li> <li>• cost and finance management in projects</li> <li>• time- and capacity management in projects</li> <li>• specific methods and instruments for successful team work</li> </ul> <p>Contents of the lecture are deepened in special exercises.</p>
<b>Literature</b>	Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.

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<b>Course L1162: Project Development and Management</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Heike Flämig, Dr. Anton Worobei
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M1133: Port Logistics				
Courses				
Title	Typ	Hrs/wk	CP	
Port Logistics (L0686)	Lecture	2	3	
Port Logistics (L1473)	Recitation Section (small)	2	3	
<b>Module Responsible</b>	Prof. Carlos Jahn			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	none			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	<p>Th</p> <p>After completing the module, students can...</p> <ul style="list-style-type: none"> <li>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;</li> <li>explain and evaluate different types of seaport terminals and their specific characteristics (cargo, transshipment technologies, logistic functional areas);</li> <li>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;</li> <li>identify future developments and trends regarding the planning and control of innovative seaport terminals and discuss them in a problem-oriented manner.</li> </ul>			
<i>Skills</i>	<p>After completing the module, students will be able to...</p> <ul style="list-style-type: none"> <li>recognize functional areas in ports and seaport terminals;</li> <li>define and evaluate suitable operating systems for container terminals;</li> <li>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;</li> <li>reliably estimate which boundary conditions influence common logistics indicators in the static planning of selected terminal types and to what extent.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	<p>After completing the module, students can...</p> <ul style="list-style-type: none"> <li>transfer the acquired knowledge to further questions of port logistics;</li> <li>discuss and successfully organize extensive task packages in small groups;</li> <li>in small groups, document work results in writing in an understandable form and present them to an appropriate extent.</li> </ul>			
<i>Autonomy</i>	<p>After completing the module, the students are able to...</p> <ul style="list-style-type: none"> <li>research and select specialist literature, including standards, guidelines and journal papers, and to develop the contents independently;</li> <li>submit own parts in an extensive written elaboration in small groups in due time and to present them jointly within a fixed time frame.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	15 %	Written elaboration	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 minutes			
<b>Assignment for the Following Curricula</b>	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			

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Course L0686: Port Logistics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>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.</p> <p>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 characteristic layouts and the technical equipment used as well as the ongoing digitization and interaction of the players involved.</p> <p>In addition, renowned guest speakers from science and practice will be regularly invited to discuss some lecture-relevant topics from alternative perspectives.</p> <p>The following contents will be conveyed in the lectures:</p> <ul style="list-style-type: none"> <li>• Instruction of structures and processes in the port</li> <li>• Planning, control, implementation and monitoring of material and information flows in the port</li> <li>• Fundamentals of different terminals, characteristic layouts and the technical equipment used</li> <li>• Handling of current issues in port logistics</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Alderton, Patrick (2013). Port Management and Operations.</li> <li>• Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium.</li> <li>• Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005.</li> <li>• Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen.</li> <li>• Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele.</li> <li>• Jahn, Carlos; Saxe, Sebastian (Hg.). Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag, 2017.</li> <li>• Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft</li> <li>• Lun, Y.H.V. and Lai, K.-H. and Cheng, T.C.E. (2010). Shipping and Logistics Management.</li> <li>• Woitschütze, Claus-Peter (2013). Verkehrsgeografie.</li> </ul>

Course L1473: Port Logistics	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>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.</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Alderton, Patrick (2013). Port Management and Operations.</li> <li>• Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium.</li> <li>• Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. (2005) Berlin Heidelberg: Springer-Verlag.</li> <li>• Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen.</li> <li>• Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele.</li> <li>• Jahn, Carlos; Saxe, Sebastian (Hg.) (2017) Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag.</li> <li>• Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft</li> <li>• Lun, Y.H.V. and Lai, K.-H. and Cheng, T.C.E. (2010). Shipping and Logistics Management.</li> <li>• Woitschütze, Claus-Peter (2013). Verkehrsgeografie.</li> </ul>

Module M1012: Laboratory of Logistics Engineering and Automatisatation			
Courses			
Title	Typ	Hrs/wk	CP
Laboratory Technical Logistics and Automatisatation (L1462)	Seminar	4	6
<b>Module Responsible</b>	Prof. Jochen Kreutzfeldt		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Bachelor degree in logistics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students will acquire the following knowledge:</p> <ol style="list-style-type: none"> <li>1. The students will learn various technical solutions for solving logistical problems using automatisatation in daily practice.</li> <li>2. The students know the necessary steps to implement a selected technical solution to automate logistical processes.</li> <li>3. The students know the approaches and obstacles to implement technical solutions for automating logistical processes.</li> </ol> <p><i>Skills</i> The students will acquire the following skills:</p> <ol style="list-style-type: none"> <li>1. The students are able to select technical solutions of automatisatation for logistical problems of warehousing, conveying, sorting, order picking and identifying and evaluate the implementability of the alternatives.</li> <li>2. The students are able to implement selected solutions of automatisatation in the model scale.</li> <li>3. The students are able to estimate the implementation costs of selected solutions of automatisatation.</li> </ol> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students will acquire the following social skills:</p> <ol style="list-style-type: none"> <li>1. The students are able to develop technical solutions for logistical problems and implement them on a model scale within a group of students.</li> <li>2. The technical solutions from the group can be jointly documented and presented to an audience.</li> <li>3. The students are able to derive new ideas and improvements from the feedback received related to their developed solution proposals.</li> </ol> <p><i>Autonomy</i> The students will acquire the following competencies:</p> <ol style="list-style-type: none"> <li>1. Students are able, under the guidance of supervisors, to develop and implement independently solutions of automatisatation for logistical problems of warehousing, conveying, sorting, order picking and identifying.</li> <li>2. The students are able to evaluate their technical solutions and discuss the pros and cons.</li> </ol>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written elaboration		
<b>Examination duration and scale</b>	Prototype construction in laboratory with documentation (group work)		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory		

<b>Course L1462: Laboratory Technical Logistics and Automatisation</b>	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Jochen Kreuzfeldt
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The aim of the seminar is the practical introduction of students in various technical solutions to logistical problems. Above all, the guided development of own solutions is the core task in the laboratory. The problems and solutions will be drawn from the following logistic topics:</p> <ul style="list-style-type: none"> <li>(1) warehousing</li> <li>(2) conveying</li> <li>(3) sorting</li> <li>(4) order picking</li> <li>(5) identifying</li> </ul> <p>The students develop technical solutions in small groups for selected problems and implement them on a lab scale. The solutions are presented to an audience and advantages and disadvantages are discussed. The recorded feedback is then added to the model solution.</p>
<b>Literature</b>	<p>Dembowski, Klaus (2015): Raspberry Pi - Das technische Handbuch. Konfiguration, Hardware, Applikationserstellung. 2., erw. überarb. Aufl. 2015. Wiesbaden: Springer Vieweg.</p> <p>Follmann, Rüdiger (2014): Das Raspberry Pi Kompendium. 2014. Aufl. Berlin, Heidelberg: Springer Berlin Heidelberg (Xpert.press).</p> <p>Griemert, Rudolf (2015): Fördertechnik. Auswahl und Berechnung von Elementen und Baugruppen. [S.I.]: Morgan Kaufmann.</p> <p>Hompel, Michael ten; Büchter, Hubert; Franzke, Ulrich (2008): Identifikationssysteme und Automatisierung. [Intralogistik]. Berlin, Heidelberg: Springer.</p> <p>Hompel, Michael ten; Beck, Maria; Sadowsky, Volker (2011): Kommissionierung. Materialflusssysteme 2 - Planung und Berechnung der Kommissionierung in der Logistik. Berlin [u.a.]: Springer.</p> <p>Jodin, Dirk; Hompel, Michael ten (2012): Sortier- und Verteilsysteme. Grundlagen, Aufbau, Berechnung und Realisierung. 2. Aufl. Berlin: Springer Berlin.</p> <p>Martin, Heinrich (2014): Transport- und Lagerlogistik. Planung, Struktur, Steuerung und Kosten von Systemen der Intralogistik. 9., vollst. überarb. u. akt. Aufl. 2014. Wiesbaden: Imprint: Springer Vieweg.</p> <p>Purdum, Jack J. (2014): Beginning C for Arduino. Learn C programming for the Arduino. Second edition.: Springer Berlin.</p> <p>McRoberts, Michael (2014): Beginning Arduino. Second edition.: Springer Berlin.</p>

Module M1100: Railways			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Railways (L1466)	Lecture	2	3
Railways (L1468)	Recitation Section (large)	2	3
<b>Module Responsible</b>	Prof. Carsten Gertz		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Introduction to railways		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	Students can...		
<i>Knowledge</i>	<ul style="list-style-type: none"> <li>conceive the entrepreneurial perspective of transport and infrastructure companies</li> <li>estimate intra- and intermodal competition</li> <li>understand regulatory and transport policy determinants</li> <li>reflect megatrends in the transport market</li> <li>understand the key performance indicators for railway transport market</li> </ul>		
<i>Skills</i>	Students can... <ul style="list-style-type: none"> <li>apply traffic Intermodal perspective</li> <li>understand strategic challenges, opportunities and issues of companies</li> <li>recognize the relevance of sustainability and digitization for companies</li> </ul>		
<b>Personal Competence</b>	Students can...		
<i>Social Competence</i>	<ul style="list-style-type: none"> <li>discuss and organize task packages in small groups</li> <li>document and present work results in small groups</li> </ul>		
<i>Autonomy</i>	Students can... <ul style="list-style-type: none"> <li>research and select literature</li> <li>submit their own shares of an extensive written work in small groups and present it collaboratively within a fixed time frame</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written elaboration		
<b>Examination duration and scale</b>	written assignment as groupwork with presentation during the semester		
<b>Assignment for the Following Curricula</b>	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		

Course L1466: Railways	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carsten Gertz, Maximilian Philip Freude
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	

Course L1468: Railways	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carsten Gertz, Maximilian Philip Freude
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M1402: Machine Learning in Logistics				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Digitalization in Traffic and Logistics (L2004)		Lecture	1	2
Basics of Machine Learning (L2003)		Lecture	1	2
Machine Learning in Logistics (L2005)		Recitation Section (small)	2	2
<b>Module Responsible</b>	Prof. Carlos Jahn			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	None			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Students understand specific methods of machine learning. They are able to select appropriate procedures for given data. They can explain the principals of different learning methods. In addition, they can explain the major conceptual differences of learning methods.			
<i>Skills</i>	Students can inspect, describe, and apply selected machine learning techniques to provided data sets. Additionally they can prepare raw data for machine learning algorithms. They are able to evaluate the usability in concrete company-relevant contexts and they know how to derive the requirements and potentials of an effective application, e.g. in relation to controlling or forecasting for the operational planning of companies or other organizations.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are capable of:			
	<ul style="list-style-type: none"> <li>• Discussing and organizing extensive research tasks in small groups</li> <li>• Jointly describing, differentiating between and evaluating problems</li> </ul>			
<i>Autonomy</i>	Students are able:			
	<ul style="list-style-type: none"> <li>• To research and select specialized literature</li> <li>• Read existing code, interpret it and modify it for new tasks</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	15 %	Presentation	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 minutes			
<b>Assignment for the Following Curricula</b>	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			

Course L2004: Digitalization in Traffic and Logistics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>When dealing with large amounts of data (big data), it is no longer possible for humans to spot all relevant data by simply looking at the raw data. In the co logistics, the handling of temporal data and movement data plays a particularly important role. In this course the visualization, the calculation of statistics, application of machine learning algorithms are covered. Students are given various tools for later practical application.</p> <p>The course utilizes the machine learning methods learned in "Basics of Machine Learning". These are used and evaluated in the context of practical application in of traffic and logistics. In addition, various pre-processing steps for raw data are presented and it is discussed, under which conditions these measurements are ap</p> <p>The lecture contents are:</p> <ul style="list-style-type: none"> <li>• The project structure for Machine Learning in science and industry</li> <li>• Use cases for machine learning in logistics</li> <li>• Image recognition in road traffic</li> <li>• Temporal data in traffic</li> <li>• Movement data</li> <li>• Automated anomaly detection</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Aggarwal, Charu C. (2017). Outlier Analysis. Springer International Publishing Switzerland.</li> <li>• Chapman, Peter and Clinton, Janet and Kerber, Randy and Khabaza, Tom and Reinartz, Thomas and Russel H. Shearer, C and Wirth, Robert (2000). DM 1.0 : Step-by-step data mining guide.</li> <li>• Géron, Aurélien (2018). Praxiseinstieg Machine Learning mit Scikit-Learn und TensorFlow: Konzepte, Tools und Techniken für intelligente Systeme. O'Reilly.</li> <li>• Haneke, Uwe and Trahasch, Stephan and Zimmer, Michael and Felden, Carsten (2019). Data Science - Grundlagen, Architekturen und Anwendungen. dpunk</li> <li>• Lenzen, Manuela (2020). Künstliche Intelligenz: Fakten, Chancen, Risiken. C.H. Beck.</li> <li>• VanderPlas, Jake (2017). Data Science mit Python : das Handbuch für den Einsatz von IPython, Jupyter, NumPy, Pandas, Matplotlib, Scikit-Learn. MITP.</li> </ul>

Course L2003: Basics of Machine Learning	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Dozenten des SD E
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Students are able to understand specific procedures of machine learning and to use on real life examples. Students are able to use appropriate procedures for given data.</p> <p>Students are able to explain the differences between instance and model based learning approaches and are able to use specific approaches in machine learning on the base of static and incremental growing data.</p> <p>By the use of uncertainty the students can explain how axioms, parameter or structures can be learned. Additional the students learn to develop different cluster techniques.</p> <p>Planned content:</p> <ul style="list-style-type: none"> <li>• Supervised Learning: <ul style="list-style-type: none"> <li>◦ Regressions</li> <li>◦ Decision trees</li> <li>◦ Bayesian networks</li> <li>◦ K-next neighbors</li> <li>◦ Logistical regressions</li> <li>◦ Neuronal Networks</li> <li>◦ Support Vector Machines</li> <li>◦ Ensemble Learning</li> </ul> </li> <li>• Unsupervised Learning: <ul style="list-style-type: none"> <li>◦ Hierarchical Clustering, K-Mean</li> </ul> </li> </ul>
<b>Literature</b>	<p>John D. Kelleher, Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies (MIT Press)</p> <p>Tom M. Mitchell, Machine Learning</p> <p>Kevin P. Murphy, Machine Learning: A Probabilistic Perspective</p>

# Module Manual M.Sc. "International Management and Engineering"

Course L2005: Machine Learning in Logistics	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Carlos Jahn
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	In the exercise, the skills which the students acquired in the lectures will be applied to real life examples.
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Aggarwal, Charu C. (2017). Outlier Analysis. Springer International Publishing Switzerland.</li> <li>• Chapman, Peter and Clinton, Janet and Kerber, Randy and Khabaza, Tom and Reinartz, Thomas and Russel H. Shearer, C and Wirth, Robert (2000). DM 1.0 : Step-by-step data mining guide.</li> <li>• Géron, Aurélien (2018). Praxiseinstieg Machine Learning mit Scikit-Learn und TensorFlow: Konzepte, Tools und Techniken für intelligente Systeme. O'Reilly.</li> <li>• Haneke, Uwe and Trahasch, Stephan and Zimmer, Michael and Felden, Carsten (2019). Data Science - Grundlagen, Architekturen und Anwendungen. dpunkt.</li> <li>• Kelleher, John D. (2015) Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies. MIT Press.</li> <li>• Mitchell, Tom M. (2005) Machine Learning. McGraw-Hill.</li> <li>• Murphy, Kevin P. (2012) Machine Learning: A Probabilistic Perspective. MIT Press.</li> <li>• VanderPlas, Jake (2017). Data Science mit Python : das Handbuch für den Einsatz von IPython, Jupyter, NumPy, Pandas, Matplotlib, Scikit-Learn. MIT Press.</li> </ul>

Module M0739: Factory Planning & Production Logistics			
Courses			
Title	Typ	Hrs/wk	CP
Factory Planning (L1445)	Lecture	3	3
Production Logistics (L1446)	Lecture	2	3
<b>Module Responsible</b>	Prof. Jochen Kreutzfeldt		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Bachelor degree in logistics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students will acquire the following knowledge:</p> <ol style="list-style-type: none"> <li>1. The students know the latest trends and developments in the planning of factories.</li> <li>2. The students can explain basic procedures of factory planning and are able to deploy these procedures while considering different conditions.</li> <li>3. The students know different methods of factory planning and are able to deal critically with these methods.</li> </ol> <p><i>Skills</i> The students will acquire the following skills:</p> <ol style="list-style-type: none"> <li>1. The students are able to analyze factories and other material flow systems with regard to new development and the need for change of these logistical systems.</li> <li>2. The students are able to plan and redesign factories and other material handling systems.</li> <li>3. The students are able to develop procedures for the implementation of new and revised material flow systems.</li> </ol> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students will acquire the following social skills:</p> <ol style="list-style-type: none"> <li>1. The students are able to develop plans for the development of new and improvement of existing material flow systems within a group.</li> <li>2. The developed planning proposal from the group work can be documented and presented together.</li> <li>3. The students are able to derive suggestions for improvement from the feedback on the planning proposals and can even provide constructive criticism themselves.</li> </ol> <p><i>Autonomy</i> The students will acquire the following independent competencies:</p> <ol style="list-style-type: none"> <li>1. The students can plan and re-design material flow systems using existing planning procedures.</li> <li>2. The students can evaluate independently the strengths and weaknesses of several techniques for factory planning and choose appropriate methods in a given context.</li> <li>3. The students are able to carry out autonomously new plans and transformations of material flow systems.</li> </ol>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L1445: Factory Planning	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Jochen Kreutzfeldt, Philipp Maximilian Braun
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The lecture gives an introduction into the planning of factories and material flows. The students will learn process models and methods to plan new factories and improve existing material flow systems. The course includes three basic topics:</p> <ol style="list-style-type: none"> <li>(1) Analysis of factory and material flow systems</li> <li>(2) Development and re-planning of factory and material flow systems</li> <li>(3) Implementation and realization of factory planning</li> </ol> <p>The students are introduced into several different methods and models per topic. Practical examples and planning exercises deepen the methods and explain the application of factory planning.</p> <p>The special requirements of factory planning in an international context are discussed. Specific requirements of Current trends and issues in the factory planning round off the lecture.</p>
<b>Literature</b>	<p>Bracht, Uwe; Wenzel, Sigrid; Geckler, Dieter (2018): Digitale Fabrik: Methoden und Praxisbeispiele. 2. Aufl.: Springer, Berlin.</p> <p>Helbing, Kurt W. (2010): Handbuch Fabrikprojektierung. Berlin, Heidelberg: Springer Berlin Heidelberg.</p> <p>Lotter, Bruno; Wiendahl, Hans-Peter (2012): Montage in der industriellen Produktion: Optimierte Abläufe, rationelle Automatisierung. 2. Aufl.: Springer, Berlin.</p> <p>Müller, Egon; Engelmann, Jörg; Löffler, Thomas; Jörg, Strauch (2009): Energieeffiziente Fabriken planen und betreiben. Berlin, Heidelberg: Springer Berlin Heidelberg.</p> <p>Schenk, Michael; Müller, Egon; Wirth, Siegfried (2014): Fabrikplanung und Fabrikbetrieb. Methoden für die wandlungsfähige, vernetzte und ressourceneffiziente Fabrik. 2. Aufl. Berlin [u.a.]: Springer Vieweg.</p> <p>Wiendahl, Hans-Peter; Reichardt, Jürgen; Nyhuis, Peter (2014): Handbuch Fabrikplanung: Konzept, Gestaltung und Umsetzung wandlungsfähiger Produktionsstätten. 2. Aufl. Carl Hanser Verlag.</p>

Course L1446: Production Logistics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dipl.-Ing. Arnd Schirrmann
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction: situation, significance and main innovation focuses of logistics in a production company, aspects of procurement, production, distribution and disposal logistics, production and transport networks</li> <li>• Logistics as a production strategy: logistics-oriented method of working in a factory, throughput time, corporate strategy, structured networking, reducing complexity, integrated organization, integrated product and production logistics (IPPL)</li> <li>• Logistics-compatible production and process structuring; logistics-compatible product, material flow, information and organizational structures</li> <li>• Logistics-oriented production control: situation and development tendencies, logistics and cybernetics, market-oriented production planning, control, monitoring, PPS systems and production control, cybernetic production organization and control, production logistics control systems.</li> <li>• Production logistics planning: key performance indicators, developing a production logistics concept, computerized aids to planning production logistics, IPPL functions, economic efficiency of logistics projects</li> <li>• Production logistics controlling: production logistics and controlling, material flow-oriented cost transparency, cost controlling (process cost accounting, costs model in IPPL), process controlling (integrated production system, methods and tools, MEPOT.net method portal)</li> </ul>
<b>Literature</b>	Pawellek, G.: Produktionslogistik: Planung - Steuerung - Controlling. Carl Hanser Verlag 2007

Module M1739: Operational Aspekts in Aviation			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Airline Operations (L1310)	Lecture	3	3
Flight Guidance I (Introduction) (L0848)	Lecture	2	2
Flight Guidance I (Introduction) (L0854)	Recitation Section (large)	1	1
Airport Operations (L1276)	Lecture	3	3
Airport Planning (L1275)	Lecture	2	2
Airport Planning (L1469)	Recitation Section (small)	1	1
Maintenance Repair Overhaul in Aviation (L2683)	Lecture	3	3
Aviation and Environment (L2376)	Lecture	3	3
<b>Module Responsible</b>	Prof. Volker Gollnick		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Air Transportation Systems		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Analysis and description of the interaction between people and aircraft in operation</p> <p><i>Skills</i> Understanding and application of design and calculation methods</p> <p>Understanding of interdisciplinary and integrative interdependencies</p> <p>Evaluation of operational issues in aviation and development of operational solution options</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Working in teams for focused solutions</p> <p>communication, assertiveness, technical persuasion</p> <p><i>Autonomy</i> Organisation of workflows and strategies for solutions</p> <p>structured task analysis and definition of solutions</p>		
<b>Workload in Hours</b>	Depends on choice of courses		
<b>Credit points</b>	6		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory		
	International Management and Engineering: Specialisation II. Logistics: Elective Compulsory		

Course L1310: Airline Operations	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Karl Echtermeyer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction and overview</li> <li>2. Airline business models</li> <li>3. Interdependencies in flight planning (network management, slot management, network structures, aircraft circulation)</li> <li>4. Operative flight preparation (weight &amp; balance, payload/range, etc.)</li> <li>5. fleet policy</li> <li>6. Aircraft assessment and fleet planning</li> <li>7. Airline organisation</li> <li>8. Aircraft maintenance, repair and overhaul</li> </ol>
<b>Literature</b>	<p>Volker Gollnick, Dieter Schmitt: The Air Transport System, Springer Berlin Heidelberg New York, 2014</p> <p>Paul Clark: "Buying the Big Jets", Ashgate 2008</p> <p>Mike Hirst: The Air Transport System, AIAA, 2008</p>

<b>Course L0848: Flight Guidance I (Introduction)</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Introduction and motivation Flight guidance principles (airspace structures, organization of air navigation services, etc.)</p> <p>Cockpit systems and Avionics (cockpit design, cockpit equipment, displays, computers and bus systems)</p> <p>Principles of flight measurement techniques (Measurement of position (geometric methods, distance measurement, direction measurement) Determination of the aircraft attitude (magnetic field- and inertial sensors) Measurement of speed</p> <p>Principles of Navigation</p> <p>Radio navigation</p> <p>Satellite navigation</p> <p>Airspace surveillance (radar systems)</p> <p>Communication systems</p> <p>Integrated Navigation and Guidance Systems</p>
<b>Literature</b>	<p>Rudolf Brockhaus, Robert Luckner, Wolfgang Alles: "Flugregelung", Springer Berlin Heidelberg New York, 2011</p> <p>Holger Flühr: "Avionik und Flugsicherungssysteme", Springer Berlin Heidelberg New York, 2013</p> <p>Volker Gollnick, Dieter Schmitt "Air Transport Systems", Springer Berlin Heidelberg New York, 2016</p> <p>R.P.G. Collinson „Introduction to Avionics“, Springer Berlin Heidelberg New York 2003</p>

<b>Course L0854: Flight Guidance I (Introduction)</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

<b>Course L1276: Airport Operations</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Peter Willems
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	FA-F Flight Operations Flight Operations - Production Infrastructures Operations Planning Master plan Airport capacity Ground handling Terminal operations
<b>Literature</b>	Richard de Neufville, Amedeo Odoni: Airport Systems, McGraw Hill, 2003

Course L1275: Airport Planning	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Ulrich Hüp
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction, definitions, overviewg</li> <li>2. Runway systems</li> <li>3. Air space strucutres around airports</li> <li>4. Airfield lightings, marking and information</li> <li>5. Airfield and terminal configuration</li> </ol>
<b>Literature</b>	<p>N. Ashford, Martin Stanton, Clifton Moore: Airport Operations, John Wiley &amp; Sons, 1991</p> <p>Richard de Neufville, Amedeo Odoni: Airport Systems, Aviation Week Books, MacGraw Hill, 2003</p>

Course L1469: Airport Planning	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Ulrich Hüp
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L2683: Maintenance Repair Overhaul in Aviation	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	

Course L2376: Aviation and Environment	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Florian Linke
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The lecture provides the necessary basics and methods for understanding the interactions between air traffic and the environment, both in terms of the effects of weather / climate on flying and with regard to the effects of air traffic on pollutant emissions, noise and climate.</p> <p>The following topics are covered:</p> <ul style="list-style-type: none"> <li>• Atmospheric physics / chemistry <ul style="list-style-type: none"> <li>◦ Structure and statics</li> <li>◦ Dynamics (water cycle, formation of weather events, high and low pressure areas, wind, gusts and turbulence)</li> <li>◦ Cloud physics (thermodynamics, contrails)</li> <li>◦ Radiation physics (energy balance, greenhouse effect)</li> <li>◦ Photochemistry (ozone chemistry)</li> </ul> </li> <li>• Impact of weather on flying <ul style="list-style-type: none"> <li>◦ Atmospheric influences on flight performance</li> <li>◦ Flight planning</li> <li>◦ Disturbances due to weather, e.g. thunderstorms, winter weather (icing), clear air turbulence, visibility</li> <li>◦ Effects of climate change and adaptation</li> </ul> </li> <li>• Effects of air traffic on the environment and climate <ul style="list-style-type: none"> <li>◦ Aviation pollutant emissions</li> <li>◦ Effect of emissions on concentrations in the atmosphere</li> <li>◦ Climate metrics / models and background scenarios</li> <li>◦ Emissions inventories</li> </ul> </li> <li>• Mitigation measures <ul style="list-style-type: none"> <li>◦ Technological measures, e.g. climate-optimized aircraft design</li> <li>◦ Alternative fuels</li> <li>◦ Operational measures, e.g. climate-optimized flight planning</li> <li>◦ Environmental policy measures, e.g. EU-ETS, CORSIA</li> <li>◦ Potentials and comparison, concept of eco-efficiency</li> </ul> </li> <li>• Local environmental impacts <ul style="list-style-type: none"> <li>◦ Local air quality (particulate matter, other emissions near the ground)</li> <li>◦ Noise (noise sources, noise metrics, noise impact, measurement, certification, psychoacoustics, noise mitigation)</li> <li>◦ Health effects</li> </ul> </li> <li>• Aspects of sustainability <ul style="list-style-type: none"> <li>◦ Other aspects, including life cycle emissions, disposal/recycling</li> <li>◦ Relation to global goals, e.g. United Nations goals for sustainable development, Paris climate agreement</li> </ul> </li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Ruijgrok, G.: Elements of Aircraft Pollution, Delft University Press, 2005</li> <li>• Friedrich, R., Reis, S.: Emissions of Air Pollutants, Springer 2004</li> <li>• Janic, M.: The Sustainability of Air Transportation, Ashgate, 2007</li> <li>• Schumann, U. (ed.): Atmospheric Physics: Background - Methods - Trends, Springer, Berlin, Heidelberg, 2012</li> <li>• Spiridonov, V., Curic, M.: Fundamentals of Meteorology, Springer, 2021</li> <li>• Kaltschmitt, M., Neuling, U.: Biokerosene - Status and Prospects, Springer, 2018</li> <li>• Roedel, W., Wagner, T.: Physik unserer Umwelt: Die Atmosphäre, Springer, 2017</li> <li>• W. Bräunling: Flugzeugtriebwerke. Springer-Verlag Berlin, Deutschland, 2009</li> <li>• G. Brüning, X. Hafer, G. Sachs: Flugleistungen, Springer, 1993</li> </ul>

Module M1406: Transport Aircraft Operations			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Airline Operations (L1310)		Lecture	3
Airport Operations (L1276)		Lecture	3
<b>Module Responsible</b>	Prof. Volker Gollnick		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Lecture Air Transportation Systems Basic Knowledge in Aviation, logistics, mobility		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Principles of Air Traffic Management and technologies Design and modelling of traffic flows, avionics and sensor systems, cockpit design Principles of Airline organization and business Fleet setup, fleet operation, aircraft selection, maintenance, repair overhaul technologies and business		
<i>Skills</i>	<ul style="list-style-type: none"> <li>• Understanding and application of different interdisciplinary interdependencies</li> <li>• Integration and assessment of new technologies in the air transportation system</li> <li>• Modelling and assessment of flight guidance systems</li> <li>• Airline fleet planning and fleet operation</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	<ul style="list-style-type: none"> <li>• Working in interdisciplinary teams</li> <li>• Communication</li> </ul>		
<i>Autonomy</i>	Organization of workflows and -strategies		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory		

Course L1310: Airline Operations	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Karl Echtermeyer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction and overview</li> <li>2. Airline business models</li> <li>3. Interdependencies in flight planning (network management, slot management, network structures, aircraft circulation)</li> <li>4. Operative flight preparation (weight &amp; balance, payload/range, etc.)</li> <li>5. fleet policy</li> <li>6. Aircraft assessment and fleet planning</li> <li>7. Airline organisation</li> <li>8. Aircraft maintenance, repair and overhaul</li> </ol>
<b>Literature</b>	Volker Gollnick, Dieter Schmitt: The Air Transport System, Springer Berlin Heidelberg New York, 2014 Paul Clark: "Buying the Big Jets", Ashgate 2008 Mike Hirst: The Air Transport System, AIAA, 2008

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Course L1276: Airport Operations	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Peter Willems
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	FA-F Flight Operations Flight Operations - Production Infrastructures Operations Planning Master plan Airport capacity Ground handling Terminal operations
<b>Literature</b>	Richard de Neufville, Amedeo Odoni: Airport Systems, McGraw Hill, 2003

Module M1813: Agile learning with agile methods				
Courses				
Title	Typ	Hrs/wk	CP	
Agile Data Science for industrial Engineers (L3009)	Project-/problem-based Learning	3	6	
<b>Module Responsible</b>	Prof. Kathrin Fischer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Scientific Writing			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know: <ul style="list-style-type: none"> <li>• Basic principles of agile work</li> <li>• Roles within agile project management based on Scrum</li> <li>• Structure and workflows of agile project groups</li> <li>• Basic functions/classes/methods of data science in python</li> <li>• Selected libraries of data science in Python</li> </ul>			
<i>Skills</i>	The students are able to: <ul style="list-style-type: none"> <li>• Plan and carry out a project based on the Scrum philosophy, in detail: <ul style="list-style-type: none"> <li>◦ Define and allocate roles in Scrum</li> <li>◦ Plan Scrum sprints based on self-defined work packages (planning)</li> <li>◦ Carry out Scrum sprints</li> <li>◦ Complete, analyse and evaluate Scrum sprints (review and retrospective)</li> <li>◦ Present project results</li> </ul> </li> <li>• Use established tools of collaborative work</li> <li>• Writing simple scientific scripts for data science in Python collaboratively</li> <li>• Record the methods and results</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to: <ul style="list-style-type: none"> <li>• Work in heterogenic project groups and accept their defined roles based on the scrum philosophy</li> <li>• Commit to group intern time management necessities</li> <li>• Manage scope adjustments under time pressure</li> <li>• Realize and judge the importance of individual commitments for collaborative work</li> <li>• Communicate with stakeholders of their group project</li> </ul>			
<i>Autonomy</i>	The students are able to: <ul style="list-style-type: none"> <li>• Evaluate work packages regarding their practicability and commit to working on these individually</li> <li>• Evaluate their own skills regarding their contribution to a given project</li> <li>• Harmonize their own time management to the group intern time management</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Group discussion	
<b>Examination</b>	Written elaboration			
<b>Examination duration and scale</b>	Approx. 5 - 10 pages per person			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			

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<b>Course L3009: Agile Data Science for industrial Engineers</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Within this course, the fundamentals of Python for Data Science are taught and applied on a collaborative level.</p> <p>The course starts with an introduction to Python which is held in workshop format, and an introduction to collaborative work and agile project management.</p> <p>During this course different projects will be carried out in project groups, following the scrum philosophy.</p> <p>The course is dedicated to programming beginners, so no prior knowledge of Python is required. However, also students with programming experience are welcome to participate.</p> <p>For the exam, teams are required to write a report on the group projects and their results.</p>
<b>Literature</b>	Schwaber, K. & Sutherland, J. (2020): The Scrum Guide. Online Ressource

**Specialization II. Aviation Systems**

**Module M1156: Systems Engineering**

**Courses**

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

<b>Module Responsible</b>	Prof. Ralf God
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<b>Admission Requirements</b>	None
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<b>Recommended Previous Knowledge</b>	<p>Basic knowledge in:</p> <ul style="list-style-type: none"> <li>• Mathematics</li> <li>• Mechanics</li> <li>• Thermodynamics</li> <li>• Electrical Engineering</li> <li>• Control Systems</li> </ul> <p>Previous knowledge in:</p> <ul style="list-style-type: none"> <li>• Aircraft Cabin Systems</li> </ul>
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<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
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<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• understand systems engineering process models, methods and tools for the development of complex Systems</li> <li>• describe innovation processes and the need for technology Management</li> <li>• explain the aircraft development process and the process of type certification for aircraft</li> <li>• explain the system development process, including requirements for systems reliability</li> <li>• identify environmental conditions and test procedures for airborne Equipment</li> <li>• value the methodology of requirements-based engineering (RBE) and model-based requirements engineering (MBRE)</li> </ul> <p><i>Skills</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• plan the process for the development of complex Systems</li> <li>• organize the development phases and development Tasks</li> <li>• assign required business activities and technical Tasks</li> <li>• apply systems engineering methods and tools</li> </ul>
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• understand their responsibilities within a development team and integrate themselves with their role in the overall process</li> </ul> <p><i>Autonomy</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• interact and communicate in a development team which has distributed tasks</li> </ul>

<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
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<b>Credit points</b>	6
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<b>Course achievement</b>	None
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<b>Examination</b>	Written exam
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<b>Examination duration and scale</b>	120 Minutes
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<b>Assignment for the Following Curricula</b>	<p>Aircraft Systems Engineering: Core Qualification: Compulsory</p> <p>International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory</p> <p>Mechatronics: Specialisation System Design: Elective Compulsory</p> <p>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory</p>
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# Module Manual M.Sc. "International Management and Engineering"

Course L1547: Systems Engineering	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Ralf God
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The objective of the lecture with the corresponding exercise is to accomplish the prerequisites for the development and integration of complex systems using the example of commercial aircraft and cabin systems. Competences in the systems engineering process, tools and methods is to be achieved. Regulations, guidelines and certification issues will be known.</p> <p>Key aspects of the course are processes for innovation and technology management, system design, system integration and certification as well as tools and methods for systems engineering:</p> <ul style="list-style-type: none"> <li>• Innovation processes</li> <li>• IP-protection</li> <li>• Technology management</li> <li>• Systems engineering</li> <li>• Aircraft program</li> <li>• Certification issues</li> <li>• Systems development</li> <li>• Safety objectives and fault tolerance</li> <li>• Environmental and operating conditions</li> <li>• Tools for systems engineering</li> <li>• Requirements-based engineering (RBE)</li> <li>• Model-based requirements engineering (MBRE)</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>- Skript zur Vorlesung</li> <li>- diverse Normen und Richtlinien (EASA, FAA, RTCA, SAE)</li> <li>- Hauschildt, J., Salomo, S.: Innovationsmanagement. Vahlen, 5. Auflage, 2010</li> <li>- NASA Systems Engineering Handbook, National Aeronautics and Space Administration, 2007</li> <li>- Hinsch, M.: Industrielles Luftfahrtmanagement: Technik und Organisation luftfahrttechnischer Betriebe. Springer, 2010</li> <li>- De Florio, P.: Airworthiness: An Introduction to Aircraft Certification. Elsevier Ltd., 2010</li> <li>- Pohl, K.: Requirements Engineering. Grundlagen, Prinzipien, Techniken. 2. korrigierte Auflage, dpunkt.Verlag, 2008</li> </ul>

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

Module M0805: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics )			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics ) (L0516)		Lecture	2
Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics ) (L0518)		Recitation Section (large)	2
<b>CP</b>			3
<b>Module Responsible</b>	Prof. Otto von Estorff		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students possess an in-depth knowledge in acoustics regarding acoustic waves, noise protection, and psycho acoustics and are able to give an overview of the corresponding theoretical and methodical basis.		
<i>Skills</i>	The students are capable to handle engineering problems in acoustics by theory-based application of the demanding methodologies and measurement procedures treated within the module.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students can work in small groups on specific problems to arrive at joint solutions.		
<i>Autonomy</i>	The students are able to independently solve challenging acoustical problems in the areas treated within the module. Possible conflicting issues and limitations can be identified and the results are critically scrutinized.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L0516: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics )	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Otto von Estorff
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	- Introduction and Motivation - Acoustic quantities - Acoustic waves - Sound sources, sound radiation - Sound energy and intensity - Sound propagation - Signal processing - Psycho acoustics - Noise - Measurements in acoustics
<b>Literature</b>	Cremer, L.; Heckl, M. (1996): Körperschall. Springer Verlag, Berlin Veit, I. (1988): Technische Akustik. Vogel-Buchverlag, Würzburg Veit, I. (1988): Flüssigkeitsschall. Vogel-Buchverlag, Würzburg

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

Module M0721: Air Conditioning			
Courses			
Title	Typ	Hrs/wk	CP
Air Conditioning (L0594)	Lecture	3	5
Air Conditioning (L0595)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Dr. Arne Speerforck		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students know the different kinds of air conditioning systems for buildings and mobile applications and how these systems are controlled. They are familiar with the change of state of humid air and are able to draw the state changes in a $h_1+x,x$ -diagram. They are able to calculate the minimum airflow needed for hygienic conditions in rooms and can choose suitable filters. They know the basic flow pattern in rooms and are able to calculate the air velocity in rooms with the help of simple methods. They know the principles to calculate an air duct network. They know the different possibilities to produce cold and are able to draw these processes into suitable thermodynamic diagrams. They know the criteria for the assessment of refrigerants.		
<i>Skills</i>	Students are able to configure air condition systems for buildings and mobile applications. They are able to calculate an air duct network and have the ability to perform simple planning tasks, regarding natural heat sources and heat sinks. They can transfer research knowledge into practice. They are able to perform scientific work in the field of air conditioning.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to discuss in small groups and develop an approach.		
<i>Autonomy</i>	Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	60 min		
<b>Assignment for the Following Curricula</b>	Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory		

Course L0594: Air Conditioning	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	5
<b>Workload in Hours</b>	Independent Study Time 108, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Dr. Arne Speerforck, Prof. Gerhard Schmitz
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>1. Overview</p> <p>1.1 Kinds of air conditioning systems</p> <p>1.2 Ventilating</p> <p>1.3 Function of an air condition system</p> <p>2. Thermodynamic processes</p> <p>2.1 Psychrometric chart</p> <p>2.2 Mixer preheater, heater</p> <p>2.3 Cooler</p> <p>2.4 Humidifier</p> <p>2.5 Air conditioning process in a Psychrometric chart</p> <p>2.6 Desiccant assisted air conditioning</p> <p>3. Calculation of heating and cooling loads</p> <p>3.1 Heating loads</p> <p>3.2 Cooling loads</p> <p>3.3 Calculation of inner cooling load</p> <p>3.4 Calculation of outer cooling load</p> <p>4. Ventilating systems</p> <p>4.1 Fresh air demand</p> <p>4.2 Air flow in rooms</p> <p>4.3 Calculation of duct systems</p> <p>4.4 Fans</p> <p>4.5 Filters</p> <p>5. Refrigeration systems</p> <p>5.1. compression chillers</p> <p>5.2 Absorption chillers</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Schmitz, G.: Klimaanlage, Skript zur Vorlesung</li> <li>• VDI Wärmeatlas, 11. Auflage, Springer Verlag, Düsseldorf 2013</li> <li>• Herwig, H.; Moschallski, A.: Wärmeübertragung, Vieweg+Teubner Verlag, Wiesbaden 2009</li> <li>• Recknagel, H.; Sprenger, E.; Schrammek, E.-R.: Taschenbuch für Heizung- und Klimatechnik 2013/2014, 76. Auflage, Deutscher Industrieverlag, 2013</li> </ul>

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

Module M1690: Aircraft Design II (Special Air Vehicle Design)			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV) (L0844)		Lecture	3
Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV) (L0847)		Recitation Section (large)	2
<b>Module Responsible</b>	Prof. Volker Gollnick		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Aircraft Design I (Design of Transport Aircraft) Air Transportation Systems		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <p>Understanding of various flight systems and its special characteristics (supersonic aircraft, rotorcraft, high performance aircraft, unmanned air systems)</p> <p>Understanding of pro's and con's and physical characteristics of different air systems</p> <p>Understanding of special mission requirements and its impact on systems definition and conceptual design</p> <p>Intensified knowledge of performance design on various air systems</p> <p><i>Skills</i></p> <p>Understanding and application of design and calculation methods</p> <p>Understanding of interdisciplinary and integrative interdependencies</p> <p>mission oriented technical definition of air systems</p> <p>special conceptual calculation methods for special equipment characteristics</p> <p>assessment of different design solutions</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>Working in teams for focused solutions</p> <p>communication, assertiveness, technical persuasion</p> <p><i>Autonomy</i></p> <p>Organisation of workflows and strategies for solutions</p> <p>structured task analysis and definition of solutions</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 min		
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L0844: Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Bernd Liebhardt, Jens Thöben
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Design of supersonic civil aircraft</li> <li>2. Principles of high performance and special operations aircraft design</li> <li>3. Principles of Rotorcraft Design</li> <li>4. Principles of Unmanned Air Systems design, air taxis, electric aircraft</li> </ol>
<b>Literature</b>	Gareth Padfield: Helicopter Flight Dynamics, Butterworth Ltd. Raymond Prouty: Helicopter Performance Stability and Control, Krieger Publ. Klaus Hünecke: Das Kampfflugzeug von Heute, Motorbuch Verlag Jay Gundelach: Designing Unmanned Aircraft Systems - Configurative Approach, AIAA

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<b>Course L0847: Aircraft Design II (Conceptual Design of Rotorcraft, special operations aircraft, UAV)</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Bernd Liebhardt, Jens Thöben
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0764: Flight Control Systems			
Courses			
Title	Typ	Hrs/wk	CP
Flight Control Systems (L0736)	Lecture	3	4
Flight Control Systems (L0740)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Frank Thielecke		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	basic knowledge of: <ul style="list-style-type: none"> <li>• mathematics</li> <li>• mechanics</li> <li>• thermo dynamics</li> <li>• electronics</li> <li>• fluid technology</li> <li>• control technology</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to...</p> <ul style="list-style-type: none"> <li>• describe the structure of primary flight control systems as well as actuation-, avionic-, high lift systems in general along with corresponding properties and applications.</li> <li>• explain different configurations and designs and their origins</li> <li>•</li> </ul> <p><i>Skills</i> Students are able to...</p> <ul style="list-style-type: none"> <li>• size primary flight control actuation systems</li> <li>• perform a controller design process for the flight control actuators</li> <li>• design high-lift kinematics</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• Develop joint solutions in mixed teams</li> </ul> <p><i>Autonomy</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• derive requirements and perform appropriate yet simplified design processes for aircraft systems from complex issues and circumstances in a self-reliant manner</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	165 Minutes		
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L0736: Flight Control Systems	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Frank Thielecke
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems)</li> <li>• Flight Control Systems (control surfaces, hinge moments; requirements of stability and controllability, actuation power; principles of reversible and irreversible flight control systems; servo actuation systems)</li> <li>• Landing Gear Systems (Configurations and geometries; analysis of landing gear systems with respect to damper dynamics, dynamics of the breaking aircraft and power consumption; design and analysis of breaking systems with respect to energy and heat; anti-skid systems)</li> <li>• Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank)</li> <li>• De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Moir, Seabridge: Aircraft Systems</li> <li>• Torenbek: Synthesis of Subsonic Airplane Design</li> <li>• Curry: Aircraft Landing Gear Design: Principles and Practices</li> </ul>

Course L0740: Flight Control Systems	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Frank Thielecke
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0763: Aircraft Energy Systems			
Courses			
Title	Typ	Hrs/wk	CP
Aircraft Energy Systems (L0735)	Lecture	3	4
Aircraft Energy Systems (L0739)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Frank Thielecke		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge in: <ul style="list-style-type: none"> <li>• Mathematics</li> <li>• Mechanics</li> <li>• Thermodynamics</li> <li>• Electrical Engineering</li> <li>• Fluid mechanics</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• Assess challenges during the design of aircraft energy systems</li> <li>• Describe essential components and design points of hydraulic and electrical supply systems</li> <li>• Give an overview of the functionality of air conditioning systems</li> <li>• Describe different system concepts for de-icing</li> <li>• Identify constraints for the electrification of aircraft systems, and evaluate possible concepts and limitations</li> <li>• Describe architectures for fuel supply systems and illustrate design examples</li> <li>• Explain possible approaches for the integration of fuel cell systems and evaluate zero-emission concepts</li> </ul> <p><i>Skills</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• Design hydraulic and electric supply systems of aircrafts</li> <li>• Analyze the thermodynamic behavior of air conditioning systems</li> <li>• Design ice protection systems</li> <li>• Apply possible electrification concepts to existing aircraft systems</li> <li>• Design fuel supply systems</li> <li>• Perform the design of a fuel cell system</li> </ul>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• Perform system design in groups and present and discuss results</li> <li>• Present systems engineering problems and discuss solutions with experts</li> </ul> <p><i>Autonomy</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• Reflect on the content of lectures autonomously</li> <li>• Apply methods learned in the course of exercises to more advanced problems</li> <li>• Identify complex system dependencies autonomously and abstract simplified models and design processes</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	165 Minutes		
<b>Assignment for the Following Curricula</b>	Energy Systems: Specialisation Energy Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L0735: Aircraft Energy Systems	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Frank Thielecke
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>Hydraulic Energy Systems (Fluids; pressure loss in valves and pipes; components of hydraulic systems like pumps, valves, etc.; pressure/flow characteristics; actuators; tanks; power and heat balances; emergency power)</li> <li>Electric Energy Systems (Generators; constant-speed-drives; DC and AC converters; electrical power distribution; bus systems; monitoring; load analysis)</li> <li>High Lift Systems (Principles; investigation of loads and system actuation power; principles and sizing of actuation and positioning systems; safety requirements and devices)</li> <li>Environmental Control Systems (Thermodynamic analysis; expansion and compression cooling systems; control strategies; cabin pressure control systems)</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>Moir, Seabridge: Aircraft Systems</li> <li>Green: Aircraft Hydraulic Systems</li> <li>Torenbek: Synthesis of Subsonic Airplane Design</li> <li>SAE1991: ARP; Air Conditioning Systems for Subsonic Airplanes</li> </ul>

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

Module M0771: Flight Physics			
Courses			
Title	Typ	Hrs/wk	CP
Aerodynamics and Flight Mechanics I (L0727)	Lecture	3	3
Flight Mechanics II (L0730)	Lecture	2	2
Flight Mechanics II (L0731)	Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Frank Thielecke		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge in: <ul style="list-style-type: none"> <li>• Mathematics</li> <li>• Mechanics</li> <li>• Thermodynamics</li> <li>• Aviation</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to...</p> <ul style="list-style-type: none"> <li>• Describe the fundamental equations of aerodynamics for compressible, incompressible and frictional flow</li> <li>• Explain the principles of wings and profiles</li> <li>• Explain the aircraft equations of motion</li> <li>• Evaluate aircraft performance and stability</li> <li>• Describe the dynamics of the longitudinal and lateral motion</li> <li>• Describe methods of flight simulation and airborne measurement technology</li> </ul> <p><i>Skills</i> Students are able to...</p> <ul style="list-style-type: none"> <li>• Perform flight mechanic simulations</li> <li>• Derive flight mechanic relations from virtual and real flight test data</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• Perform simulations in groups and discuss results</li> <li>• Evaluate flight test data in groups, discuss and present the results</li> </ul> <p><i>Autonomy</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• Process teaching content independently</li> <li>• Prepare, work out and process simulation models independently</li> <li>• Apply teaching content on virtual and real flight test data</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 Minutes (WS) + 90 Minutes (SS)		
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L0727: Aerodynamics and Flight Mechanics I	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Frank Thielecke, Dr. Ralf Heinrich
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Aerodynamics (fundamental equations of aerodynamics; compressible and incompressible flows; airfoils and wings; viscous flows)</li> <li>• Flight Mechanics (Equations of motion; flight performance; control surfaces; derivatives; lateral stability and control; trim conditions; flight maneuvers)</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II</li> <li>• Etkin, B.: Dynamics of Atmospheric Flight</li> <li>• Sachs/Hafer: Flugmechanik</li> <li>• Brockhaus: Flugregelung</li> <li>• J.D. Anderson: Introduction to flight</li> </ul>

Course L0730: Flight Mechanics II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Frank Thielecke
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• stationary asymmetric flight</li> <li>• dynamics of lateral movement</li> <li>• methods of flight simulation</li> <li>• experimental methods of flight mechanics</li> <li>• model validation using system identification</li> <li>• wind tunnel techniques</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II</li> <li>• Etkin, B.: Dynamics of Atmospheric Flight</li> <li>• Sachs/Hafer: Flugmechanik</li> <li>• Brockhaus: Flugregelung</li> <li>• J.D. Anderson: Introduction to flight</li> </ul>

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

Module M0812: Aircraft Design I (Civil Aircraft Design)				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Aircraft Design I (Design of Transport Aircraft) (L0820)		Lecture	3	3
Aircraft Design I (Design of Transport Aircraft) (L0834)		Recitation Section (large)	2	3
<b>Module Responsible</b>	Prof. Volker Gollnick			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Bachelor Mech. Eng.</li> <li>• Bachelor Traffic Systems</li> <li>• Vordiplom Mech. Eng.</li> <li>• Module Air Transport Systems</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <ol style="list-style-type: none"> <li>1. Principle understanding of integrated and civil aircraft design</li> <li>2. Understanding of the interactions and contributions of the various disciplines</li> <li>3. Impact of the relevant design parameter on the civil aircraft design</li> <li>4. Introduction of the principle design methods</li> </ol> <p><i>Skills</i></p> <p>Understanding and application of design and calculation methods</p> <p>Understanding of interdisciplinary and integrative interdependencies</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>Working in interdisciplinary teams</p> <p>Communication</p> <p><i>Autonomy</i></p> <p>Organization of workflows and -strategies</p>			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Attestation	Durchführung einer Konzeptauslegung für ein Verkehrsflugzeug
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	180 min			
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L0820: Aircraft Design I (Design of Transport Aircraft)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Volker Gollnick, Jens Thöben
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	Introduction into the aircraft design process <ol style="list-style-type: none"> <li>1. Introduction/process of aircraft design/various aircraft configurations</li> <li>2. Requirements and design objectives, main design parameter (u.a. payload-range-diagramme)</li> <li>3. Statistical methods in overall aircraft design/data base methods</li> <li>4. Cabin design (fuselage sizing, cabin interior, loading systems)</li> <li>5. Principles of aerodynamic aircraft design (polar, geometry, 2D/3D aerodynamics)</li> <li>6. Wing Design</li> <li>7. Tail wings and landing gear</li> <li>8. Principles of engine design and integration</li> <li>9. Flight performance in cruise</li> <li>10. Take off and landing field length</li> <li>11. Loads and V-n-diagramme</li> <li>12. Operating cost calculation</li> </ol>
<b>Literature</b>	J. Roskam: "Airplane Design" D.P. Raymer: "Aircraft Design - A Conceptual Approach" J.P. Fielding: "Introduction to Aircraft Design" Jenkinson, Simpkin, Rhoads: "Civil Jet Aircraft Design"

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<b>Course L0834: Aircraft Design I (Design of Transport Aircraft)</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Volker Gollnick, Jens Thöben
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M1155: Aircraft Cabin Systems			
Courses			
Title	Typ	Hrs/wk	CP
Aircraft Cabin Systems (L1545)	Lecture	3	4
Aircraft Cabin Systems (L1546)	Recitation Section (large)	1	2
<b>Module Responsible</b>	Prof. Ralf God		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge in: <ul style="list-style-type: none"> <li>• Mathematics</li> <li>• Mechanics</li> <li>• Thermodynamics</li> <li>• Electrical Engineering</li> <li>• Control Systems</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• describe cabin operations, equipment in the cabin and cabin Systems</li> <li>• explain the functional and non-functional requirements for cabin Systems</li> <li>• elucidate the necessity of cabin operating systems and emergency Systems</li> <li>• assess the challenges human factors integration in a cabin environment</li> </ul> <p><i>Skills</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• design a cabin layout for a given business model of an Airline</li> <li>• design cabin systems for safe operations</li> <li>• design emergency systems for safe man-machine interaction</li> <li>• solve comfort needs and entertainment requirements in the cabin</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• comprehend existing system solutions and explain them on the basis of existing requirements</li> <li>• discuss with experts in technical language</li> <li>• explain system functions</li> <li>• classify the criticality of functions</li> <li>• describe systems as is</li> </ul> <p><i>Autonomy</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• independently reflect on lecture content and expert presentations</li> <li>• independently develop more in-depth content</li> <li>• recognize further areas of knowledge</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 Minutes		
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L1545: Aircraft Cabin Systems	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Ralf God
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge about aircraft cabin systems and cabin operations. A basic understanding of technological and systems engineering effort to maintain an artificial but comfortable and safe travel and working environment at cruising altitude is to be achieved.</p> <p>The course provides a comprehensive overview of current technology and cabin systems in modern passenger aircraft. The Fulfillment of requirements for the cabin as the central system of work are covered on the basis of the topics comfort, ergonomics, human factors, operational processes, maintenance and energy supply:</p> <ul style="list-style-type: none"> <li>• Materials used in the cabin</li> <li>• Ergonomics and human factors</li> <li>• Cabin interior and non-electrical systems</li> <li>• Cabin electrical systems and lights</li> <li>• Cabin electronics, communication-, information- and IFE-systems</li> <li>• Cabin and passenger process chains</li> <li>• RFID Aircraft Parts Marking</li> <li>• Energy sources and energy conversion</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>- Skript zur Vorlesung</li> <li>- Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999</li> <li>- Rossow, C.-C., Wolf, K., Horst, P. (Hrsg.): Handbuch der Luftfahrzeugtechnik. Carl Hanser Verlag, 2014</li> <li>- Moir, I., Seabridge, A.: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Wiley 2008</li> <li>- Davies, M.: The standard handbook for aeronautical and astronautical engineers. McGraw-Hill, 2003</li> <li>- Kompendium der Flugmedizin. Verbesserte und ergänzte Neuauflage, Nachdruck April 2006. Fürstfeldbruck, 2006</li> <li>- Campbell, F.C.: Manufacturing Technology for Aerospace Structural Materials. Elsevier Ltd., 2006</li> </ul>

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

Module M1193: Cabin Systems Engineering			
Courses			
Title	Typ	Hrs/wk	CP
Computer and communication technology in cabin electronics and avionics (L1557)	Lecture	2	2
Computer and communication technology in cabin electronics and avionics (L1558)	Recitation Section (small)	1	1
Model-Based Systems Engineering (MBSE) with SysML/UML (L1551)	Project-/problem-based Learning	3	3
<b>Module Responsible</b>	Prof. Ralf God		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge in: <ul style="list-style-type: none"> <li>• Mathematics</li> <li>• Mechanics</li> <li>• Thermodynamics</li> <li>• Electrical Engineering</li> <li>• Control Systems</li> </ul> Previous knowledge in: <ul style="list-style-type: none"> <li>• Systems Engineering</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• describe the structure and operation of computer architectures</li> <li>• explain the structure and operation of digital communication Networks</li> <li>• explain architectures of cabin electronics, integrated modular avionics (IMA) and Aircraft Data Communication Network (ADCN)</li> <li>• understand the approach of Model-Based Systems Engineering (MBSE) in the design of hardware and software-based cabin systems</li> </ul> <p><i>Skills</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• understand, operate and maintain a Minicomputer</li> <li>• build up a network communication and communicate with other network participants</li> <li>• connect a minicomputer with a cabin management system (A380 CIDS) and communicate over a AFDX®-Network</li> <li>• model system functions by means of formal languages SysML/UML and generate software code from the models</li> <li>• execute software code on a minicomputer</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• form teams of two or small groups for the practical work</li> <li>• work out partial results themselves and combine them with others to form an overall solution</li> <li>• represent and contribute their own solution</li> <li>• take over the guidance of the team</li> <li>• contribute in the team</li> </ul> <p><i>Autonomy</i> Students are able to:</p> <ul style="list-style-type: none"> <li>• organize and plan their practical tasks</li> <li>• further develop their own skills</li> <li>• take their own initiative</li> <li>• explore their own new ways of solving problems</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 minutes		
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L1557: Computer and communication technology in cabin electronics and avionics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Ralf God
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.</p> <p>The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:</p> <ul style="list-style-type: none"> <li>• History of computer and network technology</li> <li>• Layer model in computer technology</li> <li>• Computer architectures (PC, IPC, Embedded Systems)</li> <li>• BIOS, UEFI and operating system (OS)</li> <li>• Programming languages (machine code and high-level languages)</li> <li>• Applications and Application Programming Interfaces</li> <li>• External interfaces (serial, USB, Ethernet)</li> <li>• Layer model in network technology</li> <li>• Network topologies</li> <li>• Network components</li> <li>• Bus access procedures</li> <li>• Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN)</li> <li>• Cabin electronics and cabin networks</li> </ul>
<b>Literature</b>	<p>- Skript zur Vorlesung</p> <p>- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003</p> <p>- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004</p> <p>- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006</p>

Course L1558: Computer and communication technology in cabin electronics and avionics	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Ralf God
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.</p> <p>The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:</p> <ul style="list-style-type: none"> <li>• History of computer and network technology</li> <li>• Layer model in computer technology</li> <li>• Computer architectures (PC, IPC, Embedded Systems)</li> <li>• BIOS, UEFI and operating system (OS)</li> <li>• Programming languages (machine code and high-level languages)</li> <li>• Applications and Application Programming Interfaces</li> <li>• External interfaces (serial, USB, Ethernet)</li> <li>• Layer model in network technology</li> <li>• Network topologies</li> <li>• Network components</li> <li>• Bus access procedures</li> <li>• Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN)</li> <li>• Cabin electronics and cabin networks</li> </ul>
<b>Literature</b>	<p>- Skript zur Vorlesung</p> <p>- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003</p> <p>- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004</p> <p>- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006</p>

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<b>Course L1551: Model-Based Systems Engineering (MBSE) with SysML/UML</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Ralf God
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Objectives of the problem-oriented course are the acquisition of knowledge on system design using the formal languages SysML/UML, learning about tools for modeling and finally the implementation of a project with methods and tools of Model-Based Systems Engineering (MBSE) on a realistic hardware platform (e.g. Arduino®, Raspberry Pi®):</p> <ul style="list-style-type: none"> <li>• What is a model?</li> <li>• What is Systems Engineering?</li> <li>• Survey of MBSE methodologies</li> <li>• The modelling languages SysML /UML</li> <li>• Tools for MBSE</li> <li>• Best practices for MBSE</li> <li>• Requirements specification, functional architecture, specification of a solution</li> <li>• From model to software code</li> <li>• Validation and verification: XiL methods</li> <li>• Accompanying MBSE project</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>- Skript zur Vorlesung</li> <li>- Weikiens, T.: Systems Engineering mit SysML/UML: Modellierung, Analyse, Design. 2. Auflage, dpunkt.Verlag, 2008</li> <li>- Holt, J., Perry, S.A., Brownsword, M.: Model-Based Requirements Engineering. Institution Engineering &amp; Tech, 2011</li> </ul>

Module M1691: Operational Aspekts in Aviation			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Airline Operations (L1310)	Lecture	3	3
Flight Guidance I (Introduction) (L0848)	Lecture	2	2
Flight Guidance I (Introduction) (L0854)	Recitation Section (large)	1	1
Airport Operations (L1276)	Lecture	3	3
Airport Planning (L1275)	Lecture	2	2
Airport Planning (L1469)	Recitation Section (small)	1	1
Maintenance Repair Overhaul in Aviation (L2683)	Lecture	3	3
Aviation and Environment (L2376)	Lecture	3	3
<b>Module Responsible</b>	Prof. Volker Gollnick		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Air Transportation Systems		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Analysis and description of the interaction between people and aircraft in operation</p> <p><i>Skills</i> Understanding and application of design and calculation methods</p> <p>Understanding of interdisciplinary and integrative interdependencies</p> <p>Evaluation of operational issues in aviation and development of operational solution options</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Working in teams for focused solutions</p> <p>communication, assertiveness, technical persuasion</p> <p><i>Autonomy</i> Organisation of workflows and strategies for solutions</p> <p>structured task analysis and definition of solutions</p>		
<b>Workload in Hours</b>	Depends on choice of courses		
<b>Credit points</b>	12		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory		

Course L1310: Airline Operations	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Karl Echtermeyer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction and overview</li> <li>2. Airline business models</li> <li>3. Interdependencies in flight planning (network management, slot management, network structures, aircraft circulation)</li> <li>4. Operative flight preparation (weight &amp; balance, payload/range, etc.)</li> <li>5. fleet policy</li> <li>6. Aircraft assessment and fleet planning</li> <li>7. Airline organisation</li> <li>8. Aircraft maintenance, repair and overhaul</li> </ol>
<b>Literature</b>	<p>Volker Gollnick, Dieter Schmitt: The Air Transport System, Springer Berlin Heidelberg New York, 2014</p> <p>Paul Clark: "Buying the Big Jets", Ashgate 2008</p> <p>Mike Hirst: The Air Transport System, AIAA, 2008</p>

<b>Course L0848: Flight Guidance I (Introduction)</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Introduction and motivation Flight guidance principles (airspace structures, organization of air navigation services, etc.)</p> <p>Cockpit systems and Avionics (cockpit design, cockpit equipment, displays, computers and bus systems)</p> <p>Principles of flight measurement techniques (Measurement of position (geometric methods, distance measurement, direction measurement) Determination of the aircraft attitude (magnetic field- and inertial sensors) Measurement of speed</p> <p>Principles of Navigation</p> <p>Radio navigation</p> <p>Satellite navigation</p> <p>Airspace surveillance (radar systems)</p> <p>Communication systems</p> <p>Integrated Navigation and Guidance Systems</p>
<b>Literature</b>	<p>Rudolf Brockhaus, Robert Luckner, Wolfgang Alles: "Flugregelung", Springer Berlin Heidelberg New York, 2011</p> <p>Holger Flühr: "Avionik und Flugsicherungssysteme", Springer Berlin Heidelberg New York, 2013</p> <p>Volker Gollnick, Dieter Schmitt "Air Transport Systems", Springer Berlin Heidelberg New York, 2016</p> <p>R.P.G. Collinson „Introduction to Avionics“, Springer Berlin Heidelberg New York 2003</p>

<b>Course L0854: Flight Guidance I (Introduction)</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

<b>Course L1276: Airport Operations</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Peter Willems
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	FA-F Flight Operations Flight Operations - Production Infrastructures Operations Planning Master plan Airport capacity Ground handling Terminal operations
<b>Literature</b>	Richard de Neufville, Amedeo Odoni: Airport Systems, McGraw Hill, 2003

Course L1275: Airport Planning	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Ulrich Hüp
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction, definitions, overviewg</li> <li>2. Runway systems</li> <li>3. Air space strucutres around airports</li> <li>4. Airfield lightings, marking and information</li> <li>5. Airfield and terminal configuration</li> </ol>
<b>Literature</b>	<p>N. Ashford, Martin Stanton, Clifton Moore: Airport Operations, John Wiley &amp; Sons, 1991</p> <p>Richard de Neufville, Amedeo Odoni: Airport Systems, Aviation Week Books, MacGraw Hill, 2003</p>

Course L1469: Airport Planning	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Ulrich Hüp
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L2683: Maintenance Repair Overhaul in Aviation	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	

Course L2376: Aviation and Environment	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Florian Linke
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The lecture provides the necessary basics and methods for understanding the interactions between air traffic and the environment, both in terms of the effects of weather / climate on flying and with regard to the effects of air traffic on pollutant emissions, noise and climate.</p> <p>The following topics are covered:</p> <ul style="list-style-type: none"> <li>• Atmospheric physics / chemistry <ul style="list-style-type: none"> <li>◦ Structure and statics</li> <li>◦ Dynamics (water cycle, formation of weather events, high and low pressure areas, wind, gusts and turbulence)</li> <li>◦ Cloud physics (thermodynamics, contrails)</li> <li>◦ Radiation physics (energy balance, greenhouse effect)</li> <li>◦ Photochemistry (ozone chemistry)</li> </ul> </li> <li>• Impact of weather on flying <ul style="list-style-type: none"> <li>◦ Atmospheric influences on flight performance</li> <li>◦ Flight planning</li> <li>◦ Disturbances due to weather, e.g. thunderstorms, winter weather (icing), clear air turbulence, visibility</li> <li>◦ Effects of climate change and adaptation</li> </ul> </li> <li>• Effects of air traffic on the environment and climate <ul style="list-style-type: none"> <li>◦ Aviation pollutant emissions</li> <li>◦ Effect of emissions on concentrations in the atmosphere</li> <li>◦ Climate metrics / models and background scenarios</li> <li>◦ Emissions inventories</li> </ul> </li> <li>• Mitigation measures <ul style="list-style-type: none"> <li>◦ Technological measures, e.g. climate-optimized aircraft design</li> <li>◦ Alternative fuels</li> <li>◦ Operational measures, e.g. climate-optimized flight planning</li> <li>◦ Environmental policy measures, e.g. EU-ETS, CORSIA</li> <li>◦ Potentials and comparison, concept of eco-efficiency</li> </ul> </li> <li>• Local environmental impacts <ul style="list-style-type: none"> <li>◦ Local air quality (particulate matter, other emissions near the ground)</li> <li>◦ Noise (noise sources, noise metrics, noise impact, measurement, certification, psychoacoustics, noise mitigation)</li> <li>◦ Health effects</li> </ul> </li> <li>• Aspects of sustainability <ul style="list-style-type: none"> <li>◦ Other aspects, including life cycle emissions, disposal/recycling</li> <li>◦ Relation to global goals, e.g. United Nations goals for sustainable development, Paris climate agreement</li> </ul> </li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Ruijgrok, G.: Elements of Aircraft Pollution, Delft University Press, 2005</li> <li>• Friedrich, R., Reis, S.: Emissions of Air Pollutants, Springer 2004</li> <li>• Janic, M.: The Sustainability of Air Transportation, Ashgate, 2007</li> <li>• Schumann, U. (ed.): Atmospheric Physics: Background - Methods - Trends, Springer, Berlin, Heidelberg, 2012</li> <li>• Spiridonov, V., Curic, M.: Fundamentals of Meteorology, Springer, 2021</li> <li>• Kaltschmitt, M., Neuling, U.: Biokerosene - Status and Prospects, Springer, 2018</li> <li>• Roedel, W., Wagner, T.: Physik unserer Umwelt: Die Atmosphäre, Springer, 2017</li> <li>• W. Bräunling: Flugzeugtriebwerke. Springer-Verlag Berlin, Deutschland, 2009</li> <li>• G. Brüning, X. Hafer, G. Sachs: Flugleistungen, Springer, 1993</li> </ul>

Module M1739: Operational Aspekts in Aviation			
<b>Courses</b>			
Title	Typ	Hrs/wk	CP
Airline Operations (L1310)	Lecture	3	3
Flight Guidance I (Introduction) (L0848)	Lecture	2	2
Flight Guidance I (Introduction) (L0854)	Recitation Section (large)	1	1
Airport Operations (L1276)	Lecture	3	3
Airport Planning (L1275)	Lecture	2	2
Airport Planning (L1469)	Recitation Section (small)	1	1
Maintenance Repair Overhaul in Aviation (L2683)	Lecture	3	3
Aviation and Environment (L2376)	Lecture	3	3
<b>Module Responsible</b>	Prof. Volker Gollnick		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Air Transportation Systems		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Analysis and description of the interaction between people and aircraft in operation</p> <p><i>Skills</i> Understanding and application of design and calculation methods</p> <p>Understanding of interdisciplinary and integrative interdependencies</p> <p>Evaluation of operational issues in aviation and development of operational solution options</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Working in teams for focused solutions</p> <p>communication, assertiveness, technical persuasion</p> <p><i>Autonomy</i> Organisation of workflows and strategies for solutions</p> <p>structured task analysis and definition of solutions</p>		
<b>Workload in Hours</b>	Depends on choice of courses		
<b>Credit points</b>	6		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory		
	International Management and Engineering: Specialisation II. Logistics: Elective Compulsory		

Course L1310: Airline Operations	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Karl Echtermeyer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction and overview</li> <li>2. Airline business models</li> <li>3. Interdependencies in flight planning (network management, slot management, network structures, aircraft circulation)</li> <li>4. Operative flight preparation (weight &amp; balance, payload/range, etc.)</li> <li>5. fleet policy</li> <li>6. Aircraft assessment and fleet planning</li> <li>7. Airline organisation</li> <li>8. Aircraft maintenance, repair and overhaul</li> </ol>
<b>Literature</b>	<p>Volker Gollnick, Dieter Schmitt: The Air Transport System, Springer Berlin Heidelberg New York, 2014</p> <p>Paul Clark: "Buying the Big Jets", Ashgate 2008</p> <p>Mike Hirst: The Air Transport System, AIAA, 2008</p>

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Course L0848: Flight Guidance I (Introduction)	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Introduction and motivation Flight guidance principles (airspace structures, organization of air navigation services, etc.)</p> <p>Cockpit systems and Avionics (cockpit design, cockpit equipment, displays, computers and bus systems)</p> <p>Principles of flight measurement techniques (Measurement of position (geometric methods, distance measurement, direction measurement) Determination of the aircraft attitude (magnetic field- and inertial sensors) Measurement of speed</p> <p>Principles of Navigation</p> <p>Radio navigation</p> <p>Satellite navigation</p> <p>Airspace surveillance (radar systems)</p> <p>Communication systems</p> <p>Integrated Navigation and Guidance Systems</p>
<b>Literature</b>	<p>Rudolf Brockhaus, Robert Luckner, Wolfgang Alles: "Flugregelung", Springer Berlin Heidelberg New York, 2011</p> <p>Holger Flühr: "Avionik und Flugsicherungssysteme", Springer Berlin Heidelberg New York, 2013</p> <p>Volker Gollnick, Dieter Schmitt "Air Transport Systems", Springer Berlin Heidelberg New York, 2016</p> <p>R.P.G. Collinson „Introduction to Avionics“, Springer Berlin Heidelberg New York 2003</p>

Course L0854: Flight Guidance I (Introduction)	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L1276: Airport Operations	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Peter Willems
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	FA-F Flight Operations Flight Operations - Production Infrastructures Operations Planning Master plan Airport capacity Ground handling Terminal operations
<b>Literature</b>	Richard de Neufville, Amedeo Odoni: Airport Systems, McGraw Hill, 2003

Course L1275: Airport Planning	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Ulrich Hüp
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction, definitions, overviewg</li> <li>2. Runway systems</li> <li>3. Air space strucutres around airports</li> <li>4. Airfield lightings, marking and information</li> <li>5. Airfield and terminal configuration</li> </ol>
<b>Literature</b>	<p>N. Ashford, Martin Stanton, Clifton Moore: Airport Operations, John Wiley &amp; Sons, 1991</p> <p>Richard de Neufville, Amedeo Odoni: Airport Systems, Aviation Week Books, MacGraw Hill, 2003</p>

Course L1469: Airport Planning	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	60 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Ulrich Hüp
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L2683: Maintenance Repair Overhaul in Aviation	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	

Course L2376: Aviation and Environment	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Examination Form</b>	Klausur
<b>Examination duration and scale</b>	90 min
<b>Lecturer</b>	Prof. Volker Gollnick, Dr. Florian Linke
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The lecture provides the necessary basics and methods for understanding the interactions between air traffic and the environment, both in terms of the effects of weather / climate on flying and with regard to the effects of air traffic on pollutant emissions, noise and climate.</p> <p>The following topics are covered:</p> <ul style="list-style-type: none"> <li>• Atmospheric physics / chemistry <ul style="list-style-type: none"> <li>◦ Structure and statics</li> <li>◦ Dynamics (water cycle, formation of weather events, high and low pressure areas, wind, gusts and turbulence)</li> <li>◦ Cloud physics (thermodynamics, contrails)</li> <li>◦ Radiation physics (energy balance, greenhouse effect)</li> <li>◦ Photochemistry (ozone chemistry)</li> </ul> </li> <li>• Impact of weather on flying <ul style="list-style-type: none"> <li>◦ Atmospheric influences on flight performance</li> <li>◦ Flight planning</li> <li>◦ Disturbances due to weather, e.g. thunderstorms, winter weather (icing), clear air turbulence, visibility</li> <li>◦ Effects of climate change and adaptation</li> </ul> </li> <li>• Effects of air traffic on the environment and climate <ul style="list-style-type: none"> <li>◦ Aviation pollutant emissions</li> <li>◦ Effect of emissions on concentrations in the atmosphere</li> <li>◦ Climate metrics / models and background scenarios</li> <li>◦ Emissions inventories</li> </ul> </li> <li>• Mitigation measures <ul style="list-style-type: none"> <li>◦ Technological measures, e.g. climate-optimized aircraft design</li> <li>◦ Alternative fuels</li> <li>◦ Operational measures, e.g. climate-optimized flight planning</li> <li>◦ Environmental policy measures, e.g. EU-ETS, CORSIA</li> <li>◦ Potentials and comparison, concept of eco-efficiency</li> </ul> </li> <li>• Local environmental impacts <ul style="list-style-type: none"> <li>◦ Local air quality (particulate matter, other emissions near the ground)</li> <li>◦ Noise (noise sources, noise metrics, noise impact, measurement, certification, psychoacoustics, noise mitigation)</li> <li>◦ Health effects</li> </ul> </li> <li>• Aspects of sustainability <ul style="list-style-type: none"> <li>◦ Other aspects, including life cycle emissions, disposal/recycling</li> <li>◦ Relation to global goals, e.g. United Nations goals for sustainable development, Paris climate agreement</li> </ul> </li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Ruijgrok, G.: Elements of Aircraft Pollution, Delft University Press, 2005</li> <li>• Friedrich, R., Reis, S.: Emissions of Air Pollutants, Springer 2004</li> <li>• Janic, M.: The Sustainability of Air Transportation, Ashgate, 2007</li> <li>• Schumann, U. (ed.): Atmospheric Physics: Background - Methods - Trends, Springer, Berlin, Heidelberg, 2012</li> <li>• Spiridonov, V., Curic, M.: Fundamentals of Meteorology, Springer, 2021</li> <li>• Kaltschmitt, M., Neuling, U.: Biokerosene - Status and Prospects, Springer, 2018</li> <li>• Roedel, W., Wagner, T.: Physik unserer Umwelt: Die Atmosphäre, Springer, 2017</li> <li>• W. Bräunling: Flugzeugtriebwerke. Springer-Verlag Berlin, Deutschland, 2009</li> <li>• G. Brüning, X. Hafer, G. Sachs: Flugleistungen, Springer, 1993</li> </ul>

Module M1813: Agile learning with agile methods				
Courses				
Title	Typ	Hrs/wk	CP	
Agile Data Science for industrial Engineers (L3009)	Project-/problem-based Learning	3	6	
<b>Module Responsible</b>	Prof. Kathrin Fischer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Scientific Writing			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know: <ul style="list-style-type: none"> <li>• Basic principles of agile work</li> <li>• Roles within agile project management based on Scrum</li> <li>• Structure and workflows of agile project groups</li> <li>• Basic functions/classes/methods of data science in python</li> <li>• Selected libraries of data science in Python</li> </ul>			
<i>Skills</i>	The students are able to: <ul style="list-style-type: none"> <li>• Plan and carry out a project based on the Scrum philosophy, in detail:                             <ul style="list-style-type: none"> <li>◦ Define and allocate roles in Scrum</li> <li>◦ Plan Scrum sprints based on self-defined work packages (planning)</li> <li>◦ Carry out Scrum sprints</li> <li>◦ Complete, analyse and evaluate Scrum sprints (review and retrospective)</li> <li>◦ Present project results</li> </ul> </li> <li>• Use established tools of collaborative work</li> <li>• Writing simple scientific scripts for data science in Python collaboratively</li> <li>• Record the methods and results</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to: <ul style="list-style-type: none"> <li>• Work in heterogenic project groups and accept their defined roles based on the scrum philosophy</li> <li>• Commit to group intern time management necessities</li> <li>• Manage scope adjustments under time pressure</li> <li>• Realize and judge the importance of individual commitments for collaborative work</li> <li>• Communicate with stakeholders of their group project</li> </ul>			
<i>Autonomy</i>	The students are able to: <ul style="list-style-type: none"> <li>• Evaluate work packages regarding their practicability and commit to working on these individually</li> <li>• Evaluate their own skills regarding their contribution to a given project</li> <li>• Harmonize their own time management to the group intern time management</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Group discussion	
<b>Examination</b>	Written elaboration			
<b>Examination duration and scale</b>	Approx. 5 - 10 pages per person			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			

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<b>Course L3009: Agile Data Science for industrial Engineers</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Within this course, the fundamentals of Python for Data Science are taught and applied on a collaborative level.</p> <p>The course starts with an introduction to Python which is held in workshop format, and an introduction to collaborative work and agile project management.</p> <p>During this course different projects will be carried out in project groups, following the scrum philosophy.</p> <p>The course is dedicated to programming beginners, so no prior knowledge of Python is required. However, also students with programming experience are welcome to participate.</p> <p>For the exam, teams are required to write a report on the group projects and their results.</p>
<b>Literature</b>	Schwaber, K. & Sutherland, J. (2020): The Scrum Guide. Online Ressource

**Specialization II. Mechatronics**

<b>Module M0752: Nonlinear Dynamics</b>			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Nonlinear Dynamics (L0702)	Integrated Lecture	4	6
<b>Module Responsible</b>	Prof. Norbert Hoffmann		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Calculus</li> <li>• Linear Algebra</li> <li>• Engineering Mechanics</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to reflect existing terms and concepts in Nonlinear Dynamics and to develop and research new terms and concepts.</p> <p><i>Skills</i> Students are able to apply existing methods and procedures of Nonlinear Dynamics and to develop novel methods and procedures.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can reach working results also in groups.</p> <p><i>Autonomy</i> Students are able to approach given research tasks individually and to identify and follow up novel research tasks by themselves.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	2 Hours		
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory		

<b>Course L0702: Nonlinear Dynamics</b>	
<b>Typ</b>	Integrated Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Norbert Hoffmann
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	Fundamentals of Nonlinear Dynamics.
<b>Literature</b>	S. Strogatz: Nonlinear Dynamics and Chaos. Perseus, 2013.

Module M1143: Applied Design Methodology in Mechatronics			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Applied Design Methodology in Mechatronics (L1523)		Lecture	2
Applied Design Methodology in Mechatronics (L1524)		Project-/problem-based Learning	3
<b>Module Responsible</b>	Prof. Thorsten Kern		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of mechanical design, electrical design or computer-sciences		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Science-based working on interdisciplinary product design considering targeted application of specific product design techniques		
<i>Skills</i>	Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students will solve and execute technical-scientific tasks from an industrial context in small design-teams with application of common, creative methodologies.		
<i>Autonomy</i>	Students are enabled to optimize the design and development process according to the target and topic of the design		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	30 min Presentation for a group design-work		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L1523: Applied Design Methodology in Mechatronics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thorsten Kern
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Systematic analysis and planning of the design process for products combining a multitude of disciplines</li> <li>• Structure of the engineering process with focus on engineering steps (task-definition, functional decomposition, physical principles, elements for solution, combination to systems and products, execution of design, component-tests, system-tests, product-testing and qualification/validation)</li> <li>• Creative methods (Basics, methods like lead-user-method, 6-3-5, BrainStorming, Intergalactic Thinking, ... - Applications in examples all around mechatronics topics)</li> <li>• Several design-supporting methods and tools (functional structures, GALFMOS, AEIOU-method, GAMPFT, simulation and its application, TRIZ, design for SixSigma, continous integration and testing, ...)</li> <li>• Evaluation and final selection of solution (technical and business-considerations, preference-matrix, pair-comparison), dealing with uncertainties, decision-making</li> <li>• Value-analysis</li> <li>• Derivation of architectures and architectural management</li> <li>• Project-tracking and -guidance (project-lead, guiding of employees, organization of multidisciplinary R&amp;D departments, idea-identification, responsibilities and communication)</li> <li>• Project-execution methods (Scrum, Kanbaan, ...)</li> <li>• Presentation-skills</li> <li>• Questions of aesthetic product design and design for subjective requirements (industrial design, color, haptic/optic/acoustic interfaces)</li> <li>• Evaluation of selected methods at practical examples in small teams</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Definition folgt...</li> <li>• Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, K.-H.: Konstruktionslehre: Grundlage erfolgreicher Produktentwicklung, Methoden und Anwendung, 7. Auflage, Springer Verlag, Berlin 2007</li> <li>• VDI-Richtlinien: 2206; 2221ff</li> </ul>

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<b>Course L1524: Applied Design Methodology in Mechatronics</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Thorsten Kern
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0605: Computational Structural Dynamics			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Computational Structural Dynamics (L0282)		Lecture	3
Computational Structural Dynamics (L0283)		Recitation Section (small)	1
<b>CP</b>			4
			2
<b>Module Responsible</b>	Prof. Alexander Düster		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge of partial differential equations is recommended.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students are able to + give an overview of the computational procedures for problems of structural dynamics. + explain the application of finite element programs to solve problems of structural dynamics. + specify problems of computational structural dynamics, to identify them in a given situation and to explain their mathematical and mechanical background.		
<i>Skills</i>	Students are able to + model problems of structural dynamics. + select a suitable solution procedure for a given problem of structural dynamics. + apply computational procedures to solve problems of structural dynamics. + verify and critically judge results of computational structural dynamics.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students are able to + solve problems in heterogeneous groups and to document the corresponding results.		
<i>Autonomy</i>	Students are able to + acquire independently knowledge to solve complex problems.		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	2h		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory		

Course L0282: Computational Structural Dynamics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Alexander Düster
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	1. Motivation 2. Basics of dynamics 3. Time integration methods 4. Modal analysis 5. Fourier transform 6. Applications
<b>Literature</b>	[1] K.-J. Bathe, Finite-Elemente-Methoden, Springer, 2002. [2] J.L. Humar, Dynamics of Structures, Taylor & Francis, 2012.

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

Module M0633: Industrial Process Automation				
Courses				
Title	Typ	Hrs/wk	CP	
Industrial Process Automation (L0344)	Lecture	2	3	
Industrial Process Automation (L0345)	Recitation Section (small)	2	3	
<b>Module Responsible</b>	Prof. Alexander Schlaefer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	mathematics and optimization methods principles of automata principles of algorithms and data structures programming skills			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students can evaluate and assess discrete event systems. They can evaluate properties of processes and explain methods for process analysis. The students can compare methods for process modelling and select an appropriate method for actual problems. They can discuss scheduling methods in the context of actual problems and give a detailed explanation of advantages and disadvantages of different programming methods. The students can relate process automation to methods from robotics and sensor systems as well as to recent topics like 'cyberphysical systems' and 'industry 4.0'.			
<i>Skills</i>	The students are able to develop and model processes and evaluate them accordingly. This involves taking into account optimal scheduling, understanding algorithmic complexity, and implementation using PLCs.			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students can independently define work processes within their groups, distribute tasks within the group and develop solutions collaboratively.			
<i>Autonomy</i>	The students are able to assess their level of knowledge and to document their work results adequately.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Exercices	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 minutes			
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory			

Course L0344: Industrial Process Automation	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Schlaefer
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- foundations of problem solving and system modeling, discrete event systems</li> <li>- properties of processes, modeling using automata and Petri-nets</li> <li>- design considerations for processes (mutex, deadlock avoidance, liveness)</li> <li>- optimal scheduling for processes</li> <li>- optimal decisions when planning manufacturing systems, decisions under uncertainty</li> <li>- software design and software architectures for automation, PLCs</li> </ul>
<b>Literature</b>	<p>J. Lunze: „Automatisierungstechnik“, Oldenbourg Verlag, 2012</p> <p>Reisig: Petrinetze: Modellierungstechnik, Analysemethoden, Fallstudien; Vieweg+Teubner 2010</p> <p>Hrúz, Zhou: Modeling and Control of Discrete-event Dynamic Systems; Springer 2007</p> <p>Li, Zhou: Deadlock Resolution in Automated Manufacturing Systems, Springer 2009</p> <p>Pinedo: Planning and Scheduling in Manufacturing and Services, Springer 2009</p>

Course L0345: Industrial Process Automation	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Schlaefer
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0746: Microsystem Engineering				
Courses				
Title	Typ	Hrs/wk	CP	
Microsystem Engineering (L0680)	Lecture	2	4	
Microsystem Engineering (L0682)	Project-/problem-based Learning	2	2	
<b>Module Responsible</b>	Dr. rer. nat. Thomas Kusserow			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic courses in physics, mathematics and electric engineering			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know about the most important technologies and materials of MEMS as well as their applications in sensors and actuators.			
<i>Skills</i>	Students are able to analyze and describe the functional behaviour of MEMS components and to evaluate the potential of microsystems.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to solve specific problems alone or in a group and to present the results accordingly.			
<i>Autonomy</i>	Students are able to acquire particular knowledge using specialized literature and to integrate and associate this knowledge with other fields.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Presentation	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	2h			
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Microelectronics and Microsystems: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory			

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

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

Module M0751: Vibration Theory			
Courses			
Title	Typ	Hrs/wk	CP
Vibration Theory (L0701)	Integrated Lecture	4	6
<b>Module Responsible</b>	Prof. Norbert Hoffmann		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Calculus</li> <li>• Linear Algebra</li> <li>• Engineering Mechanics</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<ul style="list-style-type: none"> <li>• Students are able to denote terms and concepts of Vibration Theory and develop them further.</li> <li>• Students know methods of modeling and simulation for free, driven, self-excited and parameter driven vibrations.</li> <li>• Students know about concepts of linear and nonlinear vibration problems.</li> <li>• Students know basic tasks of vibration problems of discrete and continuous systems.</li> </ul>		
<i>Knowledge</i>			
<i>Skills</i>			
<b>Personal Competence</b>			
<i>Social Competence</i>	<ul style="list-style-type: none"> <li>• Students are able to denote methods of Vibration Theory and develop them further.</li> <li>• Students are able to apply and expand methods of modeling and simulation for free, forced, self-excited and parameter driven vibrations.</li> <li>• Students are able to solve linear and nonlinear vibration problems.</li> </ul>		
<i>Autonomy</i>	<ul style="list-style-type: none"> <li>• Students can analyze vibration problems, work on them, and reach working results also in teams or groups.</li> <li>• Students are able to document the results of vibration studies also in groups.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	2 Hours		
<b>Assignment for the Following Curricula</b>	Energy Systems: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory		

Course L0701: Vibration Theory	
<b>Typ</b>	Integrated Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Norbert Hoffmann
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	Linear and Nonlinear Single and Multiple Degree of Freedom Vibrations <ul style="list-style-type: none"> <li>• Free vibration</li> <li>• Self-excited vibration</li> <li>• Parameter driven vibration</li> <li>• Forced vibration</li> <li>• Multi degree of freedom vibration</li> <li>• Continuum vibration</li> <li>• Irregular vibration</li> </ul>
<b>Literature</b>	German - K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen.  English - K. Magnus: Vibrations.

Module M0768: Microsystems Technology in Theory and Practice				
Courses				
Title	Typ	Hrs/wk	CP	
Microsystems Technology (L0724)	Lecture	2	4	
Microsystems Technology (L0725)	Project-/problem-based Learning	2	2	
<b>Module Responsible</b>	Prof. Hoc Khiem Trieu			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basics in physics, chemistry, mechanics and semiconductor technology			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Students are able			
	<ul style="list-style-type: none"> <li>to present and to explain current fabrication techniques for microstructures and especially methods for the fabrication of microsensors and microactuators, as well as the integration thereof in more complex systems</li> <li>to explain in details operation principles of microsensors and microactuators and</li> <li>to discuss the potential and limitation of microsystems in application.</li> </ul>			
<i>Skills</i>	Students are capable			
	<ul style="list-style-type: none"> <li>to analyze the feasibility of microsystems,</li> <li>to develop process flows for the fabrication of microstructures and</li> <li>to apply them.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to plan and carry out experiments in groups, as well as present and represent the results in front of others. These social skills are practiced both during the preparation phase, in which the groups work out and present the theory, and during the follow-up phase, in which the groups prepare, document and present their practical experiences.			
<i>Autonomy</i>	The independence of the students is demanded and promoted in that they have to transfer and apply what they have learned to ever new boundary conditions. This requirement is communicated at the beginning of the semester and consistently practiced until the exam. Students are encouraged to work independently by not being given a solution, but by learning to work out the solution step by step by asking specific questions. Students learn to ask questions independently when they are faced with a problem. They learn to independently break down problems into manageable sub-problems.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Subject theoretical and practical work	Studierenden führen in Kleingruppen ein Laborpraktikum durch. Jede Gruppe präsentiert und diskutiert die Theorie sowie die Ergebnisse ihrer Labortätigkeit. vor dem gesamten Kurs.
<b>Examination</b>	Oral exam			
<b>Examination duration and scale</b>	30 min			
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Nanoelectronics and Microsystems Technology: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Microelectronics and Microsystems: Core Qualification: Elective Compulsory			

Course L0724: Microsystems Technology	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Hoc Khiem Trieu
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction (historical view, scientific and economic relevance, scaling laws)</li> <li>• Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting)</li> <li>• Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing)</li> <li>• Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF<sub>2</sub> etching)</li> <li>• Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping)</li> <li>• Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer)</li> <li>• Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process)</li> <li>• Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer)</li> <li>• Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip)</li> <li>• Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics)</li> <li>• MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration)</li> <li>• Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship)</li> <li>• System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)</li> </ul>
<b>Literature</b>	<p>M. Madou: Fundamentals of Microfabrication, CRC Press, 2002</p> <p>N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009</p> <p>T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010</p> <p>G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008</p>

Course L0725: Microsystems Technology	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Hoc Khiem Trieu
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0808: Finite Elements Methods				
Courses				
Title	Typ	Hrs/wk	CP	
Finite Element Methods (L0291)	Lecture	2	3	
Finite Element Methods (L0804)	Recitation Section (large)	2	3	
<b>Module Responsible</b>	Prof. Otto von Estorff			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> The students possess an in-depth knowledge regarding the derivation of the finite element method and are able to give an overview of the theoretical and methodical basis of the method.</p> <p><i>Skills</i> The students are capable to handle engineering problems by formulating suitable finite elements, assembling the corresponding system matrices, and solving the resulting system of equations.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can work in small groups on specific problems to arrive at joint solutions.</p> <p><i>Autonomy</i> The students are able to independently solve challenging computational problems and develop own finite element routines. Problems can be identified and the results are critically scrutinized.</p>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	20 %	Midterm	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Civil Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Product Development, Materials and Production: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory			

Course L0291: Finite Element Methods	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Otto von Estorff
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- General overview on modern engineering</li> <li>- Displacement method</li> <li>- Hybrid formulation</li> <li>- Isoparametric elements</li> <li>- Numerical integration</li> <li>- Solving systems of equations (statics, dynamics)</li> <li>- Eigenvalue problems</li> <li>- Non-linear systems</li> <li>- Applications</li>   <li>- Programming of elements (Matlab, hands-on sessions)</li> <li>- Applications</li> </ul>
<b>Literature</b>	Bathe, K.-J. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

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

Module M1025: Fluidics				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Fluidics (L1256)		Lecture	2	3
Fluidics (L1371)		Project-/problem-based Learning	1	2
Fluidics (L1257)		Recitation Section (large)	1	1
<b>Module Responsible</b>	Prof. Dieter Krause			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Good knowledge of mechanics (stereo statics, elastostatics, hydrostatics, kinematics and kinetics), fluid mechanics, and engineering design			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	After passing the module students are able to			
	<ul style="list-style-type: none"> <li>explain structures and functionalities of hydrostatic, pneumatic, and hydrodynamic components,</li> <li>explain the interaction of hydraulic components in hydraulic systems,</li> <li>explain open and closed loop control of hydraulic systems,</li> <li>describe functioning and applications of hydrodynamic torque converters, brakes and clutches as well as centrifugal pumps and aggregates in plant technology</li> </ul>			
<i>Skills</i>	After passing the module students are able to			
	<ul style="list-style-type: none"> <li>analyse and assess hydraulic and pneumatic components and systems,</li> <li>design and dimension hydraulic systems for mechanical applications,</li> <li>perform numerical simulations of hydraulic systems based on abstract problem definitions,</li> <li>select and adapt pump characteristic curves for hydraulic systems</li> <li>dimension hydrodynamic torque converters and brakes for mechanical aggregates.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	After passing the module students are able to			
	<ul style="list-style-type: none"> <li>discuss and present functional context in groups,</li> <li>organise teamwork autonomously.</li> </ul>			
<i>Autonomy</i>	After passing the module students are able to			
	<ul style="list-style-type: none"> <li>obtain necessary knowledge for the simulation.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Attestation	Simulation hydrostatischer Systeme
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Course L1256: Fluidics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>Lecture</b></p> <p>Hydrostatics</p> <ul style="list-style-type: none"> <li>• physical fundamentals</li> <li>• hydraulic fluids</li> <li>• hydrostatic machines</li> <li>• valves</li> <li>• components</li> <li>• hydrostatic transmissions</li> <li>• examples from industry</li> </ul> <p>Pneumatics</p> <ul style="list-style-type: none"> <li>• generation of compressed air</li> <li>• pneumatic motors</li> <li>• Examples of use</li> </ul> <p>Hydrodynamics</p> <ul style="list-style-type: none"> <li>• physical fundamentals</li> <li>• hydraulic continuous-flow machines</li> <li>• hydrodynamic transmissions</li> <li>• interoperation of motor and transmission</li> </ul> <p><b>Exercise</b></p> <p>Hydrostatics</p> <ul style="list-style-type: none"> <li>• reading and design of hydraulic diagrams</li> <li>• dimensioning of hydrostatic traction and working drives</li> <li>• performance calculation</li> </ul> <p>Hydrodynamics</p> <ul style="list-style-type: none"> <li>• calculation / dimensioning of hydrodynamic torque converters</li> <li>• calculation / dimensioning of centrifugal pumps</li> <li>• creating and reading of characteristic curves of pumps and systems</li> </ul> <p>Field trip</p> <ul style="list-style-type: none"> <li>• field trip to a regional company from the hydraulic industry.</li> </ul> <p><b>Exercise</b></p> <p>Numerical simulation of hydrostatic systems</p> <ul style="list-style-type: none"> <li>• getting to know a numerical simulation environment for hydraulic systems</li> <li>• transformation of a task into a simulation model</li> <li>• simulation of common components</li> <li>• variation of simulation parameters</li> <li>• using simulations for system dimensioning and optimisation</li> <li>• (partly) self-organised teamwork</li> </ul>
<b>Literature</b>	<p>Bücher</p> <ul style="list-style-type: none"> <li>• Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011</li> <li>• Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Pneumatik, Shaker Verlag, Aachen, 2006</li> <li>• Matthies, H.J. Renius, K.Th.: Einführung in die Ölhydraulik, Teubner Verlag, 2006</li> <li>• Beitz, W., Grote, K.-H.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage</li> </ul> <p>Skript zur Vorlesung</p>

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

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

Module M0832: Advanced Topics in Control			
Courses			
Title	Typ	Hrs/wk	CP
Advanced Topics in Control (L0661)	Lecture	2	3
Advanced Topics in Control (L0662)	Recitation Section (small)	2	3
<b>Module Responsible</b>	Prof. Herbert Werner		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	H-infinity optimal control, mixed-sensitivity design, linear matrix inequalities		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i> <ul style="list-style-type: none"> <li>• Students can explain the advantages and shortcomings of the classical gain scheduling approach</li> <li>• They can explain the representation of nonlinear systems in the form of quasi-LPV systems</li> <li>• They can explain how stability and performance conditions for LPV systems can be formulated as LMI conditions</li> <li>• They can explain how gridding techniques can be used to solve analysis and synthesis problems for LPV systems</li> <li>• They are familiar with polytopic and LFT representations of LPV systems and some of the basic synthesis techniques associated with each of these model structures</li> </ul> <i>Skills</i> <ul style="list-style-type: none"> <li>• Students can explain how graph theoretic concepts are used to represent the communication topology of multiagent systems</li> <li>• They can explain the convergence properties of first order consensus protocols</li> <li>• They can explain analysis and synthesis conditions for formation control loops involving either LTI or LPV agent models</li> <li>• Students can explain concepts behind linear and qLPV Model Predictive Control (MPC)</li> <li>• Students can construct LPV models of nonlinear plants and carry out a mixed-sensitivity design of gain-scheduled controllers; they can do this using polytopic, LFT or general LPV models</li> <li>• They can use standard software tools (Matlab robust control toolbox) for these tasks</li> <li>• Students can design distributed formation controllers for groups of agents with either LTI or LPV dynamics, using Matlab tools provided</li> <li>• Students can design MPC controllers for linear and non-linear systems using Matlab tools</li> </ul> <b>Personal Competence</b> <i>Social Competence</i> Students can work in small groups and arrive at joint results. <i>Autonomy</i> Students can find required information in sources provided (lecture notes, literature, software documentation) and use it to solve given problems.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Oral exam		
<b>Examination duration and scale</b>	30 min		
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory		

Course L0661: Advanced Topics in Control	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Herbert Werner
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Linear Parameter-Varying (LPV) Gain Scheduling                             <ul style="list-style-type: none"> <li>- Linearizing gain scheduling, hidden coupling</li> <li>- Jacobian linearization vs. quasi-LPV models</li> <li>- Stability and induced L2 norm of LPV systems</li> <li>- Synthesis of LPV controllers based on the two-sided projection lemma</li> <li>- Simplifications: controller synthesis for polytopic and LFT models</li> <li>- Experimental identification of LPV models</li> <li>- Controller synthesis based on input/output models</li> <li>- Applications: LPV torque vectoring for electric vehicles, LPV control of a robotic manipulator</li> </ul> </li> <li>• Control of Multi-Agent Systems                             <ul style="list-style-type: none"> <li>- Communication graphs</li> <li>- Spectral properties of the graph Laplacian</li> <li>- First and second order consensus protocols</li> <li>- Formation control, stability and performance</li> <li>- LPV models for agents subject to nonholonomic constraints</li> <li>- Application: formation control for a team of quadrotor helicopters</li> </ul> </li> <li>• Linear and Nonlinear Model Predictive Control based on LMIs</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Werner, H., Lecture Notes "Advanced Topics in Control"</li> <li>• Selection of relevant research papers made available as pdf documents via StudIP</li> </ul>

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

Module M0846: Control Systems Theory and Design			
Courses			
Title	Typ	Hrs/wk	CP
Control Systems Theory and Design (L0656)	Lecture	2	4
Control Systems Theory and Design (L0657)	Recitation Section (small)	2	2
<b>Module Responsible</b>	Prof. Herbert Werner		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Introduction to Control Systems		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	<ul style="list-style-type: none"> <li>• Students can explain how linear dynamic systems are represented as state space models; they can interpret the system response to initial states or external excitation as trajectories in state space</li> <li>• They can explain the system properties controllability and observability, and their relationship to state feedback and state estimation, respectively</li> <li>• They can explain the significance of a minimal realisation</li> <li>• They can explain observer-based state feedback and how it can be used to achieve tracking and disturbance rejection</li> <li>• They can extend all of the above to multi-input multi-output systems</li> <li>• They can explain the z-transform and its relationship with the Laplace Transform</li> <li>• They can explain state space models and transfer function models of discrete-time systems</li> <li>• They can explain the experimental identification of ARX models of dynamic systems, and how the identification problem can be solved by solving a normal equation</li> <li>• They can explain how a state space model can be constructed from a discrete-time impulse response</li> </ul>		
<i>Skills</i>	<ul style="list-style-type: none"> <li>• Students can transform transfer function models into state space models and vice versa</li> <li>• They can assess controllability and observability and construct minimal realisations</li> <li>• They can design LQG controllers for multivariable plants</li> <li>• They can carry out a controller design both in continuous-time and discrete-time domain, and decide which is appropriate for a given sampling rate</li> <li>• They can identify transfer function models and state space models of dynamic systems from experimental data</li> <li>• They can carry out all these tasks using standard software tools (Matlab Control Toolbox, System Identification Toolbox, Simulink)</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students can work in small groups on specific problems to arrive at joint solutions.		
<i>Autonomy</i>	<p>Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it when solving given problems.</p> <p>They can assess their knowledge in weekly on-line tests and thereby control their learning progress.</p>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory Computer Science in Engineering: Specialisation II. Engineering Science: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory		

Course L0656: Control Systems Theory and Design	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Herbert Werner
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>State space methods (single-input single-output)</p> <ul style="list-style-type: none"> <li>• State space models and transfer functions, state feedback</li> <li>• Coordinate basis, similarity transformations</li> <li>• Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem</li> <li>• Controllability and pole placement</li> <li>• State estimation, observability, Kalman decomposition</li> <li>• Observer-based state feedback control, reference tracking</li> <li>• Transmission zeros</li> <li>• Optimal pole placement, symmetric root locus</li> </ul> <p>Multi-input multi-output systems</p> <ul style="list-style-type: none"> <li>• Transfer function matrices, state space models of multivariable systems, Gilbert realization</li> <li>• Poles and zeros of multivariable systems, minimal realization</li> <li>• Closed-loop stability</li> <li>• Pole placement for multivariable systems, LQR design, Kalman filter</li> </ul> <p>Digital Control</p> <ul style="list-style-type: none"> <li>• Discrete-time systems: difference equations and z-transform</li> <li>• Discrete-time state space models, sampled data systems, poles and zeros</li> <li>• Frequency response of sampled data systems, choice of sampling rate</li> </ul> <p>System identification and model order reduction</p> <ul style="list-style-type: none"> <li>• Least squares estimation, ARX models, persistent excitation</li> <li>• Identification of state space models, subspace identification</li> <li>• Balanced realization and model order reduction</li> </ul> <p>Case study</p> <ul style="list-style-type: none"> <li>• Modelling and multivariable control of a process evaporator using Matlab and Simulink</li> </ul> <p>Software tools</p> <ul style="list-style-type: none"> <li>• Matlab/Simulink</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Werner, H., Lecture Notes „Control Systems Theory and Design“</li> <li>• T. Kailath "Linear Systems", Prentice Hall, 1980</li> <li>• K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997</li> <li>• L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999</li> </ul>

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

Module M0563: Robotics				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Robotics: Modelling and Control (L0168)		Integrated Lecture	4	4
Robotics: Modelling and Control (L1305)		Project-/problem-based Learning	2	2
<b>Module Responsible</b>	Dr. Martin Gomse			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Fundamentals of electrical engineering Broad knowledge of mechanics Fundamentals of control theory			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to describe fundamental properties of robots and solution approaches for multiple problems in robotics.</p> <p><i>Skills</i> Students are able to derive and solve equations of motion for various manipulators.</p> <p>Students can generate trajectories in various coordinate systems.</p> <p>Students can design linear and partially nonlinear controllers for robotic manipulators.</p>			
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to work goal-oriented in small mixed groups.</p> <p><i>Autonomy</i> Students are able to recognize and improve knowledge deficits independently.</p> <p>With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.</p>			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Subject theoretical and practical work	and Teilnahme an PBL-Einheiten sowie Erreichen des Gesamtziels und der jeweiligen Session-Ziele
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Course L0168: Robotics: Modelling and Control	
<b>Typ</b>	Integrated Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 64, Study Time in Lecture 56
<b>Lecturer</b>	Dr. Martin Gomse
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	Fundamental kinematics of rigid body systems Newton-Euler equations for manipulators Trajectory generation Linear and nonlinear control of robots
<b>Literature</b>	Craig, John J.: Introduction to Robotics Mechanics and Control, Third Edition, Prentice Hall. ISBN 0201-54361-3 Spong, Mark W.; Hutchinson, Seth; Vidyasagar, M. : Robot Modeling and Control. WILEY. ISBN 0-471-64990-2

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Course L1305: Robotics: Modelling and Control	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Martin Gomse
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M1813: Agile learning with agile methods				
Courses				
Title	Typ	Hrs/wk	CP	
Agile Data Science for industrial Engineers (L3009)	Project-/problem-based Learning	3	6	
<b>Module Responsible</b>	Prof. Kathrin Fischer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Scientific Writing			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know: <ul style="list-style-type: none"> <li>• Basic principles of agile work</li> <li>• Roles within agile project management based on Scrum</li> <li>• Structure and workflows of agile project groups</li> <li>• Basic functions/classes/methods of data science in python</li> <li>• Selected libraries of data science in Python</li> </ul>			
<i>Skills</i>	The students are able to: <ul style="list-style-type: none"> <li>• Plan and carry out a project based on the Scrum philosophy, in detail: <ul style="list-style-type: none"> <li>◦ Define and allocate roles in Scrum</li> <li>◦ Plan Scrum sprints based on self-defined work packages (planning)</li> <li>◦ Carry out Scrum sprints</li> <li>◦ Complete, analyse and evaluate Scrum sprints (review and retrospective)</li> <li>◦ Present project results</li> </ul> </li> <li>• Use established tools of collaborative work</li> <li>• Writing simple scientific scripts for data science in Python collaboratively</li> <li>• Record the methods and results</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to: <ul style="list-style-type: none"> <li>• Work in heterogenic project groups and accept their defined roles based on the scrum philosophy</li> <li>• Commit to group intern time management necessities</li> <li>• Manage scope adjustments under time pressure</li> <li>• Realize and judge the importance of individual commitments for collaborative work</li> <li>• Communicate with stakeholders of their group project</li> </ul>			
<i>Autonomy</i>	The students are able to: <ul style="list-style-type: none"> <li>• Evaluate work packages regarding their practicability and commit to working on these individually</li> <li>• Evaluate their own skills regarding their contribution to a given project</li> <li>• Harmonize their own time management to the group intern time management</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Group discussion	
<b>Examination</b>	Written elaboration			
<b>Examination duration and scale</b>	Approx. 5 - 10 pages per person			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			

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<b>Course L3009: Agile Data Science for industrial Engineers</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Within this course, the fundamentals of Python for Data Science are taught and applied on a collaborative level.</p> <p>The course starts with an introduction to Python which is held in workshop format, and an introduction to collaborative work and agile project management.</p> <p>During this course different projects will be carried out in project groups, following the scrum philosophy.</p> <p>The course is dedicated to programming beginners, so no prior knowledge of Python is required. However, also students with programming experience are welcome to participate.</p> <p>For the exam, teams are required to write a report on the group projects and their results.</p>
<b>Literature</b>	Schwaber, K. & Sutherland, J. (2020): The Scrum Guide. Online Ressource

**Specialization II. Product Development and Production**

**Module M1143: Applied Design Methodology in Mechatronics**

Courses			
Title	Typ	Hrs/wk	CP
Applied Design Methodology in Mechatronics (L1523)	Lecture	2	2
Applied Design Methodology in Mechatronics (L1524)	Project-/problem-based Learning	3	4
<b>Module Responsible</b>	Prof. Thorsten Kern		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of mechanical design, electrical design or computer-sciences		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Science-based working on interdisciplinary product design considering targeted application of specific product design techniques</p> <p><i>Skills</i> Creative handling of processes used for scientific preparation and formulation of complex product design problems / Application of various product design techniques following theoretical aspects.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students will solve and execute technical-scientific tasks from an industrial context in small design-teams with application of common, creative methodologies.</p> <p><i>Autonomy</i> Students are enabled to optimize the design and development process according to the target and topic of the design</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Subject theoretical and practical work		
<b>Examination duration and scale</b>	30 min Presentation for a group design-work		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

**Course L1523: Applied Design Methodology in Mechatronics**

<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Thorsten Kern
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Systematic analysis and planning of the design process for products combining a multitude of disciplines</li> <li>• Structure of the engineering process with focus on engineering steps (task-definition, functional decomposition, physical principles, elements for solution, combination to systems and products, execution of design, component-tests, system-tests, product-testing and qualification/validation)</li> <li>• Creative methods (Basics, methods like lead-user-method, 6-3-5, BrainStorming, Intergalactic Thinking, ... - Applications in examples all around mechatronics topics)</li> <li>• Several design-supporting methods and tools (functional structures, GALFAMOS, AEIOU-method, GAMPFT, simulation and its application, TRIZ, design for SixSigma, continuous integration and testing, ...)</li> <li>• Evaluation and final selection of solution (technical and business-considerations, preference-matrix, pair-comparison), dealing with uncertainties, decision-making</li> <li>• Value-analysis</li> <li>• Derivation of architectures and architectural management</li> <li>• Project-tracking and -guidance (project-lead, guiding of employees, organization of multidisciplinary R&amp;D departments, idea-identification, responsibilities and communication)</li> <li>• Project-execution methods (Scrum, Kanbaan, ...)</li> <li>• Presentation-skills</li> <li>• Questions of aesthetic product design and design for subjective requirements (industrial design, color, haptic/optic/acoustic interfaces)</li> <li>• Evaluation of selected methods at practical examples in small teams</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Definition folgt...</li> <li>• Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, K.-H.: Konstruktionslehre: Grundlage erfolgreicher Produktentwicklung, Methoden und Anwendung, 7. Auflage, Springer Verlag, Berlin 2007</li> <li>• VDI-Richtlinien: 2206; 2221ff</li> </ul>

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<b>Course L1524: Applied Design Methodology in Mechatronics</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Thorsten Kern
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0604: High-Order FEM				
Courses				
Title	Typ	Hrs/wk	CP	
High-Order FEM (L0280)	Lecture	3	4	
High-Order FEM (L0281)	Recitation Section (large)	1	2	
<b>Module Responsible</b>	Prof. Alexander Düster			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Knowledge of partial differential equations is recommended.			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Students are able to + give an overview of the different (h, p, hp) finite element procedures. + explain high-order finite element procedures. + specify problems of finite element procedures, to identify them in a given situation and to explain their mathematical and mechanical background.			
<i>Skills</i>	Students are able to + apply high-order finite elements to problems of structural mechanics. + select for a given problem of structural mechanics a suitable finite element procedure. + critically judge results of high-order finite elements. + transfer their knowledge of high-order finite elements to new problems.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students are able to + solve problems in heterogeneous groups and to document the corresponding results.			
<i>Autonomy</i>	Students are able to + assess their knowledge by means of exercises and E-Learning. + acquaint themselves with the necessary knowledge to solve research oriented tasks.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Presentation	Forschendes Lernen
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Energy Systems: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory			

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Course L0280: High-Order FEM	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Alexander Düster
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Motivation</li> <li>3. Hierarchic shape functions</li> <li>4. Mapping functions</li> <li>5. Computation of element matrices, assembly, constraint enforcement and solution</li> <li>6. Convergence characteristics</li> <li>7. Mechanical models and finite elements for thin-walled structures</li> <li>8. Computation of thin-walled structures</li> <li>9. Error estimation and hp-adaptivity</li> <li>10. High-order fictitious domain methods</li> </ol>
<b>Literature</b>	<p>[1] Alexander Düster, High-Order FEM, Lecture Notes, Technische Universität Hamburg-Harburg, 164 pages, 2014</p> <p>[2] Barna Szabo, Ivo Babuska, Introduction to Finite Element Analysis - Formulation, Verification and Validation, John Wiley &amp; Sons, 2011</p>

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

Module M1156: Systems Engineering			
Courses			
Title	Typ	Hrs/wk	CP
Systems Engineering (L1547)	Lecture	3	4
Systems Engineering (L1548)	Recitation Section (large)	1	2
<b>Module Responsible</b>	Prof. Ralf God		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge in: <ul style="list-style-type: none"> <li>• Mathematics</li> <li>• Mechanics</li> <li>• Thermodynamics</li> <li>• Electrical Engineering</li> <li>• Control Systems</li> </ul> Previous knowledge in: <ul style="list-style-type: none"> <li>• Aircraft Cabin Systems</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	Students are able to: <ul style="list-style-type: none"> <li>• understand systems engineering process models, methods and tools for the development of complex Systems</li> <li>• describe innovation processes and the need for technology Management</li> <li>• explain the aircraft development process and the process of type certification for aircraft</li> <li>• explain the system development process, including requirements for systems reliability</li> <li>• identify environmental conditions and test procedures for airborne Equipment</li> <li>• value the methodology of requirements-based engineering (RBE) and model-based requirements engineering (MBRE)</li> </ul>		
<i>Knowledge</i>			
<i>Skills</i>	Students are able to: <ul style="list-style-type: none"> <li>• plan the process for the development of complex Systems</li> <li>• organize the development phases and development Tasks</li> <li>• assign required business activities and technical Tasks</li> <li>• apply systems engineering methods and tools</li> </ul>		
<b>Personal Competence</b>			
<i>Social Competence</i>	Students are able to: <ul style="list-style-type: none"> <li>• understand their responsibilities within a development team and integrate themselves with their role in the overall process</li> </ul>		
<i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> <li>• interact and communicate in a development team which has distributed tasks</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 Minutes		
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

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Course L1547: Systems Engineering	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 78, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Ralf God
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The objective of the lecture with the corresponding exercise is to accomplish the prerequisites for the development and integration of complex systems using the example of commercial aircraft and cabin systems. Competences in the systems engineering process, tools and methods is to be achieved. Regulations, guidelines and certification issues will be known.</p> <p>Key aspects of the course are processes for innovation and technology management, system design, system integration and certification as well as tools and methods for systems engineering:</p> <ul style="list-style-type: none"> <li>• Innovation processes</li> <li>• IP-protection</li> <li>• Technology management</li> <li>• Systems engineering</li> <li>• Aircraft program</li> <li>• Certification issues</li> <li>• Systems development</li> <li>• Safety objectives and fault tolerance</li> <li>• Environmental and operating conditions</li> <li>• Tools for systems engineering</li> <li>• Requirements-based engineering (RBE)</li> <li>• Model-based requirements engineering (MBRE)</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>- Skript zur Vorlesung</li> <li>- diverse Normen und Richtlinien (EASA, FAA, RTCA, SAE)</li> <li>- Hauschildt, J., Salomo, S.: Innovationsmanagement. Vahlen, 5. Auflage, 2010</li> <li>- NASA Systems Engineering Handbook, National Aeronautics and Space Administration, 2007</li> <li>- Hinsch, M.: Industrielles Luftfahrtmanagement: Technik und Organisation luftfahrttechnischer Betriebe. Springer, 2010</li> <li>- De Florio, P.: Airworthiness: An Introduction to Aircraft Certification. Elsevier Ltd., 2010</li> <li>- Pohl, K.: Requirements Engineering. Grundlagen, Prinzipien, Techniken. 2. korrigierte Auflage, dpunkt.Verlag, 2008</li> </ul>

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

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
<b>Module Responsible</b>	Prof. Bodo Fiedler		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics: chemistry / physics / materials science		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the necessary testing and analysis.</p> <p>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).</p> <p><i>Skills</i> Students are capable of</p> <ul style="list-style-type: none"> <li>• using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials.</li> <li>• approximate sizing using the network theory of the structural elements implement and evaluate.</li> <li>• selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can</p> <ul style="list-style-type: none"> <li>• arrive at funded work results in heterogenius groups and document them.</li> <li>• provide appropriate feedback and handle feedback on their own performance constructively.</li> </ul> <p><i>Autonomy</i> Students are able to</p> <ul style="list-style-type: none"> <li>- assess their own strengths and weaknesses.</li> <li>- assess their own state of learning in specific terms and to define further work steps on this basis.</li> <li>- assess possible consequences of their professional activity.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Bodo Fiedler
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- Microstructure and properties of the matrix and reinforcing materials and their interaction</li> <li>- Development of composite materials</li> <li>- Mechanical and physical properties</li> <li>- Mechanics of Composite Materials</li> <li>- Laminate theory</li> <li>- Test methods</li> <li>- Non destructive testing</li> <li>- Failure mechanisms</li> <li>- Theoretical models for the prediction of properties</li> <li>- Application</li> </ul>
<b>Literature</b>	Hall, Clyne: Introduction to Composite materials, Cambridge University Press Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press Mallick: Fibre-Reinforced Composites, Marcel Dekker, New York

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

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

Module M1012: Laboratory of Logistics Engineering and Automatisatation			
Courses			
Title	Typ	Hrs/wk	CP
Laboratory Technical Logistics and Automatisatation (L1462)	Seminar	4	6
<b>Module Responsible</b>	Prof. Jochen Kreutzfeldt		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Bachelor degree in logistics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students will acquire the following knowledge:</p> <ol style="list-style-type: none"> <li>1. The students will learn various technical solutions for solving logistical problems using automatisatation in daily practice.</li> <li>2. The students know the necessary steps to implement a selected technical solution to automate logistical processes.</li> <li>3. The students know the approaches and obstacles to implement technical solutions for automating logistical processes.</li> </ol> <p><i>Skills</i> The students will acquire the following skills:</p> <ol style="list-style-type: none"> <li>1. The students are able to select technical solutions of automatisatation for logistical problems of warehousing, conveying, sorting, order picking and identifying and evaluate the implementability of the alternatives.</li> <li>2. The students are able to implement selected solutions of automatisatation in the model scale.</li> <li>3. The students are able to estimate the implementation costs of selected solutions of automatisatation.</li> </ol> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students will acquire the following social skills:</p> <ol style="list-style-type: none"> <li>1. The students are able to develop technical solutions for logistical problems and implement them on a model scale within a group of students.</li> <li>2. The technical solutions from the group can be jointly documented and presented to an audience.</li> <li>3. The students are able to derive new ideas and improvements from the feedback received related to their developed solution proposals.</li> </ol> <p><i>Autonomy</i> The students will acquire the following competencies:</p> <ol style="list-style-type: none"> <li>1. Students are able, under the guidance of supervisors, to develop and implement independently solutions of automatisatation for logistical problems of warehousing, conveying, sorting, order picking and identifying.</li> <li>2. The students are able to evaluate their technical solutions and discuss the pros and cons.</li> </ol>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written elaboration		
<b>Examination duration and scale</b>	Prototype construction in laboratory with documentation (group work)		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory		

<b>Course L1462: Laboratory Technical Logistics and Automatisation</b>	
<b>Typ</b>	Seminar
<b>Hrs/wk</b>	4
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Jochen Kreuzfeldt
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>The aim of the seminar is the practical introduction of students in various technical solutions to logistical problems. Above all, the guided development of own solutions is the core task in the laboratory. The problems and solutions will be drawn from the following logistic topics:</p> <ol style="list-style-type: none"> <li>(1) warehousing</li> <li>(2) conveying</li> <li>(3) sorting</li> <li>(4) order picking</li> <li>(5) identifying</li> </ol> <p>The students develop technical solutions in small groups for selected problems and implement them on a lab scale. The solutions are presented to an audience and advantages and disadvantages are discussed. The recorded feedback is then added to the model solution.</p>
<b>Literature</b>	<p>Dembowski, Klaus (2015): Raspberry Pi - Das technische Handbuch. Konfiguration, Hardware, Applikationserstellung. 2., erw. überarb. Aufl. 2015. Wiesbaden: Springer Vieweg.</p> <p>Follmann, Rüdiger (2014): Das Raspberry Pi Kompendium. 2014. Aufl. Berlin, Heidelberg: Springer Berlin Heidelberg (Xpert.press).</p> <p>Griemert, Rudolf (2015): Fördertechnik. Auswahl und Berechnung von Elementen und Baugruppen. [S.I.]: Morgan Kaufmann.</p> <p>Hompel, Michael ten; Büchter, Hubert; Franzke, Ulrich (2008): Identifikationssysteme und Automatisierung. [Intralogistik]. Berlin, Heidelberg: Springer.</p> <p>Hompel, Michael ten; Beck, Maria; Sadowsky, Volker (2011): Kommissionierung. Materialflusssysteme 2 - Planung und Berechnung der Kommissionierung in der Logistik. Berlin [u.a.]: Springer.</p> <p>Jodin, Dirk; Hompel, Michael ten (2012): Sortier- und Verteilsysteme. Grundlagen, Aufbau, Berechnung und Realisierung. 2. Aufl. Berlin: Springer Berlin.</p> <p>Martin, Heinrich (2014): Transport- und Lagerlogistik. Planung, Struktur, Steuerung und Kosten von Systemen der Intralogistik. 9., vollst. überarb. u. akt. Aufl. 2014. Wiesbaden: Imprint: Springer Vieweg.</p> <p>Purdum, Jack J. (2014): Beginning C for Arduino. Learn C programming for the Arduino. Second edition.: Springer Berlin.</p> <p>McRoberts, Michael (2014): Beginning Arduino. Second edition.: Springer Berlin.</p>

Module M1174: Automation Technology and Systems	
<b>Courses</b>	
<b>Title</b>	<b>Typ</b> <b>Hrs/wk</b> <b>CP</b>
Automation Technology and Systems (L2329)	Lecture 4 4
Automation Technology and Systems (L2331)	Project-/problem-based Learning 1 1
Automation Technology and Systems (L2330)	Recitation Section (small) 1 1
<b>Module Responsible</b>	Prof. Thorsten Schüppstuhl
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	without major course assessment
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
<i>Knowledge</i>	Students <ul style="list-style-type: none"> <li>know the characteristic components of an automation systems and have good understanding of their interaction</li> <li>know methods for a systematical analysis of automation tasks and are able to use them</li> <li>have special competences in industrial robot based automation systems</li> </ul>
<i>Skills</i>	Students are able to... <ul style="list-style-type: none"> <li>analyze complex Automation tasks</li> <li>develop application based concepts and solutions</li> <li>design subsystems and integrate into one system</li> <li>investigate and evaluate safety of machinery</li> <li>create simple programs for robots and programmable logic controllers</li> <li>design of circuit for pneumatic applications</li> </ul>
<b>Personal Competence</b>	
<i>Social Competence</i>	Students are able to ... <ul style="list-style-type: none"> <li>find solutions for automation and handling tasks in groups</li> <li>develop solutions in a production environment with qualified personnel at technical level and represent decisions.</li> </ul>
<i>Autonomy</i>	Students are able to ... <ul style="list-style-type: none"> <li>analyze automation tasks independently</li> <li>generate programs for robots and programmable logic devices autonomously</li> <li>develop solutions for practice oriented tasks of automation independently</li> <li>design safety concepts for automation applications</li> <li>assess consequences of their professional actions and responsibilities</li> </ul>
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84
<b>Credit points</b>	6
<b>Course achievement</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	120 min
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory

Course L2329: Automation Technology and Systems	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	4
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 64, Study Time in Lecture 56
<b>Lecturer</b>	Prof. Thorsten Schüppstuhl
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	
<b>Literature</b>	

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

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

Module M0563: Robotics				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Robotics: Modelling and Control (L0168)		Integrated Lecture	4	4
Robotics: Modelling and Control (L1305)		Project-/problem-based Learning	2	2
<b>Module Responsible</b>	Dr. Martin Gomse			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Fundamentals of electrical engineering Broad knowledge of mechanics Fundamentals of control theory			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to describe fundamental properties of robots and solution approaches for multiple problems in robotics.</p> <p><i>Skills</i> Students are able to derive and solve equations of motion for various manipulators.</p> <p>Students can generate trajectories in various coordinate systems.</p> <p>Students can design linear and partially nonlinear controllers for robotic manipulators.</p>			
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to work goal-oriented in small mixed groups.</p> <p><i>Autonomy</i> Students are able to recognize and improve knowledge deficits independently.</p> <p>With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.</p>			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Subject theoretical and practical work	and Teilnahme an PBL-Einheiten sowie Erreichen des Gesamtziels und der jeweiligen Session-Ziele
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			
Course L0168: Robotics: Modelling and Control				
<b>Typ</b>	Integrated Lecture			
<b>Hrs/wk</b>	4			
<b>CP</b>	4			
<b>Workload in Hours</b>	Independent Study Time 64, Study Time in Lecture 56			
<b>Lecturer</b>	Dr. Martin Gomse			
<b>Language</b>	EN			
<b>Cycle</b>	WiSe			
<b>Content</b>	Fundamental kinematics of rigid body systems Newton-Euler equations for manipulators Trajectory generation Linear and nonlinear control of robots			
<b>Literature</b>	Craig, John J.: Introduction to Robotics Mechanics and Control, Third Edition, Prentice Hall. ISBN 0201-54361-3 Spong, Mark W.; Hutchinson, Seth; Vidyasagar, M. : Robot Modeling and Control. WILEY. ISBN 0-471-64990-2			

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<b>Course L1305: Robotics: Modelling and Control</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Martin Gomse
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0808: Finite Elements Methods				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Finite Element Methods (L0291)		Lecture	2	3
Finite Element Methods (L0804)		Recitation Section (large)	2	3
<b>Module Responsible</b>	Prof. Otto von Estorff			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students possess an in-depth knowledge regarding the derivation of the finite element method and are able to give an overview of the theoretical and methodical basis of the method.			
<i>Skills</i>	The students are capable to handle engineering problems by formulating suitable finite elements, assembling the corresponding system matrices, and solving the resulting system of equations.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students can work in small groups on specific problems to arrive at joint solutions.			
<i>Autonomy</i>	The students are able to independently solve challenging computational problems and develop own finite element routines. Problems can be identified and the results are critically scrutinized.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	20 %	Midterm	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Civil Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Product Development, Materials and Production: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory			

Course L0291: Finite Element Methods	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Otto von Estorff
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- General overview on modern engineering</li> <li>- Displacement method</li> <li>- Hybrid formulation</li> <li>- Isoparametric elements</li> <li>- Numerical integration</li> <li>- Solving systems of equations (statics, dynamics)</li> <li>- Eigenvalue problems</li> <li>- Non-linear systems</li> <li>- Applications</li>   <li>- Programming of elements (Matlab, hands-on sessions)</li> <li>- Applications</li> </ul>
<b>Literature</b>	Bathe, K.-J. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

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

Module M1024: Methods of Integrated Product Development			
Courses			
Title	Typ	Hrs/wk	CP
Integrated Product Development II (L1254)	Lecture	3	3
Integrated Product Development II (L1255)	Project-/problem-based Learning	2	3
<b>Module Responsible</b>	Prof. Dieter Krause		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge of Integrated product development and applying CAE systems		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> After passing the module students are able to:</p> <ul style="list-style-type: none"> <li>• explain technical terms of design methodology,</li> <li>• describe essential elements of construction management,</li> <li>• describe current problems and the current state of research of integrated product development.</li> </ul> <p><i>Skills</i> After passing the module students are able to:</p> <ul style="list-style-type: none"> <li>• select and apply proper construction methods for non-standardized solutions of problems as well as adapt new boundary conditions,</li> <li>• solve product development problems with the assistance of a workshop based approach,</li> <li>• choose and execute appropriate moderation techniques.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> After passing the module students are able to:</p> <ul style="list-style-type: none"> <li>• prepare and lead team meetings and moderation processes,</li> <li>• work in teams on complex tasks,</li> <li>• represent problems and solutions and advance ideas.</li> </ul> <p><i>Autonomy</i> After passing the module students are able to:</p> <ul style="list-style-type: none"> <li>• give a structured feedback and accept a critical feedback,</li> <li>• implement the accepted feedback autonomously.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Oral exam		
<b>Examination duration and scale</b>	30 Minuten		
<b>Assignment for the Following Curricula</b>	Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L1254: Integrated Product Development II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Dieter Krause
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>Lecture</b></p> <p>The lecture extends and enhances the learned content of the module "Integrated Product Development and lightweight design" and is based on the knowledge and skills acquired there.</p> <p>Topics of the course include in particular:</p> <ul style="list-style-type: none"> <li>• Methods of product development,</li> <li>• Presentation techniques,</li> <li>• Industrial Design,</li> <li>• Design for variety</li> <li>• Modularization methods,</li> <li>• Design catalogs,</li> <li>• Adapted QFD matrix,</li> <li>• Systematic material selection,</li> <li>• Assembly oriented design,</li> </ul> <p>Construction management</p> <ul style="list-style-type: none"> <li>• CE mark, declaration of conformity including risk assessment,</li> <li>• Patents, patent rights, patent monitoring</li> <li>• Project management (cost, time, quality) and escalation principles,</li> <li>• Development management for mechatronics,</li> <li>• Technical Supply Chain Management.</li> </ul> <p><b>Exercise (PBL)</b></p> <p>In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and design management will be enhanced.</p> <p>Students learn an independently moderated and workshop based approach through industry related practice examples to solve complex and currently existing issues in product development. They will learn the ability to apply important methods of product development and design management autonomous and acquire further expertise in the field of integrated product development. Besides personal skills, such as teamwork, guiding discussions and representing work results will be acquired through the workshop based structure of the event under its own planning and management.</p>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Andreassen, M.M., Design for Assembly, Berlin, Springer 1985.</li> <li>• Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007.</li> <li>• Beckmann, H.: Supply Chain Management, Berlin, Springer 2004.</li> <li>• Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer, Weinheim, Beltz 2007.</li> <li>• Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006.</li> <li>• Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000.</li> <li>• Simpson, T.W., Siddique, Z., Jiao, R.J.: Product Platform and Product Family Design. Methods and Applications, New York, Springer 2013.</li> </ul>

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

Module M1025: Fluidics				
Courses				
Title	Typ	Hrs/wk	CP	
Fluidics (L1256)	Lecture	2	3	
Fluidics (L1371)	Project-/problem-based Learning	1	2	
Fluidics (L1257)	Recitation Section (large)	1	1	
<b>Module Responsible</b>	Prof. Dieter Krause			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Good knowledge of mechanics (stereo statics, elastostatics, hydrostatics, kinematics and kinetics), fluid mechanics, and engineering design			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	After passing the module students are able to			
	<ul style="list-style-type: none"> <li>explain structures and functionalities of hydrostatic, pneumatic, and hydrodynamic components,</li> <li>explain the interaction of hydraulic components in hydraulic systems,</li> <li>explain open and closed loop control of hydraulic systems,</li> <li>describe functioning and applications of hydrodynamic torque converters, brakes and clutches as well as centrifugal pumps and aggregates in plant technology</li> </ul>			
<i>Skills</i>	After passing the module students are able to			
	<ul style="list-style-type: none"> <li>analyse and assess hydraulic and pneumatic components and systems,</li> <li>design and dimension hydraulic systems for mechanical applications,</li> <li>perform numerical simulations of hydraulic systems based on abstract problem definitions,</li> <li>select and adapt pump characteristic curves for hydraulic systems</li> <li>dimension hydrodynamic torque converters and brakes for mechanical aggregates.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	After passing the module students are able to			
	<ul style="list-style-type: none"> <li>discuss and present functional context in groups,</li> <li>organise teamwork autonomously.</li> </ul>			
<i>Autonomy</i>	After passing the module students are able to			
	<ul style="list-style-type: none"> <li>obtain necessary knowledge for the simulation.</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Attestation	Simulation hydrostatischer Systeme
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Course L1256: Fluidics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Dieter Krause
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p><b>Lecture</b></p> <p>Hydrostatics</p> <ul style="list-style-type: none"> <li>• physical fundamentals</li> <li>• hydraulic fluids</li> <li>• hydrostatic machines</li> <li>• valves</li> <li>• components</li> <li>• hydrostatic transmissions</li> <li>• examples from industry</li> </ul> <p>Pneumatics</p> <ul style="list-style-type: none"> <li>• generation of compressed air</li> <li>• pneumatic motors</li> <li>• Examples of use</li> </ul> <p>Hydrodynamics</p> <ul style="list-style-type: none"> <li>• physical fundamentals</li> <li>• hydraulic continuous-flow machines</li> <li>• hydrodynamic transmissions</li> <li>• interoperation of motor and transmission</li> </ul> <p><b>Exercise</b></p> <p>Hydrostatics</p> <ul style="list-style-type: none"> <li>• reading and design of hydraulic diagrams</li> <li>• dimensioning of hydrostatic traction and working drives</li> <li>• performance calculation</li> </ul> <p>Hydrodynamics</p> <ul style="list-style-type: none"> <li>• calculation / dimensioning of hydrodynamic torque converters</li> <li>• calculation / dimensioning of centrifugal pumps</li> <li>• creating and reading of characteristic curves of pumps and systems</li> </ul> <p>Field trip</p> <ul style="list-style-type: none"> <li>• field trip to a regional company from the hydraulic industry.</li> </ul> <p><b>Exercise</b></p> <p>Numerical simulation of hydrostatic systems</p> <ul style="list-style-type: none"> <li>• getting to know a numerical simulation environment for hydraulic systems</li> <li>• transformation of a task into a simulation model</li> <li>• simulation of common components</li> <li>• variation of simulation parameters</li> <li>• using simulations for system dimensioning and optimisation</li> <li>• (partly) self-organised teamwork</li> </ul>
<b>Literature</b>	<p>Bücher</p> <ul style="list-style-type: none"> <li>• Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011</li> <li>• Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Pneumatik, Shaker Verlag, Aachen, 2006</li> <li>• Matthies, H.J. Renius, K.Th.: Einführung in die Ölhydraulik, Teubner Verlag, 2006</li> <li>• Beitz, W., Grote, K.-H.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage</li> </ul> <p>Skript zur Vorlesung</p>

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

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

Module M0633: Industrial Process Automation				
Courses				
Title	Typ	Hrs/wk	CP	
Industrial Process Automation (L0344)	Lecture	2	3	
Industrial Process Automation (L0345)	Recitation Section (small)	2	3	
<b>Module Responsible</b>	Prof. Alexander Schlaefer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	mathematics and optimization methods principles of automata principles of algorithms and data structures programming skills			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students can evaluate and assess discrete event systems. They can evaluate properties of processes and explain methods for process analysis. The students can compare methods for process modelling and select an appropriate method for actual problems. They can discuss scheduling methods in the context of actual problems and give a detailed explanation of advantages and disadvantages of different programming methods. The students can relate process automation to methods from robotics and sensor systems as well as to recent topics like 'cyberphysical systems' and 'industry 4.0'.			
<i>Skills</i>	The students are able to develop and model processes and evaluate them accordingly. This involves taking into account optimal scheduling, understanding algorithmic complexity, and implementation using PLCs.			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students can independently define work processes within their groups, distribute tasks within the group and develop solutions collaboratively.			
<i>Autonomy</i>	The students are able to assess their level of knowledge and to document their work results adequately.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Exercices	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 minutes			
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory			

Course L0344: Industrial Process Automation	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Schlaefer
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>- foundations of problem solving and system modeling, discrete event systems</li> <li>- properties of processes, modeling using automata and Petri-nets</li> <li>- design considerations for processes (mutex, deadlock avoidance, liveness)</li> <li>- optimal scheduling for processes</li> <li>- optimal decisions when planning manufacturing systems, decisions under uncertainty</li> <li>- software design and software architectures for automation, PLCs</li> </ul>
<b>Literature</b>	<p>J. Lunze: „Automatisierungstechnik“, Oldenbourg Verlag, 2012</p> <p>Reisig: Petrinetze: Modellierungstechnik, Analysemethoden, Fallstudien; Vieweg+Teubner 2010</p> <p>Hrúz, Zhou: Modeling and Control of Discrete-event Dynamic Systems; Springer 2007</p> <p>Li, Zhou: Deadlock Resolution in Automated Manufacturing Systems, Springer 2009</p> <p>Pinedo: Planning and Scheduling in Manufacturing and Services, Springer 2009</p>

Course L0345: Industrial Process Automation	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Schlaefer
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0739: Factory Planning & Production Logistics			
Courses			
Title	Typ	Hrs/wk	CP
Factory Planning (L1445)	Lecture	3	3
Production Logistics (L1446)	Lecture	2	3
<b>Module Responsible</b>	Prof. Jochen Kreutzfeldt		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Bachelor degree in logistics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students will acquire the following knowledge:</p> <ol style="list-style-type: none"> <li>1. The students know the latest trends and developments in the planning of factories.</li> <li>2. The students can explain basic procedures of factory planning and are able to deploy these procedures while considering different conditions.</li> <li>3. The students know different methods of factory planning and are able to deal critically with these methods.</li> </ol> <p><i>Skills</i> The students will acquire the following skills:</p> <ol style="list-style-type: none"> <li>1. The students are able to analyze factories and other material flow systems with regard to new development and the need for change of these logistical systems.</li> <li>2. The students are able to plan and redesign factories and other material handling systems.</li> <li>3. The students are able to develop procedures for the implementation of new and revised material flow systems.</li> </ol>		
<b>Personal Competence</b>	<p><i>Social Competence</i> The students will acquire the following social skills:</p> <ol style="list-style-type: none"> <li>1. The students are able to develop plans for the development of new and improvement of existing material flow systems within a group.</li> <li>2. The developed planning proposal from the group work can be documented and presented together.</li> <li>3. The students are able to derive suggestions for improvement from the feedback on the planning proposals and can even provide constructive criticism themselves.</li> </ol> <p><i>Autonomy</i> The students will acquire the following independent competencies:</p> <ol style="list-style-type: none"> <li>1. The students can plan and re-design material flow systems using existing planning procedures.</li> <li>2. The students can evaluate independently the strengths and weaknesses of several techniques for factory planning and choose appropriate methods in a given context.</li> <li>3. The students are able to carry out autonomously new plans and transformations of material flow systems.</li> </ol>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L1445: Factory Planning	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Jochen Kreutzfeldt, Philipp Maximilian Braun
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>The lecture gives an introduction into the planning of factories and material flows. The students will learn process models and methods to plan new factories and improve existing material flow systems. The course includes three basic topics:</p> <ol style="list-style-type: none"> <li>(1) Analysis of factory and material flow systems</li> <li>(2) Development and re-planning of factory and material flow systems</li> <li>(3) Implementation and realization of factory planning</li> </ol> <p>The students are introduced into several different methods and models per topic. Practical examples and planning exercises deepen the methods and explain the application of factory planning.</p> <p>The special requirements of factory planning in an international context are discussed. Specific requirements of Current trends and issues in the factory planning round off the lecture.</p>
<b>Literature</b>	<p>Bracht, Uwe; Wenzel, Sigrid; Geckler, Dieter (2018): Digitale Fabrik: Methoden und Praxisbeispiele. 2. Aufl.: Springer, Berlin.</p> <p>Helbing, Kurt W. (2010): Handbuch Fabrikprojektierung. Berlin, Heidelberg: Springer Berlin Heidelberg.</p> <p>Lotter, Bruno; Wiendahl, Hans-Peter (2012): Montage in der industriellen Produktion: Optimierte Abläufe, rationelle Automatisierung. 2. Aufl.: Springer, Berlin.</p> <p>Müller, Egon; Engelmann, Jörg; Löffler, Thomas; Jörg, Strauch (2009): Energieeffiziente Fabriken planen und betreiben. Berlin, Heidelberg: Springer Berlin Heidelberg.</p> <p>Schenk, Michael; Müller, Egon; Wirth, Siegfried (2014): Fabrikplanung und Fabrikbetrieb. Methoden für die wandlungsfähige, vernetzte und ressourceneffiziente Fabrik. 2. Aufl. Berlin [u.a.]: Springer Vieweg.</p> <p>Wiendahl, Hans-Peter; Reichardt, Jürgen; Nyhuis, Peter (2014): Handbuch Fabrikplanung: Konzept, Gestaltung und Umsetzung wandlungsfähiger Produktionsstätten. 2. Aufl. Carl Hanser Verlag.</p>

Course L1446: Production Logistics	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dipl.-Ing. Arnd Schirrmann
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction: situation, significance and main innovation focuses of logistics in a production company, aspects of procurement, production, distribution and disposal logistics, production and transport networks</li> <li>• Logistics as a production strategy: logistics-oriented method of working in a factory, throughput time, corporate strategy, structured networking, reducing complexity, integrated organization, integrated product and production logistics (IPPL)</li> <li>• Logistics-compatible production and process structuring; logistics-compatible product, material flow, information and organizational structures</li> <li>• Logistics-oriented production control: situation and development tendencies, logistics and cybernetics, market-oriented production planning, control, monitoring, PPS systems and production control, cybernetic production organization and control, production logistics control systems.</li> <li>• Production logistics planning: key performance indicators, developing a production logistics concept, computerized aids to planning production logistics, IPPL functions, economic efficiency of logistics projects</li> <li>• Production logistics controlling: production logistics and controlling, material flow-oriented cost transparency, cost controlling (process cost accounting, costs model in IPPL), process controlling (integrated production system, methods and tools, MEPOT.net method portal)</li> </ul>
<b>Literature</b>	Pawellek, G.: Produktionslogistik: Planung - Steuerung - Controlling. Carl Hanser Verlag 2007

Module M1170: Phenomena and Methods in Materials Science			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Experimental Methods for the Characterization of Materials (L1580)		Lecture	2
Phase equilibria and transformations (L1579)		Lecture	2
Übung zu Phänomene und Methoden der Materialwissenschaft (L2991)		Recitation Section (large)	2
<b>Module Responsible</b>	Prof. Jörg Weißmüller		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge in Materials Science, e.g. Werkstoffwissenschaft I/II		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.		
<i>Skills</i>	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to present solutions to specialists and to develop ideas further.		
<i>Autonomy</i>	The students are able to ... <ul style="list-style-type: none"> <li>• assess their own strengths and weaknesses.</li> <li>• gather new necessary expertise by their own.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory		

Course L1580: Experimental Methods for the Characterization of Materials	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Shan Shi
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography)</li> <li>• Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements)</li> <li>• Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)</li> </ul>
<b>Literature</b>	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

<b>Course L1579: Phase equilibria and transformations</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Jörg Weißmüller
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	Fundamentals of statistical physics, formal structure of phenomenological thermodynamics, simple atomistic models and free-energy functions of solid solutions and compounds. Corrections due to nonlocal interaction (elasticity, gradient terms). Phase equilibria and alloy phase diagrams as consequence thereof. Simple atomistic considerations for interaction energies in metallic solid solutions. Diffusion in real systems. Kinetics of phase transformations for real-life boundary conditions. Partitioning, stability and morphology at solidification fronts. Order of phase transformations; glass transition. Phase transitions in nano- and microscale systems.
<b>Literature</b>	D.A. Porter, K.E. Easterling, "Phase transformations in metals and alloys", New York, CRC Press, Taylor & Francis, 2009, 3. Auflage Peter Haasen, „Physikalische Metallkunde“ , Springer 1994 Herbert B. Callen, "Thermodynamics and an introduction to thermostatistics", New York, NY: Wiley, 1985, 2. Auflage. Robert W. Cahn und Peter Haasen, "Physical Metallurgy", Elsevier 1996 H. Ibach, "Physics of Surfaces and Interfaces" 2006, Berlin: Springer.

<b>Course L2991: Übung zu Phänomene und Methoden der Materialwissenschaft</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Shan Shi
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	
<b>Literature</b>	

Module M0867: Production Planning & Control and Digital Enterprise			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
The Digital Enterprise (L0932)		Lecture	2
Production Planning and Control (L0929)		Lecture	2
Production Planning and Control (L0930)		Recitation Section (small)	1
Exercise: The Digital Enterprise (L0933)		Recitation Section (small)	1
<b>Module Responsible</b>	Prof. Hermann Lödging		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Fundamentals of Production and Quality Management		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students can explain the contents of the module in detail and take a critical position to them.</p> <p><i>Skills</i> Students are capable of choosing and applying models and methods from the module to industrial problems.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students can develop joint solutions in mixed teams and present them to others.</p> <p><i>Autonomy</i> -</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	180 Minuten		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L0932: The Digital Enterprise	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Robert Rost
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered.</p> <p>Content:</p> <ul style="list-style-type: none"> <li>• Business Process Management and Data Modelling, Simulation</li> <li>• Knowledge and Competence Management</li> <li>• Process Management (PPC, Workflow Management)</li> <li>• Computer Aided Planning (CAP) and NC-Programming</li> <li>• Virtual Reality (VR) and Augmented Reality (AR)</li> <li>• Computer Aided Quality Management (CAQ)</li> <li>• Industry 4.0</li> </ul>
<b>Literature</b>	Scheer, A.-W.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002 Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag, Berlin 3. Auflage 2006 Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004 Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007 Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006

Course L0929: Production Planning and Control	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Hermann Lödding
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Models of Production and Inventory Management</li> <li>• Production Programme Planning and Lot Sizing</li> <li>• Order and Capacity Scheduling</li> <li>• Selected Strategies of PPC</li> <li>• Manufacturing Control</li> <li>• Production Controlling</li> <li>• Supply Chain Management</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Vorlesungsskript</li> <li>• Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008</li> <li>• Nyhuis, P.; Wiendahl, H.-P.: Logistische Kennlinien, Springer 2002</li> </ul>

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

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

Module M1813: Agile learning with agile methods				
Courses				
Title	Typ	Hrs/wk	CP	
Agile Data Science for industrial Engineers (L3009)	Project-/problem-based Learning	3	6	
<b>Module Responsible</b>	Prof. Kathrin Fischer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Scientific Writing			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know: <ul style="list-style-type: none"> <li>• Basic principles of agile work</li> <li>• Roles within agile project management based on Scrum</li> <li>• Structure and workflows of agile project groups</li> <li>• Basic functions/classes/methods of data science in python</li> <li>• Selected libraries of data science in Python</li> </ul>			
<i>Skills</i>	The students are able to: <ul style="list-style-type: none"> <li>• Plan and carry out a project based on the Scrum philosophy, in detail: <ul style="list-style-type: none"> <li>◦ Define and allocate roles in Scrum</li> <li>◦ Plan Scrum sprints based on self-defined work packages (planning)</li> <li>◦ Carry out Scrum sprints</li> <li>◦ Complete, analyse and evaluate Scrum sprints (review and retrospective)</li> <li>◦ Present project results</li> </ul> </li> <li>• Use established tools of collaborative work</li> <li>• Writing simple scientific scripts for data science in Python collaboratively</li> <li>• Record the methods and results</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to: <ul style="list-style-type: none"> <li>• Work in heterogenic project groups and accept their defined roles based on the scrum philosophy</li> <li>• Commit to group intern time management necessities</li> <li>• Manage scope adjustments under time pressure</li> <li>• Realize and judge the importance of individual commitments for collaborative work</li> <li>• Communicate with stakeholders of their group project</li> </ul>			
<i>Autonomy</i>	The students are able to: <ul style="list-style-type: none"> <li>• Evaluate work packages regarding their practicability and commit to working on these individually</li> <li>• Evaluate their own skills regarding their contribution to a given project</li> <li>• Harmonize their own time management to the group intern time management</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Group discussion	
<b>Examination</b>	Written elaboration			
<b>Examination duration and scale</b>	Approx. 5 - 10 pages per person			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			

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<b>Course L3009: Agile Data Science for industrial Engineers</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Within this course, the fundamentals of Python for Data Science are taught and applied on a collaborative level.</p> <p>The course starts with an introduction to Python which is held in workshop format, and an introduction to collaborative work and agile project management.</p> <p>During this course different projects will be carried out in project groups, following the scrum philosophy.</p> <p>The course is dedicated to programming beginners, so no prior knowledge of Python is required. However, also students with programming experience are welcome to participate.</p> <p>For the exam, teams are required to write a report on the group projects and their results.</p>
<b>Literature</b>	Schwaber, K. & Sutherland, J. (2020): The Scrum Guide. Online Ressource

**Specialization II. Renewable Energy**

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
<b>Module Responsible</b>	Prof. Martin Kaltschmitt		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	none		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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 evaluate 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.</p> <p><i>Skills</i> 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 evaluate the economic and ecologic conditions of these systems. They can select calculation methods within the radiation theory for these topics.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module.</p> <p><i>Autonomy</i> Students can independently exploit sources and acquire the particular knowledge about the subject area with respect to emphasis for 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	3 hours written exam		
<b>Assignment for the Following Curricula</b>	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		

<b>Course L0016: Energy Meteorology</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Volker Matthias, Dr. Beate Geyer
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction: radiation source Sun, Astronomical Foundations, Fundamentals of radiation</li> <li>• Structure of the atmosphere</li> <li>• Properties and laws of radiation                             <ul style="list-style-type: none"> <li>◦ Polarization</li> <li>◦ Radiation quantities</li> <li>◦ Planck's radiation law</li> <li>◦ Wien's displacement law</li> <li>◦ Stefan-Boltzmann law</li> <li>◦ Kirchhoff's law</li> <li>◦ Brightness temperature</li> <li>◦ Absorption, reflection, transmission</li> </ul> </li> <li>• Radiation balance, global radiation, energy balance</li> <li>• Atmospheric extinction</li> <li>• Mie and Rayleigh scattering</li> <li>• Radiative transfer</li> <li>• Optical effects in the atmosphere</li> <li>• Calculation of the sun and calculate radiation on inclined surfaces</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Helmut Kraus: Die Atmosphäre der Erde</li> <li>• Hans Häckel: Meteorologie</li> <li>• Grant W. Petty: A First Course in Atmospheric Radiation</li> <li>• Martin Kaltschmitt, Wolfgang Streicher, Andreas Wiese: Renewable Energy</li> <li>• Alexander Löw, Volker Matthias: Skript Optik Strahlung Fernerkundung</li> </ul>

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

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Course L0018: Collector Technology	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Agis Papadopoulos
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction: Energy demand and application of solar energy.</li> <li>• Heat transfer in the solar thermal energy: conduction, convection, radiation.</li> <li>• Collectors: Types, structure, efficiency, dimensioning, concentrated systems.</li> <li>• Energy storage: Requirements, types.</li> <li>• Passive solar energy: components and systems.</li> <li>• Solar thermal low temperature systems: collector variants, construction, calculation.</li> <li>• Solar thermal high temperature systems: Classification of solar power plants construction.</li> <li>• Solar air conditioning.</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Vorlesungsskript.</li> <li>• Kaltschmitt, Streicher und Wiese (Hrsg.). Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte, 5. Auflage, Springer, 2013.</li> <li>• Stieglitz und Heinzel .Thermische Solarenergie: Grundlagen, Technologie, Anwendungen. Springer, 2012.</li> <li>• Von Böckh und Wetzel. Wärmeübertragung: Grundlagen und Praxis, Springer, 2011.</li> <li>• Baehr und Stephan. Wärme- und Stoffübertragung. Springer, 2009.</li> <li>• de Vos. Thermodynamics of solar energy conversion. Wiley-VCH, 2008.</li> <li>• Mohr, Svoboda und Unger. Praxis solarthermischer Kraftwerke. Springer, 1999.</li> </ul>

Course L0015: Solar Power Generation	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Martin Schlecht, Prof. Alf Mews, Roman Fritsches-Baguhl, Paola Pignatelli
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Photovoltaics:</p> <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Primary energies and consumption, available solar energy</li> <li>3. Physics of the ideal solar cell</li> <li>4. Light absorption, PN transition, characteristic sizes of the solar cell, efficiency</li> <li>5. Physics of the real solar cell</li> <li>6. Charge carrier recombination, characteristic curves, barrier layer recombination, equivalent circuit diagram</li> <li>7. Increasing efficiency</li> <li>8. Methods for increasing the quantum yield and reducing recombination</li> <li>9. Hetero- and tandem structures</li> <li>10. Heterojunction, Schottky, electrochemical, MIS and SIS cell, tandem cell</li> <li>11. Concentrator cells</li> <li>12. Concentrator optics and tracking systems, concentrator cells</li> <li>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)</li> <li>14. Modules</li> <li>15. Switches</li> </ol> <p>Concentrating solar power plants:</p> <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Point focused technologies</li> <li>3. Line focused technologies</li> <li>4. Design of CSP projects</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• A. Götzberger, B. Voß, J. Knobloch: Sonnenenergie: Photovoltaik, Teubner Studienskripten, Stuttgart, 1995</li> <li>• A. Götzberger: Sonnenenergie: Photovoltaik : Physik und Technologie der Solarzelle, Teubner Stuttgart, 1994</li> <li>• H.-J. Lewerenz, H. Jungblut: Photovoltaik, Springer, Berlin, Heidelberg, New York, 1995</li> <li>• A. Götzberger: Photovoltaic solar energy generation, Springer, Berlin, 2005</li> <li>• C. Hu, R. M. White: Solar Cells, Mc Graw Hill, New York, 1983</li> <li>• H.-G. Wagemann: Grundlagen der photovoltaischen Energiewandlung: Solarstrahlung, Halbleitereigenschaften und Solarzellenkonzepte, Teubner, Stuttgart, 1994</li> <li>• R. J. van Overstraeten, R.P. Mertens: Physics, technology and use of photovoltaics, Adam Hilger Ltd, Bristol and Boston, 1986</li> <li>• B. O. Seraphin: Solar energy conversion Topics of applied physics V 01 31, Springer, Berlin, Heidelberg, New York, 1995</li> <li>• P. Würfel: Physics of Solar cells, Principles and new concepts, Wiley-VCH, Weinheim 2005</li> <li>• U. Rindelhardt: Photovoltaische Stromversorgung, Teubner-Reihe Umwelt, Stuttgart 2001</li> <li>• V. Quaschnig: Regenerative Energiesysteme, Hanser, München, 2003</li> <li>• G. Schmitz: Regenerative Energien, Ringvorlesung TU Hamburg-Harburg 1994/95, Institut für Energietechnik</li> </ul>

Module M0527: Marine Soil Technics			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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
<b>Module Responsible</b>	Dr. Isabel Höfer		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge in analysis and differential equations Basics of maritime technology		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students can 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.</p> <p><i>Skills</i> 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 .</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> none</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	2 hours written exam		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory		

Course L0068: Analysis of Maritime Systems	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud, Dr. Alexander Mitzlaff
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Hydrostatic analysis <ul style="list-style-type: none"> <li>◦ Buoyancy,</li> <li>◦ Stability,</li> </ul> </li> <li>2. Hydrodynamic analysis <ul style="list-style-type: none"> <li>◦ Froude-Krylov force</li> <li>◦ Morison's equation,</li> <li>◦ Radiation and diffraction</li> <li>◦ transparent/compact structures</li> </ul> </li> <li>3. Evaluation of offshore structures: Reliability techniques (security, reliability, disposability) <ul style="list-style-type: none"> <li>◦ Short-term statistics</li> <li>◦ Long-term statistics and extreme events</li> </ul> </li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• G. Clauss, E. Lehmann, C. Østergaard. Offshore Structures Volume I: Conceptual Design and Hydrodynamics. Springer Verlag Berlin, 1992</li> <li>• E. V. Lewis (Editor), Principles of Naval Architecture ,SNAME, 1988</li> <li>• Journal of Offshore Mechanics and Arctic Engineering</li> <li>• Proceedings of International Conference on Offshore Mechanics and Arctic Engineering</li> <li>• S. Chakrabarti (Ed.), Handbook of Offshore Engineering, Volumes 1-2, Elsevier, 2005</li> <li>• S. K. Chakrabarti, Hydrodynamics of Offshore Structures , WIT Press, 2001</li> </ul>

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

Course L0067: Offshore Geotechnical Engineering	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Jan Dührkop
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Overview and Introduction Offshore Geotechnics</li> <li>• Introduction to Soil Mechanics</li> <li>• Offshore soil investigation</li> <li>• Focus on cyclical effects</li> <li>• Geotechnical design of offshore foundations</li> <li>• Monopiles</li> <li>• Jackets</li> <li>• Heavyweight foundations</li> <li>• Geotechnical preliminary exploration for the use of lift boats and platforms</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press.</li> <li>• Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>• BSH-Standard Baugrunderkundung für Offshore-Windenergieparks</li> <li>• Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen.</li> <li>• EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst &amp; Sohn, Berlin.</li> </ul>

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
<b>Module Responsible</b>	Prof. Martin Kaltschmitt		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Module: Technical Thermodynamics I Module: Technical Thermodynamics II		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p><i>Skills</i> 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.</p> <p>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.</p>		
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module.</p> <p><i>Autonomy</i> Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	3 hours written exam		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Fröba
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction to electrochemical energy conversion</li> <li>2. Function and structure of electrolyte</li> <li>3. Low-temperature fuel cell               <ul style="list-style-type: none"> <li>◦ Types</li> <li>◦ Thermodynamics of the PEM fuel cell</li> <li>◦ Cooling and humidification strategy</li> </ul> </li> <li>4. High-temperature fuel cell               <ul style="list-style-type: none"> <li>◦ The MCFC</li> <li>◦ The SOFC</li> <li>◦ Integration Strategies and partial reforming</li> </ul> </li> <li>5. Fuels               <ul style="list-style-type: none"> <li>◦ Supply of fuel</li> <li>◦ Reforming of natural gas and biogas</li> <li>◦ Reforming of liquid hydrocarbons</li> </ul> </li> <li>6. Energetic Integration and control of fuel cell systems</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Hamann, C.; Vielstich, W.: Elektrochemie 3. Aufl.; Weinheim: Wiley - VCH, 2003</li> </ul>

Course L0019: Energy Trading	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Michael Sagorje, Dr. Sven Orłowski
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Basic concepts and tradable products in energy markets</li> <li>• Primary energy markets</li> <li>• Electricity Markets</li> <li>• European Emissions Trading Scheme</li> <li>• Influence of renewable energy</li> <li>• Real options</li> <li>• Risk management</li> </ul> <p>Within the exercise the various tasks are actively discussed and applied to various cases of application.</p>
<b>Literature</b>	

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

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<b>Course L0025: Deep Geothermal Energy</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Ben Norden
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction to the deep geothermal use</li> <li>2. Geological Basics I</li> <li>3. Geological Basics II</li> <li>4. Geology and thermal aspects</li> <li>5. Rock Physical Aspects</li> <li>6. Geochemical aspects</li> <li>7. Exploration of deep geothermal reservoirs</li> <li>8. Drilling technologies, piping and expansion</li> <li>9. Borehole Geophysics</li> <li>10. Underground system characterization and reservoir engineering</li> <li>11. Microbiology and Upper-day system components</li> <li>12. Adapted investment concepts, cost and environmental aspect</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012)</li> <li>• <a href="http://www.geo-energy.org">www.geo-energy.org</a></li> <li>• Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2012.</li> <li>• Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013.</li> <li>• Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001)</li> <li>• Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH &amp; Co. KGaA; Auflage: 1. Auflage (19. April 2010)</li> </ul>

Module M0518: Waste and Energy			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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
<b>Module Responsible</b>	Prof. Kerstin Kuchta		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of process engineering		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to describe and explain in detail techniques, processes and concepts for treatment and energy recovery from wastes.</p> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> 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 colleagues. Furthermore, they can give and accept professional constructive criticism.</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>
	Yes	20 %	Written elaboration
<b>Examination</b>	Presentation		
<b>Examination duration and scale</b>	PowerPoint presentation (10-15 minutes)		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Fundamentals on primary and secondary production of raw materials (steel, aluminum, phosphorous, copper, precious metals, rare metals)</li> <li>• Use and demand of metals and minerals in industry and society</li> <li>• collection systems and concepts</li> <li>• quota and efficiency</li> <li>• Advanced sorting technologies</li> <li>• mechanical pretreatment</li> <li>• advanced treatment</li> <li>• Chemical analysis of Critical Materials in post-consumer products</li> <li>• Analytical tools in Resource Management (Material Flow Analysis, Recycling Performance Indicators, Criticality Assessment, statistical analysis of uncertainties)</li> </ul>
<b>Literature</b>	

Course L0048: Waste Recycling Technologies	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Fundamentals on primary and secondary production of raw materials (steel, aluminum, phosphorous, copper, precious metals, rare metals)</li> <li>• Use and demand of metals and minerals in industry and society</li> <li>• collection systems and concepts</li> <li>• quota and efficiency</li> <li>• Advanced sorting technologies</li> <li>• mechanical pretreatment</li> <li>• advanced treatment</li> <li>• Chemical analysis of Critical Materials in post-consumer products</li> <li>• Analytical tools in Resource Management (Material Flow Analysis, Recycling Performance Indicators, Criticality Assessment, statistical analysis of uncertainties)</li> </ul>
<b>Literature</b>	

Course L0049: Waste to Energy	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Rüdiger Siechau
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Project-based lecture</li> <li>• Introduction into the " Waste to Energy " consisting of: <ul style="list-style-type: none"> <li>◦ Thermal Process ( incinerator , RDF combustion )</li> <li>◦ Biological processes ( Wet-/Dryfermentation )</li> <li>◦ technology , energy , emissions, approval , etc.</li> </ul> </li> <li>• Group work <ul style="list-style-type: none"> <li>◦ design of systems/plants for energy recovery from waste</li> <li>◦ The following points are to be processed : <ul style="list-style-type: none"> <li>▪ Input: waste ( fraction collection and transportation, current quantity , material flows , possible amount of development )</li> <li>▪ Plant (design, process diagram , technology, energy production )</li> <li>▪ Output ( energy quantity / type , by-products )</li> <li>▪ Costs and revenues</li> <li>▪ Climate and resource protection ( CO2 balance , substitution of primary raw materials / fossil fuels )</li> <li>▪ Location and approval (infrastructure , expiration authorization procedure)</li> <li>▪ Focus at the whole concept ( advantages, disadvantages , risks and opportunities , discussion )</li> </ul> </li> </ul> </li> <li>• Grading: No Exam , but presentation of the results of the working group</li> </ul>
<b>Literature</b>	<p><b>Literatur:</b></p> <p>Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010</p> <p>Powerpoint-Folien in Stud IP</p> <p><b>Literature:</b></p> <p>Introduction to Waste Management; Kranert Martin , Klaus Cord - Landwehr (Ed. ), Vieweg + Teubner Verlag , 2010</p> <p>PowerPoint slides in Stud IP</p>

Module M0749: Waste Treatment and Solid Matter Process Technology			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
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
<b>Module Responsible</b>	Prof. Kerstin Kuchta		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of <ul style="list-style-type: none"> <li>• thermo dynamics</li> <li>• fluid dynamics</li> <li>• chemistry</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p>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.</p> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can</p> <ul style="list-style-type: none"> <li>• respectfully work together as a team and discuss technical tasks</li> <li>• participate in subject-specific and interdisciplinary discussions,</li> <li>• develop cooperated solutions</li> <li>• promote the scientific development and accept professional constructive criticism.</li> </ul> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Werner Sitzmann
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	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 BtI - and WPC - products. Aspects of explosion protection and plant design complete the lecture.
<b>Literature</b>	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamasse, 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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals</li> <li>• basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition</li> <li>• Incineration techniques: grate firing, ash transfer, boiler</li> <li>• Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination</li> <li>• Ash treatment: Mass, quality, treatment concepts, recycling, disposal</li> </ul>
<b>Literature</b>	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

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

Module M0511: Electrical Energy from Solar Radiation and Wind Power			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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
<b>Module Responsible</b>	Dr. Isabel Höfer		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Module: Technical Thermodynamics I, Module: Technical Thermodynamics II, Module: Fundamentals of Fluid Mechanics		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p>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.</p> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can discuss scientific tasks subject-specificly and multidisciplinary within a seminar.</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	2.5 hours written exam + written elaboration (incl. presentation) in sustainability management		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 2, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Anne Rödl
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• What is "sustainability"?</li> <li>• Why is this concept an important topic for companies?</li> <li>• What opportunities and business risks are addressed or are associated with it?</li> <li>• 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?</li> <li>• What concepts or frameworks exist for the implementation of sustainability management in companies?</li> <li>• Which sustainability labels exist for products or companies? What do they have in common, and where do they differ?</li> </ul> <p>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.</p> <p>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.</p>
<b>Literature</b>	<p>Die folgenden Bücher bieten einen Überblick:</p> <p>Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage</p> <p>Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.</p>

Course L0013: Hydro Power Use	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Stefan Achleitner
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction, importance of water power in the national and global context</li> <li>• Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies</li> <li>• Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems</li> <li>• Construction of hydroelectric power plants: description of the individual components and their technical system interaction</li> <li>• Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc.</li> <li>• Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection</li> <li>• Hydropower and the Environment</li> <li>• Examples from practice</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage</li> <li>• Quaschnig, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage</li> <li>• Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage</li> <li>• von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage</li> <li>• Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006</li> </ul>

Course L0011: Wind Turbine Plants	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Rudolf Zelleremann
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Historical development</li> <li>• Wind: origins, geographic and temporal distribution, locations</li> <li>• Power coefficient, rotor thrust</li> <li>• Aerodynamics of the rotor</li> <li>• Operating performance</li> <li>• Power limitation, partial load, pitch and stall control</li> <li>• Plant selection, yield prediction, economy</li> <li>• Excursion</li> </ul>
<b>Literature</b>	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005

Course L0012: Wind Energy Use - Focus Offshore	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Martin Skiba
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering</li> <li>• Physical fundamentals for utilization of wind energy</li> <li>• 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</li> <li>• Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures</li> <li>• Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection</li> <li>• Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics</li> <li>• Development and planning of offshore wind farms</li> <li>• Operation and optimization of offshore wind farms</li> <li>• Day excursion</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage</li> <li>• Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidelberg, 1997, 3. Auflage</li> <li>• Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4. Auflage</li> <li>• Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage</li> <li>• Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage</li> </ul>

Module M0508: Fluid Mechanics and Ocean Energy				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Energy from the Ocean (L0002)		Lecture	2	2
Fluid Mechanics II (L0001)		Lecture	2	4
<b>Module Responsible</b>	Prof. Michael Schlüter			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Technische Thermodynamik I-II Wärme- und Stoffübertragung			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students are able to 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).			
<i>Skills</i>	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.			
<b>Personal Competence</b>				
<i>Social Competence</i>	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.			
<i>Autonomy</i>	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.			
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	No	10 %	Group discussion	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	3h			
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Moustafa Abdel-Maksoud
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction to ocean energy conversion</li> <li>2. Wave properties <ul style="list-style-type: none"> <li>◦ Linear wave theory</li> <li>◦ Nonlinear wave theory</li> <li>◦ Irregular waves</li> <li>◦ Wave energy</li> <li>◦ Refraction, reflection and diffraction of waves</li> </ul> </li> <li>3. Wave energy converters <ul style="list-style-type: none"> <li>◦ Overview of the different technologies</li> <li>◦ Methods for design and calculation</li> </ul> </li> <li>4. Ocean current turbine</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Cruz, J., Ocean wave energy, Springer Series in Green Energy and Technology, UK, 2008.</li> <li>• Brooke, J., Wave energy conversion, Elsevier, 2003.</li> <li>• McCormick, M.E., Ocean wave energy conversion, Courier Dover Publications, USA, 2013.</li> <li>• Falnes, J., Ocean waves and oscillating systems, Cambridge University Press, UK, 2002.</li> <li>• Charlier, R. H., Charles, W. F., Ocean energy. Tide and tidal Power. Berlin, Heidelberg, 2009.</li> <li>• Clauss, G. F., Lehmann, E., Østergaard, C., Offshore Structures. Volume 1, Conceptual Design. Springer-Verlag, Berlin 1992</li> </ul>

Course L0001: Fluid Mechanics II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Differential equations for momentum-, heat and mass transfer</li> <li>• Examples for simplifications of the Navier-Stokes Equations</li> <li>• Unsteady momentum transfer</li> <li>• Free shear layer, turbulence and free jets</li> <li>• Flow around particles - Solids Process Engineering</li> <li>• Coupling of momentum and heat transfer - Thermal Process Engineering</li> <li>• Rheology – Bioprocess Engineering</li> <li>• Coupling of momentum- and mass transfer – Reactive mixing, Chemical Process Engineering</li> <li>• Flow throu porous structures - heterogeneous catalysis</li> <li>• Pumps and turbines - Energy- and Environmental Process Engineering</li> <li>• Wind- and Wave-Turbines - Renewable Energy</li> <li>• Introduction into Computational Fluid Dynamics</li> </ul>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.</li> <li>2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.</li> <li>3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>4. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994.</li> <li>6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006.</li> <li>7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008.</li> <li>8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007</li> <li>9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009.</li> <li>10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.</li> <li>11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008.</li> <li>12. Schlichting, H. : Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.</li> <li>13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> </ol>

Module M1294: Bioenergy				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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
<b>Module Responsible</b>	Prof. Martin Kaltschmitt			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	none			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	Students are able to 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.			
<i>Skills</i>	Students can apply the learned theoretical knowledge of biomass-based energy systems to explain relationships for different tasks, like dimensioning 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.			
<b>Personal Competence</b>				
<i>Social Competence</i>	Students can participate in discussions to design and evaluate energy systems using biomass as an energy source.			
<i>Autonomy</i>	Students can independently exploit sources with respect to the emphasis of the lectures. They can choose and acquire 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.			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Subject theoretical and practical work	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	3 hours written exam			
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Energy and Bioprocess Technology: 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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Oliver Lüdtkke
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• General introduction</li> <li>• What are biofuels?</li> <li>• Markets &amp; trends</li> <li>• Legal framework</li> <li>• Greenhouse gas savings</li> <li>• Generations of biofuels               <ul style="list-style-type: none"> <li>◦ first-generation bioethanol                   <ul style="list-style-type: none"> <li>▪ raw materials</li> <li>▪ fermentation distillation</li> </ul> </li> <li>◦ biobutanol / ETBE</li> <li>◦ second-generation bioethanol                   <ul style="list-style-type: none"> <li>▪ bioethanol from straw</li> </ul> </li> <li>◦ first-generation biodiesel                   <ul style="list-style-type: none"> <li>▪ raw materials</li> <li>▪ Production Process</li> <li>▪ Biodiesel &amp; Natural Resources</li> </ul> </li> <li>◦ HVO / HEFA</li> <li>◦ second-generation biodiesel                   <ul style="list-style-type: none"> <li>▪ Biodiesel from Algae</li> </ul> </li> </ul> </li> <li>• Biogas as fuel               <ul style="list-style-type: none"> <li>◦ the first biogas generation                   <ul style="list-style-type: none"> <li>▪ raw materials</li> <li>▪ fermentation</li> <li>▪ purification to biomethane</li> </ul> </li> <li>◦ Biogas second generation and gasification processes</li> </ul> </li> <li>• Methanol / DME from wood and Tall oil ©</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Skriptum zur Vorlesung</li> <li>• Drapcho, Nhuan, Walker; Biofuels Engineering Process Technology</li> <li>• Harwardt; Systematic design of separations for processing of biorenewables</li> <li>• Kaltschmitt; Hartmann; Energie aus Biomasse: Grundlagen, Techniken und Verfahren</li> <li>• Mousdale; Biofuels - Biotechnology, Chemistry and Sustainable Development</li> <li>• VDI Wärmeatlas</li> </ul>

Course L0062: Biofuels Process Technology	
<b>Typ</b>	Recitation Section (small)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Oliver Lüdtkke
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Life Cycle Assessment               <ul style="list-style-type: none"> <li>◦ Good example for the evaluation of CO2 savings potential by alternative fuels - Choice of system boundaries and databases</li> </ul> </li> <li>• Bioethanol production               <ul style="list-style-type: none"> <li>◦ 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 ...</li> </ul> </li> <li>• Biodiesel production               <ul style="list-style-type: none"> <li>◦ Procedural options for solid / liquid separation, including basic equations for estimating power, energy demand, selectivity and throughput</li> </ul> </li> <li>• Biomethane production               <ul style="list-style-type: none"> <li>◦ Chemical reactions that are relevant in the production of biofuels, including equilibria, activation energies, shift reactions</li> </ul> </li> </ul>
<b>Literature</b>	Skriptum zur Vorlesung

Course L1769: World Market for Commodities from Agriculture and Forestry	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Michael Köhl, Bernhard Chilla
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>1) Markets for Agricultural Commodities</p> <p>What are the major markets and how are markets functioning</p> <p>Recent trends in world production and consumption.</p> <p>World trade is growing fast. Logistics. Bottlenecks.</p> <p>The major countries with surplus production</p> <p>Growing net import requirements, primarily of China, India and many other countries.</p> <p>Tariff and non-tariff market barriers. Government interferences.</p> <p>2) Closer Analysis of Individual Markets</p> <p>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.</p> <p>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 &amp; fats for non-food purposes, primarily as a feedstock for biodiesel but also in the chemical industry.</p> <p>Importance of oilmeals as an animal feed for the production of livestock and aquaculture</p> <p>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.</p> <p>Regional differences in productivity. The winners and losers in global agricultural production.</p> <p>3) Forecasts: Future Global Demand &amp; Production of Vegetable Oils</p> <p>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 &amp; 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.</p> <p>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.</p> <p>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?</p> <p>The myth and the realities of palm oil in the world of today and tomorrow.</p> <p>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.</p>
<b>Literature</b>	Lecture material

<b>Course L1767: Thermal Biomass Utilization</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Martin Kaltschmitt
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>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.</p> <p>The course is structured as follows:</p> <ul style="list-style-type: none"> <li>• Biomass as an energy carrier within the energy system; use of biomass in Germany and world-wide, overview on the content of the course</li> <li>• Photosynthesis, composition of organic matter, plant production, energy crops, residues, organic waste</li> <li>• Biomass provision chains for woody and herbaceous biomass, harvesting and provision, transport, storage, drying</li> <li>• Thermo-chemical conversion of solid biofuels <ul style="list-style-type: none"> <li>◦ Basics of thermo-chemical conversion</li> <li>◦ 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</li> <li>◦ Gasification: Gasification technologies, producer gas cleaning technologies, options to use the cleaned producer gas for the provision of heat, electricity and/or fuels</li> <li>◦ 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</li> </ul> </li> <li>• 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)</li> <li>• Bio-chemical conversion of biomass <ul style="list-style-type: none"> <li>◦ Basics of bio-chemical conversion</li> <li>◦ 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</li> <li>◦ Ethanol production: Process technologies for feedstock containing sugar, starch or celluloses, use of ethanol as a fuel, use of the stillage</li> </ul> </li> </ul>
<b>Literature</b>	<b>Kaltschmitt, M.; Hartmann, H. (Hrsg.): Energie aus Biomasse; Springer, Berlin, Heidelberg, 2009, 2. Auflage</b>

<b>Course L2386: Thermal Biomass Utilization</b>	
<b>Typ</b>	Practical Course
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Martin Kaltschmitt, Dr. Marvin Scherzinger
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>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.</p> <p>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.</p>
<b>Literature</b>	<p>- Kaltschmitt, Martin; Hartmann, Hans; Hofbauer, Hermann: Energie aus Biomasse: Grundlagen, Techniken und Verfahren. 3. Auflage. Berlin Heidelberg: Springer Science &amp; Business Media, 2016. -ISBN 978-3-662-47437-2</p> <p>- Versuchsskript</p>

Module M1813: Agile learning with agile methods				
Courses				
Title	Typ	Hrs/wk	CP	
Agile Data Science for industrial Engineers (L3009)	Project-/problem-based Learning	3	6	
<b>Module Responsible</b>	Prof. Kathrin Fischer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Scientific Writing			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know: <ul style="list-style-type: none"> <li>• Basic principles of agile work</li> <li>• Roles within agile project management based on Scrum</li> <li>• Structure and workflows of agile project groups</li> <li>• Basic functions/classes/methods of data science in python</li> <li>• Selected libraries of data science in Python</li> </ul>			
<i>Skills</i>	The students are able to: <ul style="list-style-type: none"> <li>• Plan and carry out a project based on the Scrum philosophy, in detail: <ul style="list-style-type: none"> <li>◦ Define and allocate roles in Scrum</li> <li>◦ Plan Scrum sprints based on self-defined work packages (planning)</li> <li>◦ Carry out Scrum sprints</li> <li>◦ Complete, analyse and evaluate Scrum sprints (review and retrospective)</li> <li>◦ Present project results</li> </ul> </li> <li>• Use established tools of collaborative work</li> <li>• Writing simple scientific scripts for data science in Python collaboratively</li> <li>• Record the methods and results</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to: <ul style="list-style-type: none"> <li>• Work in heterogenic project groups and accept their defined roles based on the scrum philosophy</li> <li>• Commit to group intern time management necessities</li> <li>• Manage scope adjustments under time pressure</li> <li>• Realize and judge the importance of individual commitments for collaborative work</li> <li>• Communicate with stakeholders of their group project</li> </ul>			
<i>Autonomy</i>	The students are able to: <ul style="list-style-type: none"> <li>• Evaluate work packages regarding their practicability and commit to working on these individually</li> <li>• Evaluate their own skills regarding their contribution to a given project</li> <li>• Harmonize their own time management to the group intern time management</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Group discussion	
<b>Examination</b>	Written elaboration			
<b>Examination duration and scale</b>	Approx. 5 - 10 pages per person			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			

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<b>Course L3009: Agile Data Science for industrial Engineers</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Within this course, the fundamentals of Python for Data Science are taught and applied on a collaborative level.</p> <p>The course starts with an introduction to Python which is held in workshop format, and an introduction to collaborative work and agile project management.</p> <p>During this course different projects will be carried out in project groups, following the scrum philosophy.</p> <p>The course is dedicated to programming beginners, so no prior knowledge of Python is required. However, also students with programming experience are welcome to participate.</p> <p>For the exam, teams are required to write a report on the group projects and their results.</p>
<b>Literature</b>	Schwaber, K. & Sutherland, J. (2020): The Scrum Guide. Online Ressource

**Specialization II. Process Engineering and Biotechnology**

**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

<b>Module Responsible</b>	Prof. Martin Kaltschmitt
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	Module: Technical Thermodynamics I Module: Technical Thermodynamics II
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p><i>Skills</i> 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.</p> <p>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.</p>
<b>Personal Competence</b>	<p><i>Social Competence</i> Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module.</p> <p><i>Autonomy</i> Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions.</p>
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84
<b>Credit points</b>	6
<b>Course achievement</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	3 hours written exam
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Fröba
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction to electrochemical energy conversion</li> <li>2. Function and structure of electrolyte</li> <li>3. Low-temperature fuel cell                             <ul style="list-style-type: none"> <li>◦ Types</li> <li>◦ Thermodynamics of the PEM fuel cell</li> <li>◦ Cooling and humidification strategy</li> </ul> </li> <li>4. High-temperature fuel cell                             <ul style="list-style-type: none"> <li>◦ The MCFC</li> <li>◦ The SOFC</li> <li>◦ Integration Strategies and partial reforming</li> </ul> </li> <li>5. Fuels                             <ul style="list-style-type: none"> <li>◦ Supply of fuel</li> <li>◦ Reforming of natural gas and biogas</li> <li>◦ Reforming of liquid hydrocarbons</li> </ul> </li> <li>6. Energetic Integration and control of fuel cell systems</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Hamann, C.; Vielstich, W.: Elektrochemie 3. Aufl.; Weinheim: Wiley - VCH, 2003</li> </ul>

Course L0019: Energy Trading	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Michael Sagorje, Dr. Sven Orłowski
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Basic concepts and tradable products in energy markets</li> <li>• Primary energy markets</li> <li>• Electricity Markets</li> <li>• European Emissions Trading Scheme</li> <li>• Influence of renewable energy</li> <li>• Real options</li> <li>• Risk management</li> </ul> <p>Within the exercise the various tasks are actively discussed and applied to various cases of application.</p>
<b>Literature</b>	

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

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<b>Course L0025: Deep Geothermal Energy</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Ben Norden
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Introduction to the deep geothermal use</li> <li>2. Geological Basics I</li> <li>3. Geological Basics II</li> <li>4. Geology and thermal aspects</li> <li>5. Rock Physical Aspects</li> <li>6. Geochemical aspects</li> <li>7. Exploration of deep geothermal reservoirs</li> <li>8. Drilling technologies, piping and expansion</li> <li>9. Borehole Geophysics</li> <li>10. Underground system characterization and reservoir engineering</li> <li>11. Microbiology and Upper-day system components</li> <li>12. Adapted investment concepts, cost and environmental aspect</li> </ol>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012)</li> <li>• <a href="http://www.geo-energy.org">www.geo-energy.org</a></li> <li>• Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2012.</li> <li>• Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013.</li> <li>• Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001)</li> <li>• Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH &amp; Co. KGaA; Auflage: 1. Auflage (19. April 2010)</li> </ul>

Module M0874: Wastewater Systems			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b> <b>CP</b>
Wastewater Systems - Collection, Treatment and Reuse (L0934)		Lecture	2                  2
Wastewater Systems - Collection, Treatment and Reuse (L0943)		Recitation Section (large)	1                  1
Advanced Wastewater Treatment (L0357)		Lecture	2                  2
Advanced Wastewater Treatment (L0358)		Recitation Section (large)	1                  1
<b>Module Responsible</b>	Prof. Ralf Otterpohl		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge of wastewater management and the key processes involved in wastewater treatment.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	Students are able to outline key areas of the full range of treatment systems in waste water management, as well as their mutual dependence for sustainable water protection. They can describe relevant economic, environmental and social factors.		
<i>Skills</i>	Students are able to pre-design and explain the available wastewater treatment processes and the scope of their application in municipal and for some industrial treatment plants.		
<b>Personal Competence</b>			
<i>Social Competence</i>	Social skills are not targeted in this module.		
<i>Autonomy</i>	Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject.		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Environmental Engineering: Specialisation Water: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Compulsory		

Course L0934: Wastewater Systems - Collection, Treatment and Reuse	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Ralf Otterpohl
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Understanding the global situation with water and wastewater</li> <li>• Regional planning and decentralised systems</li> <li>• Overview on innovative approaches</li> <li>• In depth knowledge on advanced wastewater treatment options for different situations, for end-of-pipe and reuse</li> <li>• Mathematical Modelling of Nitrogen Removal</li> <li>• Exercises with calculations and design</li> </ul>
<b>Literature</b>	Henze, Mogens: Wastewater Treatment: Biological and Chemical Processes, Springer 2002, 430 pages  George Tchobanoglous, Franklin L. Burton, H. David Stensel: Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy McGraw-Hill, 2004 - 1819 pages

Course L0943: Wastewater Systems - Collection, Treatment and Reuse	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Ralf Otterpohl
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Course L0357: Advanced Wastewater Treatment	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Joachim Behrendt
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Survey on advanced wastewater treatment</p> <p>reuse of reclaimed municipal wastewater</p> <p>Precipitation</p> <p>Flocculation</p> <p>Depth filtration</p> <p>Membrane Processes</p> <p>Activated carbon adsorption</p> <p>Ozonation</p> <p>"Advanced Oxidation Processes"</p> <p>Disinfection</p>
<b>Literature</b>	<p>Metcalf &amp; Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003</p> <p>Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987</p> <p>Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007</p> <p>Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006</p> <p>Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003</p>

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<b>Course L0358: Advanced Wastewater Treatment</b>	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Dr. Joachim Behrendt
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Aggregate organic compounds (sum parameters)</p> <p>Industrial wastewater</p> <p>Processes for industrial wastewater treatment</p> <p>Precipitation</p> <p>Flocculation</p> <p>Activated carbon adsorption</p> <p>Recalcitrant organic compounds</p>
<b>Literature</b>	<p>Metcalf &amp; Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003</p> <p>Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987</p> <p>Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007</p> <p>Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006</p> <p>Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003</p>

Module M1702: Process Imaging	
<b>Courses</b>	
<b>Title</b>	<b>Typ</b> <b>Hrs/wk</b> <b>CP</b>
Process Imaging (L2723)	Lecture 2 3
Process Imaging (L2724)	Project-/problem-based Learning 2 3
<b>Module Responsible</b>	Prof. Alexander Penn
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b> <i>Knowledge</i> <i>Skills</i>	
<b>Personal Competence</b> <i>Social Competence</i> <i>Autonomy</i>	
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Credit points</b>	6
<b>Course achievement</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	120 min
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation B - Industrial Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation B - Industrial Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Energy and Bioprocess Technology: 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 Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Bioprocess 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 Chemical Process Engineering: Elective Compulsory Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory Information and Communication Systems: Specialisation Communication Systems, Focus Signal Processing: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: 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 Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Elective Compulsory

Course L2723: Process Imaging	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Penn
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	
<b>Literature</b>	

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<b>Course L2724: Process Imaging</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Penn, Dr. Stefan Benders
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	
<b>Literature</b>	

Module M0617: High Pressure Chemical Engineering				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
High pressure plant and vessel design (L1278)		Lecture	2	2
Industrial Processes Under High Pressure (L0116)		Lecture	2	2
Advanced Separation Processes (L0094)		Lecture	2	2
<b>Module Responsible</b>	Dr. Monika Johannsen			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Fundamentals of Chemistry, Chemical Engineering, Fluid Process Engineering, Thermal Separation Processes, Thermodynamics, Heterogeneous Equilibria			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	After a successful completion of this module, students can: <ul style="list-style-type: none"> <li>explain the influence of pressure on the properties of compounds, phase equilibria, and production processes,</li> <li>describe the thermodynamic fundamentals of separation processes with supercritical fluids,</li> <li>exemplify models for the description of solid extraction and countercurrent extraction,</li> <li>discuss parameters for optimization of processes with supercritical fluids.</li> </ul>			
<i>Skills</i>	After successful completion of this module, students are able to: <ul style="list-style-type: none"> <li>compare separation processes with supercritical fluids and conventional solvents,</li> <li>assess the application potential of high-pressure processes at a given separation task,</li> <li>include high pressure methods in a given multistep industrial application,</li> <li>estimate economics of high-pressure processes in terms of investment and operating costs,</li> <li>perform an experiment with a high pressure apparatus under guidance,</li> <li>evaluate experimental results,</li> <li>prepare an experimental protocol.</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	After successful completion of this module, students are able to: <ul style="list-style-type: none"> <li>present a scientific topic from an original publication in teams of 2 and defend the contents together.</li> </ul>			
<i>Autonomy</i>				
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	15 %	Presentation	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 min			
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation B - Industrial Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory			

<b>Course L1278: High pressure plant and vessel design</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Arne Pietsch
<b>Language</b>	DE/EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. Basic laws and certification standards</li> <li>2. Basics for calculations of pressurized vessels</li> <li>3. Stress hypothesis</li> <li>4. Selection of materials and fabrication processes</li> <li>5. vessels with thin walls</li> <li>6. vessels with thick walls</li> <li>7. Safety installations</li> <li>8. Safety analysis</li> </ol> <p>Applications:</p> <ul style="list-style-type: none"> <li>- subsea technology (manned and unmanned vessels)</li> <li>- steam vessels</li> <li>- heat exchangers</li> <li>- LPG, LEG transport vessels</li> </ul>
<b>Literature</b>	<p>Apparate und Armaturen in der chemischen Hochdrucktechnik, Springer Verlag</p> <p>Spain and Paauwe: High Pressure Technology, Vol. I und II, M. Dekker Verlag</p> <p>AD-Merkblätter, Heumanns Verlag</p> <p>Bertucco; Vetter: High Pressure Process Technology, Elsevier Verlag</p> <p>Sherman; Stadtmuller: Experimental Techniques in High-Pressure Research, Wiley &amp; Sons Verlag</p> <p>Klapp: Apparate- und Anlagentechnik, Springer Verlag</p>

Course L0116: Industrial Processes Under High Pressure	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Carsten Zetzl
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Part I : Physical Chemistry and Thermodynamics</p> <ol style="list-style-type: none"> <li>1. Introduction: Overview, achieving high pressure, range of parameters.</li> <li>2. Influence of pressure on properties of fluids: P,v,T-behaviour, enthalpy, internal energy, entropy, heat capacity, viscosity, thermal conductivity, diffusion coefficients, interfacial tension.</li> <li>3. Influence of pressure on heterogeneous equilibria: Phenomenology of phase equilibria</li> <li>4. Overview on calculation methods for (high pressure) phase equilibria). Influence of pressure on transport processes, heat and mass transfer.</li> </ol> <p>Part II : High Pressure Processes</p> <ol style="list-style-type: none"> <li>5. Separation processes at elevated pressures: Absorption, adsorption (pressure swing adsorption), distillation (distillation of air), condensation (liquefaction of gases)</li> <li>6. Supercritical fluids as solvents: Gas extraction, cleaning, solvents in reacting systems, dyeing, impregnation, particle formation (formulation)</li> <li>7. Reactions at elevated pressures. Influence of elevated pressure on biochemical systems: Resistance against pressure</li> </ol> <p><b>Part III : Industrial production</b></p> <ol style="list-style-type: none"> <li>8. Reaction : Haber-Bosch-process, methanol-synthesis, polymerizations; Hydrations, pyrolysis, hydrocracking; Wet air oxidation, supercritical water oxidation (SCWO)</li> <li>9. Separation : Linde Process, De-Caffeination, Petrol and Bio-Refinery</li> <li>10. Industrial High Pressure Applications in Biofuel and Biodiesel Production</li> <li>11. Sterilization and Enzyme Catalysis</li> <li>12. Solids handling in high pressure processes, feeding and removal of solids, transport within the reactor.</li> <li>13. Supercritical fluids for materials processing.</li> <li>14. Cost Engineering</li> </ol> <p>Learning Outcomes: After a successful completion of this module, the student should be able to</p> <ul style="list-style-type: none"> <li>- understand of the influences of pressure on properties of compounds, phase equilibria, and production processes.</li> <li>- Apply high pressure approaches in the complex process design tasks</li> <li>- Estimate Efficiency of high pressure alternatives with respect to investment and operational costs</li> </ul> <p>Performance Record:</p> <ol style="list-style-type: none"> <li>1. Presence (28 h)</li> <li>2. Oral presentation of original scientific article (15 min) with written summary</li> <li>3. Written examination and Case study ( 2+3 : 32 h Workload)</li> </ol> <p>Workload: 60 hours total</p>
<b>Literature</b>	<p>Literatur:</p> <p>Script: High Pressure Chemical Engineering. G. Brunner: Gas Extraction. An Introduction to Fundamentals of Supercritical Fluids and the Application to Separation Processes. Steinkopff, Darmstadt, Springer, New York, 1994.</p>

Course L0094: Advanced Separation Processes	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Monika Johannsen
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction/Overview on Properties of Supercritical Fluids (SCF) and their Application in Gas Extraction Processes</li> <li>• Solubility of Compounds in Supercritical Fluids and Phase Equilibrium with SCF</li> <li>• Extraction from Solid Substrates: Fundamentals, Hydrodynamics and Mass Transfer</li> <li>• Extraction from Solid Substrates: Applications and Processes (including Supercritical Water)</li> <li>• Countercurrent Multistage Extraction: Fundamentals and Methods, Hydrodynamics and Mass Transfer</li> <li>• Countercurrent Multistage Extraction: Applications and Processes</li> <li>• Solvent Cycle, Methods for Precipitation</li> <li>• Supercritical Fluid Chromatography (SFC): Fundamentals and Application</li> <li>• Simulated Moving Bed Chromatography (SMB)</li> <li>• Membrane Separation of Gases at High Pressures</li> <li>• Separation by Reactions in Supercritical Fluids (Enzymes)</li> </ul>
<b>Literature</b>	G. Brunner: Gas Extraction. An Introduction to Fundamentals of Supercritical Fluids and the Application to Separation Processes. Steinkopff, Darmstadt, Springer, New York, 1994.

Module M1335: BIO II: Artificial Joint Replacement			
<b>Courses</b>			
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>
Artificial Joint Replacement (L1306)		Lecture	2
			<b>CP</b>
			3
<b>Module Responsible</b>	Prof. Michael Morlock		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge of orthopedic and surgical techniques is recommended.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
<i>Knowledge</i>	The students can name the different kinds of artificial limbs.		
<i>Skills</i>	The students can explain the advantages and disadvantages of different kinds of endoprotheses.		
<b>Personal Competence</b>			
<i>Social Competence</i>	The students are able to discuss issues related to endoprothese with student mates and the teachers.		
<i>Autonomy</i>	The students are able to acquire information on their own. They can also judge the information with respect to its credibility.		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
<b>Credit points</b>	3		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Orientation Studies: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory		

Course L1306: Artificial Joint Replacement	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Morlock
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	Inhalt (deutsch)  1. EINLEITUNG (Bedeutung, Ziel, Grundlagen, allg. Geschichte des künstlichen Gelenkersatzes) 2. FUNKTIONSANALYSE (Der menschliche Gang, die menschliche Arbeit, die sportliche Aktivität) 3. DAS HÜFTGELENK (Anatomie, Biomechanik, Gelenkersatz Schaftseite und Pfannenseite, Evolution der Implantate) 4. DAS KNIEGELENK (Anatomie, Biomechanik, Bandersatz, Gelenkersatz femorale, tibiale und patelläre Komponenten) 5. DER FUß (Anatomie, Biomechanik, Gelenkersatz, orthopädische Verfahren) 6. DIE SCHULTER (Anatomie, Biomechanik, Gelenkersatz) 7. DER ELLBOGEN (Anatomie, Biomechanik, Gelenkersatz) 8. DIE HAND (Anatomie, Biomechanik, Gelenkersatz) 9. TRIBOLOGIE NATÜRLICHER UND KÜNSTLICHER GELENKE (Korrosion, Reibung, Verschleiß)
<b>Literature</b>	Literatur:  Kapandji, I.: Funktionelle Anatomie der Gelenke (Band 1-4), Enke Verlag, Stuttgart, 1984.  Nigg, B., Herzog, W.: Biomechanics of the musculo-skeletal system, John Wiley&Sons, New York 1994  Nordin, M., Frankel, V.: Basic Biomechanics of the Musculoskeletal System, Lea&Febiger, Philadelphia, 1989.  Czichos, H.: Tribologiehandbuch, Vieweg, Wiesbaden, 2003.  Sobotta und Netter für Anatomie der Gelenke

Module M1179: Medical Basics and Pathology			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Medical Basics and Pathology I (L1599)	Lecture	2	2
Medical Basics and Pathology II (L1600)	Lecture	2	2
Medical Basics and Pathology III (L1602)	Lecture	2	2
<b>Module Responsible</b>	Prof. Michael Morlock		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b> <i>Knowledge</i> <i>Skills</i>			
<b>Personal Competence</b> <i>Social Competence</i> <i>Autonomy</i>			
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 minutes		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Biomedical Engineering: Core Qualification: Compulsory		
Course L1599: Medical Basics and Pathology I			
<b>Typ</b>	Lecture		
<b>Hrs/wk</b>	2		
<b>CP</b>	2		
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28		
<b>Lecturer</b>	Dr. Julian Schulze zur Wiesch		
<b>Language</b>	DE		
<b>Cycle</b>	SoSe		
<b>Content</b>	Upon successful completion of the course, participants should be able to describe the foundations of the organization of the German health system and to describe different ways of treatment in the hospital. They should be able to describe the anatomy, physiology and basic diagnostic possibilities for the following organ system: heart / circulatory system, lungs, digestive tract, kidney, including the technical possibilities of monitoring heart-lung function, in the emergency department, in the monitoring stations and in intensive care and the basics of cardiopulmonary resuscitation. Furthermore, the anatomy and physiology of the nervous system will be explored. The importance and possibilities of preventive medicine of serious public health problems are described. Students prepare their own sub-themes in the form of small lectures and discuss various clinical cases on these topics interactively as problem-based learning. This course/Lecture by excursions into our emergency room, our endoscopy unit, mini-laparoscopy and our ICU as well as out patient clinics.		
<b>Literature</b>	Wird in der Veranstaltung bekannt gegeben		

Course L1600: Medical Basics and Pathology II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Johannes Kluwe
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Major diseases of</p> <ul style="list-style-type: none"> <li>the gastrointestinal system and the liver,</li> <li>the hormone system,</li> <li>the kidneys.</li> </ul> <p>The lecture will focus on pathophysiology, symptoms, diagnostic and therapeutic principles of these diseases.</p> <p>I Gastrointestinal tract and liver:</p> <ul style="list-style-type: none"> <li>Gastrointestinal bleeding: causes, symptoms, endoscopic treatment options</li> <li>Colorectal cancer: basics, principle of prophylactic screening, therapy</li> <li>Liver diseases / liver cirrhosis: causes, symptoms, complications, therapeutic options</li> </ul> <p>II Hormones:</p> <ul style="list-style-type: none"> <li>Diabetes mellitus type 1 and 2: pathophysiology, complications, basics of glucose metabolism, therapeutic principles</li> <li>Thyroid gland - hyper- and hypothyroidism: causes, symptoms diagnostics, therapy</li> </ul> <p>III Kidneys</p> <ul style="list-style-type: none"> <li>Functions and failure, diagnostics, principles of renal replacement therapy</li> </ul>
<b>Literature</b>	Wird in der Veranstaltung bekannt gegeben

Course L1602: Medical Basics and Pathology III	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Dr. Dominic Wichmann
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>a) Basic understanding of the pathology/pathophysiology of cardiac diseases and their stage-adapted treatments: coronary heart disease, myocardial infarction, mitral valve insufficiencies, aortic valve stenosis</p> <p>b) Basic understanding of the pathology/pathophysiology of pulmonary diseases and their stage-adapted treatments: asthma, chronic obstructive pulmonary disease, pneumonia, bronchial cancer</p> <p>c) Basic understanding of infectious diseases, immune-system and autoimmune diseases</p>
<b>Literature</b>	Skript zur Vorlesung.

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
<b>Module Responsible</b>	Prof. Kerstin Kuchta		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basics of <ul style="list-style-type: none"> <li>• thermo dynamics</li> <li>• fluid dynamics</li> <li>• chemistry</li> </ul>		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> 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.</p> <p>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.</p> <p><i>Skills</i> 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.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> Students can</p> <ul style="list-style-type: none"> <li>• respectfully work together as a team and discuss technical tasks</li> <li>• participate in subject-specific and interdisciplinary discussions,</li> <li>• develop cooperated solutions</li> <li>• promote the scientific development and accept professional constructive criticism.</li> </ul> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Werner Sitzmann
<b>Language</b>	DE
<b>Cycle</b>	SoSe
<b>Content</b>	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 BtI - and WPC - products. Aspects of explosion protection and plant design complete the lecture.
<b>Literature</b>	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamasse, 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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Kerstin Kuchta
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals</li> <li>• basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition</li> <li>• Incineration techniques: grate firing, ash transfer, boiler</li> <li>• Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination</li> <li>• Ash treatment: Mass, quality, treatment concepts, recycling, disposal</li> </ul>
<b>Literature</b>	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

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

Module M0630: Robotics and Navigation in Medicine				
<b>Courses</b>				
<b>Title</b>		<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
Robotics and Navigation in Medicine (L0335)		Lecture	2	3
Robotics and Navigation in Medicine (L0338)		Project Seminar	2	2
Robotics and Navigation in Medicine (L0336)		Recitation Section (small)	1	1
<b>Module Responsible</b>	Prof. Alexander Schlaefer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>principles of math (algebra, analysis/calculus)</li> <li>principles of programming, e.g., in Java or C++</li> <li>solid R or Matlab skills</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.			
<i>Skills</i>	The students are able to design and evaluate navigation systems and robotic systems for medical applications.			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students discuss the results of other groups, provide helpful feedback and can incorporate feedback into their work.			
<i>Autonomy</i>	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.			
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Written elaboration	
	Yes	10 %	Presentation	
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	90 minutes			
<b>Assignment for the Following Curricula</b>	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Medical Technology: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory			

Course L0335: Robotics and Navigation in Medicine	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Alexander Schlaefer
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>kinematics</li> <li>calibration</li> <li>tracking systems</li> <li>navigation and image guidance</li> <li>motion compensation</li> </ul> The seminar extends and complements the contents of the lecture with respect to recent research results.
<b>Literature</b>	Spong et al.: Robot Modeling and Control, 2005 Troccaz: Medical Robotics, 2012 Further literature will be given in the lecture.

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

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

Module M0896: Bioprocess and Biosystems Engineering			
<b>Courses</b>			
<b>Title</b>	<b>Typ</b>	<b>Hrs/wk</b>	<b>CP</b>
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
<b>Module Responsible</b>	Prof. An-Ping Zeng		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Knowledge of bioprocess engineering and process engineering at bachelor level		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> After completion of this module, participants will be able to:</p> <ul style="list-style-type: none"> <li>differentiate between different kinds of bioreactors and describe their key features</li> <li>identify and characterize the peripheral and control systems of bioreactors</li> <li>depict integrated biosystems (bioprocesses including up- and downstream processing)</li> <li>name different sterilization methods and evaluate those in terms of different applications</li> <li>recall and define the advanced methods of modern systems-biological approaches</li> <li>connect the multiple "omics"-methods and evaluate their application for biological questions</li> <li>recall the fundamentals of modeling and simulation of biological networks and biotechnological processes and to discuss their methods</li> <li>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.</li> </ul> <p><i>Skills</i> After completion of this module, participants will be able to:</p> <ul style="list-style-type: none"> <li>describe different process control strategies for bioreactors and chose them after analysis of characteristics of a given bioprocess</li> <li>plan and construct a bioreactor system including peripherals from lab to pilot plant scale</li> <li>adapt a present bioreactor system to a new process and optimize it</li> <li>develop concepts for integration of bioreactors into bioproduction processes</li> <li>combine the different modeling methods into an overall modeling approach, to apply these methods to specific problems and to evaluate the achieved results critically</li> <li>connect all process components of biotechnological processes for a holistic system view.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> 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.</p> <p>The students can reflect their specific knowledge orally and discuss it with other students and teachers.</p> <p><i>Autonomy</i> 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.</p> <ul style="list-style-type: none"> <li></li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 110, Study Time in Lecture 70		
<b>Credit points</b>	6		
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Description</b>
	Yes	20 %	Presentation
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 min		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. An-Ping Zeng, Dr. Johannes Möller
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p><b>Design of bioreactors and peripheries:</b></p> <ul style="list-style-type: none"> <li>• reactor types and geometry</li> <li>• materials and surface treatment</li> <li>• agitation system design</li> <li>• insertion of stirrer</li> <li>• sealings</li> <li>• fittings and valves</li> <li>• peripherals</li> <li>• materials</li> <li>• standardization</li> <li>• demonstration in laboratory and pilot plant</li> </ul> <p><b>Sterile operation:</b></p> <ul style="list-style-type: none"> <li>• theory of sterilisation processes</li> <li>• different sterilisation methods</li> <li>• sterilisation of reactor and probes</li> <li>• industrial sterile test, automated sterilisation</li> <li>• introduction of biological material</li> <li>• autoclaves</li> <li>• continuous sterilisation of fluids</li> <li>• deep bed filters, tangential flow filters</li> <li>• demonstration and practice in pilot plant</li> </ul> <p><b>Instrumentation and control:</b></p> <ul style="list-style-type: none"> <li>• temperature control and heat exchange</li> <li>• dissolved oxygen control and mass transfer</li> <li>• aeration and mixing</li> <li>• used gassing units and gassing strategies</li> <li>• control of agitation and power input</li> <li>• pH and reactor volume, foaming, membrane gassing</li> </ul> <p><b>Bioreactor selection and scale-up:</b></p> <ul style="list-style-type: none"> <li>• selection criteria</li> <li>• scale-up and scale-down</li> <li>• reactors for mammalian cell culture</li> </ul> <p><b>Integrated biosystem:</b></p> <ul style="list-style-type: none"> <li>• interactions and integration of microorganisms, bioreactor and downstream processing</li> <li>• Miniplant technologies</li> </ul> <p><b>Team work with presentation:</b></p> <ul style="list-style-type: none"> <li>• Operation mode of selected bioprocesses (e.g. fundamentals of batch, fed-batch and continuous cultivation)</li> </ul>
<b>Literature</b>	<ul style="list-style-type: none"> <li>• Storhas, Winfried, Bioreaktoren und periphere Einrichtungen, Braunschweig: Vieweg, 1994</li> <li>• Chmiel, Horst, Bioprozeßtechnik; Springer 2011</li> <li>• Krahe, Martin, Biochemical Engineering, Ullmann's Encyclopedia of Industrial Chemistry</li> <li>• Pauline M. Doran, Bioprocess Engineering Principles, Second Edition, Academic Press, 2013</li> <li>• Other lecture materials to be distributed</li> </ul>

<b>Course L1037: Bioreactors and Biosystems Engineering</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 46, Study Time in Lecture 14
<b>Lecturer</b>	Prof. An-Ping Zeng, Dr. Johannes Möller
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p><b>Introduction to Biosystems Engineering (Exercise)</b></p> <p><b>Experimental basis and methods for biosystems analysis</b></p> <ul style="list-style-type: none"> <li>• Introduction to genomics, transcriptomics and proteomics</li> <li>• More detailed treatment of metabolomics</li> <li>• Determination of in-vivo kinetics</li> <li>• Techniques for rapid sampling</li> <li>• Quenching and extraction</li> <li>• Analytical methods for determination of metabolite concentrations</li> </ul> <p><b>Analysis, modelling and simulation of biological networks</b></p> <ul style="list-style-type: none"> <li>• Metabolic flux analysis</li> <li>• Introduction</li> <li>• Isotope labelling</li> <li>• Elementary flux modes</li> <li>• Mechanistic and structural network models</li> <li>• Regulatory networks</li> <li>• Systems analysis</li> <li>• Structural network analysis</li> <li>• Linear and non-linear dynamic systems</li> <li>• Sensitivity analysis (metabolic control analysis)</li> </ul> <p><b>Modelling and simulation for bioprocess engineering</b></p> <ul style="list-style-type: none"> <li>• Modelling of bioreactors</li> <li>• Dynamic behaviour of bioprocesses</li> </ul> <p><b>Selected projects for biosystems engineering</b></p> <ul style="list-style-type: none"> <li>• Miniaturisation of bioreaction systems</li> <li>• Miniplant technology for the integration of biosynthesis and downstream processing</li> <li>• Technical and economic overall assessment of bioproduction processes</li> </ul>
<b>Literature</b>	<p>E. Klipp et al. Systems Biology in Practice, Wiley-VCH, 2006</p> <p>R. Dohrn: Miniplant-Technik, Wiley-VCH, 2006</p> <p>G.N. Stephanopoulos et. al.: Metabolic Engineering, Academic Press, 1998</p> <p>I.J. Dunn et. al.: Biological Reaction Engineering, Wiley-VCH, 2003</p> <p>Lecture materials to be distributed</p>

<b>Course L1036: Biosystems Engineering</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. An-Ping Zeng
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p><b>Introduction to Biosystems Engineering</b></p> <p><b>Experimental basis and methods for biosystems analysis</b></p> <ul style="list-style-type: none"> <li>• Introduction to genomics, transcriptomics and proteomics</li> <li>• More detailed treatment of metabolomics</li> <li>• Determination of in-vivo kinetics</li> <li>• Techniques for rapid sampling</li> <li>• Quenching and extraction</li> <li>• Analytical methods for determination of metabolite concentrations</li> </ul> <p><b>Analysis, modelling and simulation of biological networks</b></p> <ul style="list-style-type: none"> <li>• Metabolic flux analysis</li> <li>• Introduction</li> <li>• Isotope labelling</li> <li>• Elementary flux modes</li> <li>• Mechanistic and structural network models</li> <li>• Regulatory networks</li> <li>• Systems analysis</li> <li>• Structural network analysis</li> <li>• Linear and non-linear dynamic systems</li> <li>• Sensitivity analysis (metabolic control analysis)</li> </ul> <p><b>Modelling and simulation for bioprocess engineering</b></p> <ul style="list-style-type: none"> <li>• Modelling of bioreactors</li> <li>• Dynamic behaviour of bioprocesses</li> </ul> <p><b>Selected projects for biosystems engineering</b></p> <ul style="list-style-type: none"> <li>• Miniaturisation of bioreaction systems</li> <li>• Miniplant technology for the integration of biosynthesis and downstream processing</li> <li>• Technical and economic overall assessment of bioproduction processes</li> </ul>
<b>Literature</b>	<p>E. Klipp et al. Systems Biology in Practice, Wiley-VCH, 2006</p> <p>R. Dohrn: Miniplant-Technik, Wiley-VCH, 2006</p> <p>G.N. Stephanopoulos et. al.: Metabolic Engineering, Academic Press, 1998</p> <p>I.J. Dunn et. al.: Biological Reaction Engineering, Wiley-VCH, 2003</p> <p>Lecture materials to be distributed</p>



Course L0877: Applied Molecular Biology	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Johannes Gescher
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<p>Lecture and PBL</p> <ul style="list-style-type: none"> <li>- Methods in genetics / molecular cloning</li> <li>- Industrial relevance of microbes and their biocatalysts</li> <li>- Biotransformation at extreme conditions</li> <li>- Genomics</li> <li>- Protein engineering techniques</li> <li>- Synthetic biology</li> </ul>
<b>Literature</b>	<p>Relevante Literatur wird im Kurs zur Verfügung gestellt.</p> <p>Grundwissen in Molekularbiologie, Genetik, Mikrobiologie und Biotechnologie erforderlich.</p> <p>Lehrbuch: Brock - Mikrobiologie / Microbiology (Madigan et al.)</p>

Course L0999: Technical Microbiology	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Johannes Gescher
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• History of microbiology and biotechnology</li> <li>• Enzymes</li> <li>• Molecular biology</li> <li>• Fermentation</li> <li>• Downstream Processing</li> <li>• Industrial microbiological processes</li> <li>• Technical enzyme application</li> <li>• Biological Waste Water treatment</li> </ul>
<b>Literature</b>	<p><b>Microbiology</b>, 2013, Madigan, M., Martinko, J. M., Stahl, D. A., Clark, D. P. (eds.), formerly „Brock“, Pearson</p> <p><b>Industrielle Mikrobiologie</b>, 2012, Sahm, H., Antranikian, G., Stahmann, K.-P., Takors, R. (eds.) Springer Berlin, Heidelberg, New York, Tokyo.</p> <p><b>Angewandte Mikrobiologie</b>, 2005, Antranikian, G. (ed.), Springer, Berlin, Heidelberg, New York, Tokyo.</p>

Course L1000: Technical Microbiology	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Johannes Gescher
<b>Language</b>	EN
<b>Cycle</b>	SoSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

Module M0541: Process and Plant Engineering II			
Courses			
Title	Typ	Hrs/wk	CP
Process and Plant Engineering II (L0097)	Lecture	2	4
Process and Plant Engineering II (L0098)	Recitation Section (large)	2	2
<b>Module Responsible</b>	Prof. Mirko Skiborowski		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	unit operation of thermal and mechanical separation chemical reactor engineering		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> students can:</p> <ul style="list-style-type: none"> <li>- present process control concepts of apparatus and complex process plants</li> <li>- classify process models and model equations</li> <li>- explain numerical methods and their use in simulation tasks</li> <li>- explain the solving strategy of flowsheet simulation</li> <li>- explain, present and discuss projects phases within the planning of processes</li> <li>- present and explain the critical path method</li> </ul> <p><i>Skills</i> students are capable of:</p> <ul style="list-style-type: none"> <li>- formulation of targets of process control concepts and the translation into industrial practice</li> <li>- design and evaluation of process control concepts and structures</li> <li>- analyse the model structure and parameters from the process simulation</li> <li>- optimization of calculation sequence with respect to flowsheet simulation</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> students are capable of:</p> <ul style="list-style-type: none"> <li>• develop solutions in heterogeneous small groups</li> </ul> <p><i>Autonomy</i> students are capable of:</p> <ul style="list-style-type: none"> <li>• tapping new knowledge on a special subject by literature research</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	120 Min.		
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Process Engineering: Core Qualification: Compulsory		

Course L0097: Process and Plant Engineering II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Mirko Skiborowski, Dr. Thomas Waluga
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ol style="list-style-type: none"> <li>1. <b>Process optimization</b> Application areas Formulation of constrained optimization Solving strategy Classes of optimization tasks</li> <li>2. <b>Process control</b> Typical control functions of equipment and apparatus in process engineering Structures of control systems Plantwide control</li> <li>3. <b>Process Modeling</b> Process models (steady state and dynamic behaviour) Degrees of freedom Examples from industrial practice</li> <li>4. <b>Process simulation</b> Structured approach Numerical methods Flowsheeting Solution methods Examples for experimental validation in industrial practice Application of flowsheet simulation</li> <li>5. <b>Plant design and construction</b> Introduction Industrial project implementation Project execution: Applied aspects in industrial use critical path method</li> </ol>
<b>Literature</b>	<p>Literatur (Planung und Bau von Produktionsanlagen):</p> <p>G. Barnecker, Planung und Bau verfahrenstechnischer Anlagen, Springer Verlag, 2001</p> <p>F.P. Helmus, Anlagenplanung, Wiley-VCH Verlag, Weinheim, 2003</p> <p>E. Klapp, Apparate- und Anlagentechnik, Springer -Verlag, Berlin, 1980</p> <p>P. Rinza, Projektmanagement: Planung, Überwachung und Steuerung von technischen und nichttechnischen Vorhaben, Düsseldorf, VDI-Verlag, 1994</p> <p>K. Sattler, W. Kasper, Verfahrenstechnische Anlagen, Wiley-VCH Verlag, Weinheim, 2000</p> <p>G.H. Vogel, Verfahrensentwicklung, Wiley-VCH, Weinheim, 2002</p> <p>K.H. Weber, Inbetriebnahme verfahrenstechnischer Anlagen, VDI Verlag, Düsseldorf, 1996</p> <p>E. Wegener, Montagerechte Anlagenplanung, Wiley-VCH Verlag, Weinheim, 2003</p>

Course L0098: Process and Plant Engineering II	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Mirko Skiborowski, Dr. Thomas Waluga
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

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
<b>Module Responsible</b>	Prof. Michael Schlüter		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	All lectures from the undergraduate studies, especially mathematics, chemistry, thermodynamics, fluid mechanics, heat- and mass transfer.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> Students are able to:</p> <ul style="list-style-type: none"> <li>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.</li> <li>explain the main transport laws and their application as well as the limits of application.</li> <li>describe how transport coefficients for heat- and mass transfer can be derived experimentally.</li> <li>compare different multiphase reactors like trickle bed reactors, pipe reactors, stirring tanks and bubble column reactors.</li> <li>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.</li> </ul> <p><i>Skills</i> The students are able to:</p> <ul style="list-style-type: none"> <li>optimize multiphase reactors by using mass- and energy balances,</li> <li>use transport processes for the design of technical processes,</li> <li>to choose a multiphase reactor for a specific application.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students are able to discuss in international teams in english and develop an approach under pressure of time.</p> <p><i>Autonomy</i> 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.</p>		
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84		
<b>Credit points</b>	6		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	15 min Presentation + 90 min multiple choice written examen		
<b>Assignment for the Following Curricula</b>	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	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Interfaces in MPF (boundary layers, surfactants)</li> <li>• Hydrodynamics &amp; pressure drop in Film Flows</li> <li>• Hydrodynamics &amp; pressure drop in Gas-Liquid Pipe Flows</li> <li>• Hydrodynamics &amp; pressure drop in Bubbly Flows</li> <li>• Mass Transfer in Film Flows</li> <li>• Mass Transfer in Gas-Liquid Pipe Flows</li> <li>• Mass Transfer in Bubbly Flows</li> <li>• Reactive mass Transfer in Multiphase Flows</li> <li>• Film Flow: Application Trickle Bed Reactors</li> <li>• Pipe Flow: Application Tubular Reactors</li> <li>• Bubbly Flow: Application Bubble Column Reactors</li> </ul>
<b>Literature</b>	<p>Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.</p> <p>Clift, R.; Grace, J.R.; Weber, M.E.: Bubbles, Drops and Particles, Academic Press, New York, 1978.</p> <p>Fan, L.-S.; Tsuchiya, K.: Bubble Wake Dynamics in Liquids and Liquid-Solid Suspensions, Butterworth-Heinemann Series in Chemical Engineering, Boston, USA, 1990.</p> <p>Hewitt, G.F.; Delhay, J.M.; Zuber, N. (Ed.): Multiphase Science and Technology. Hemisphere Publishing Corp, Vol. 1/1982 bis Vol. 6/1992.</p> <p>Kolev, N.I.: Multiphase flow dynamics. Springer, Vol. 1 and 2, 2002.</p> <p>Levy, S.: Two-Phase Flow in Complex Systems. Verlag John Wiley &amp; Sons, Inc, 1999.</p> <p>Crowe, C.T.: Multiphase Flows with Droplets and Particles. CRC Press, Boca Raton, Fla, 1998.</p>

Course L0105: Reactor Design Using Local Transport Processes	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>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.</p> <p>The four students in each team have to:</p> <ul style="list-style-type: none"> <li>• collect and discuss material properties and equations for design from the literature,</li> <li>• calculate the optimal hydrodynamic design,</li> <li>• check the plausibility of the results critically,</li> <li>• write an exposé with the results.</li> </ul> <p>This exposé will be used as basis for the discussion within the oral group examen of each team.</p>
<b>Literature</b>	see actual literature list in StudIP with recent published papers

Module Manual M.Sc. "International Management and Engineering"

<b>Course L0103: Heat &amp; Mass Transfer in Process Engineering</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Introduction - Transport Processes in Chemical Engineering</li> <li>• Molecular Heat- and Mass Transfer: Applications of Fourier's and Fick's Law</li> <li>• Convective Heat and Mass Transfer: Applications in Process Engineering</li> <li>• Unsteady State Transport Processes: Cooling &amp; Drying</li> <li>• Transport at fluidic Interfaces: Two Film, Penetration, Surface Renewal</li> <li>• Transport Laws &amp; Balance Equations with turbulence, sinks and sources</li> <li>• Experimental Determination of Transport Coefficients</li> <li>• Design and Scale Up of Reactors for Heat- and Mass Transfer</li> <li>• Reactive Mass Transfer</li> <li>• Processes with Phase Changes - Evaporization and Condensation</li> <li>• Radiative Heat Transfer - Fundamentals</li> <li>• Radiative Heat Transfer - Solar Energy</li> </ul>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Baehr, Stephan: Heat and Mass Transfer, Wiley 2002.</li> <li>2. Bird, Stewart, Lightfoot: Transport Phenomena, Springer, 2000.</li> <li>3. John H. Lienhard: A Heat Transfer Textbook, Phlogiston Press, Cambridge Massachusetts, 2008.</li> <li>4. Myers: Analytical Methods in Conduction Heat Transfer, McGraw-Hill, 1971.</li> <li>5. Incropera, De Witt: Fundamentals of Heat and Mass Transfer, Wiley, 2002.</li> <li>6. Beek, Muttzall: Transport Phenomena, Wiley, 1983.</li> <li>7. Crank: The Mathematics of Diffusion, Oxford, 1995.</li> <li>8. Madhusudana: Thermal Contact Conductance, Springer, 1996.</li> <li>9. Treybal: Mass-Transfer-Operation, McGraw-Hill, 1987.</li> </ol>

Module M1334: BIO II: Biomaterials			
Courses			
Title	Typ	Hrs/wk	CP
Biomaterials (L0593)	Lecture	2	3
<b>Module Responsible</b>	Prof. Michael Morlock		
<b>Admission Requirements</b>	None		
<b>Recommended Previous Knowledge</b>	Basic knowledge of orthopedic and surgical techniques is recommended.		
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i> The students can describe the materials of the human body and the materials being used in medical engineering, and their fields of use.</p> <p><i>Skills</i> The students can explain the advantages and disadvantages of different kinds of biomaterials.</p> <p><b>Personal Competence</b></p> <p><i>Social Competence</i> The students are able to discuss issues related to materials being present or being used for replacements with student mates and the teachers.</p> <p><i>Autonomy</i> The students are able to acquire information on their own. They can also judge the information with respect to its credibility.</p>		
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28		
<b>Credit points</b>	3		
<b>Course achievement</b>	None		
<b>Examination</b>	Written exam		
<b>Examination duration and scale</b>	90 min		
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory		

<b>Course L0593: Biomaterials</b>	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 62, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Morlock
<b>Language</b>	EN
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Topics to be covered include:</p> <ol style="list-style-type: none"> <li>1. Introduction (Importance, nomenclature, relations)</li> <li>2. Biological materials               <ol style="list-style-type: none"> <li>2.1 Basics (components, testing methods)</li> <li>2.2 Bone (composition, development, properties, influencing factors)</li> <li>2.3 Cartilage (composition, development, structure, properties, influencing factors)</li> <li>2.4 Fluids (blood, synovial fluid)</li> </ol> </li> <li>3 Biological structures               <ol style="list-style-type: none"> <li>3.1 Menisci of the knee joint</li> <li>3.2 Intervertebral discs</li> <li>3.3 Teeth</li> <li>3.4 Ligaments</li> <li>3.5 Tendons</li> <li>3.6 Skin</li> <li>3.7 Nerves</li> <li>3.8 Muscles</li> </ol> </li> <li>4. Replacement materials               <ol style="list-style-type: none"> <li>4.1 Basics (history, requirements, norms)</li> <li>4.2 Steel (alloys, properties, reaction of the body)</li> <li>4.3 Titan (alloys, properties, reaction of the body)</li> <li>4.4 Ceramics and glas (properties, reaction of the body)</li> <li>4.5 Plastics (properties of PMMA, HDPE, PET, reaction of the body)</li> <li>4.6 Natural replacement materials</li> </ol> </li> </ol> <p>Knowledge of composition, structure, properties, function and changes/adaptations of biological and technical materials (which are used for replacements in-vivo). Acquisition of basics for theses work in the area of biomechanics.</p>
<b>Literature</b>	<p>Hastings G and Ducheyne P.: Natural and living biomaterials. Boca Raton: CRC Press, 1984.</p> <p>Williams D.: Definitions in biomaterials. Oxford: Elsevier, 1987.</p> <p>Hastings G.: Mechanical properties of biomaterials: proceedings held at Keele University, September 1978. New York: Wiley, 1998.</p> <p>Black J.: Orthopaedic biomaterials in research and practice. New York: Churchill Livingstone, 1988.</p> <p>Park J. Biomaterials: an introduction. New York: Plenum Press, 1980.</p> <p>Wintermantel, E. und Ha, S.-W : Biokompatible Werkstoffe und Bauweisen. Berlin, Springer, 1996.</p>

Module M0542: Fluid Mechanics in Process Engineering	
<b>Courses</b>	
<b>Title</b>	<b>Typ</b> <b>Hrs/wk</b> <b>CP</b>
Applications of Fluid Mechanics in Process Engineering (L0106)	Recitation Section (large) 2 2
Fluid Mechanics II (L0001)	Lecture 2 4
<b>Module Responsible</b>	Prof. Michael Schlüter
<b>Admission Requirements</b>	None
<b>Recommended Previous Knowledge</b>	<ul style="list-style-type: none"> <li>• Mathematics I-III</li> <li>• Fundamentals in Fluid Mechanics</li> <li>• Technical Thermodynamics I-II</li> <li>• Heat- and Mass Transfer</li> </ul>
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
<i>Knowledge</i>	The students are able to describe different applications of fluid mechanics in Process Engineering, Bioprocess Engineering, Energy- and Environmental Process Engineering and Renewable Energies. They are able to use the fundamentals of fluid mechanics for calculations of certain engineering problems. 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 in an example of free jets, empirical solutions in an example with the Forchheimer equation, numerical methods in an example of Large Eddy Simulation).
<i>Skills</i>	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.
<b>Personal Competence</b>	
<i>Social Competence</i>	The students are able to discuss a given problem in small groups and to develop an approach.
<i>Autonomy</i>	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.
<b>Workload in Hours</b>	Independent Study Time 124, Study Time in Lecture 56
<b>Credit points</b>	6
<b>Course achievement</b>	None
<b>Examination</b>	Written exam
<b>Examination duration and scale</b>	180 min
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: 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 Process Engineering: Core Qualification: Compulsory

Course L0106: Applications of Fluid Mechanics in Process Engineering	
<b>Typ</b>	Recitation Section (large)
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	The Exercise-Lecture will bridge the gap between the theoretical content from the lecture and practical calculations. For this aim a special exercise is calculated at the blackboard that shows how the theoretical knowledge from the lecture can be used to solve real problems in Process Engineering.
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.</li> <li>2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.</li> <li>3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>4. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994.</li> <li>6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006.</li> <li>7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008.</li> <li>8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007</li> <li>9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009.</li> <li>10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.</li> <li>11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008.</li> <li>12. Schlichting, H. : Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.</li> <li>13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> <li>14. White, F.: Fluid Mechanics, Mcgraw-Hill, ISBN-10: 0071311211, ISBN-13: 978-0071311212, 2011.</li> </ol>

Course L0001: Fluid Mechanics II	
<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	4
<b>Workload in Hours</b>	Independent Study Time 92, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Michael Schlüter
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Differential equations for momentum-, heat and mass transfer</li> <li>• Examples for simplifications of the Navier-Stokes Equations</li> <li>• Unsteady momentum transfer</li> <li>• Free shear layer, turbulence and free jets</li> <li>• Flow around particles - Solids Process Engineering</li> <li>• Coupling of momentum and heat transfer - Thermal Process Engineering</li> <li>• Rheology – Bioprocess Engineering</li> <li>• Coupling of momentum- and mass transfer – Reactive mixing, Chemical Process Engineering</li> <li>• Flow threwn porous structures - heterogeneous catalysis</li> <li>• Pumps and turbines - Energy- and Environmental Process Engineering</li> <li>• Wind- and Wave-Turbines - Renewable Energy</li> <li>• Introduction into Computational Fluid Dynamics</li> </ul>
<b>Literature</b>	<ol style="list-style-type: none"> <li>1. Brauer, H.: Grundlagen der Einphasen- und Mehrphasenströmungen. Verlag Sauerländer, Aarau, Frankfurt (M), 1971.</li> <li>2. Brauer, H.; Mewes, D.: Stoffaustausch einschließlich chemischer Reaktion. Frankfurt: Sauerländer 1972.</li> <li>3. Crowe, C. T.: Engineering fluid mechanics. Wiley, New York, 2009.</li> <li>4. Durst, F.: Strömungsmechanik: Einführung in die Theorie der Strömungen von Fluiden. Springer-Verlag, Berlin, Heidelberg, 2006.</li> <li>5. Fox, R.W.; et al.: Introduction to Fluid Mechanics. J. Wiley &amp; Sons, 1994.</li> <li>6. Herwig, H.: Strömungsmechanik: Eine Einführung in die Physik und die mathematische Modellierung von Strömungen. Springer Verlag, Berlin, Heidelberg, New York, 2006.</li> <li>7. Herwig, H.: Strömungsmechanik: Einführung in die Physik von technischen Strömungen: Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008.</li> <li>8. Kuhlmann, H.C.: Strömungsmechanik. München, Pearson Studium, 2007</li> <li>9. Oertl, H.: Strömungsmechanik: Grundlagen, Grundgleichungen, Lösungsmethoden, Softwarebeispiele. Vieweg+ Teubner / GWV Fachverlage GmbH, Wiesbaden, 2009.</li> <li>10. Schade, H.; Kunz, E.: Strömungslehre. Verlag de Gruyter, Berlin, New York, 2007.</li> <li>11. Truckenbrodt, E.: Fluidmechanik 1: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide. Springer-Verlag, Berlin, Heidelberg, 2008.</li> <li>12. Schlichting, H. : Grenzschicht-Theorie. Springer-Verlag, Berlin, 2006.</li> <li>13. van Dyke, M.: An Album of Fluid Motion. The Parabolic Press, Stanford California, 1882.</li> </ol>

**Module M0519: Particle Technology and Solid Matter Process Technology**

Courses				
Title	Typ	Hrs/wk	CP	
Advanced Particle Technology II (L0051)	Project-/problem-based Learning	1	1	
Advanced Particle Technology II (L0050)	Lecture	2	2	
Experimental Course Particle Technology (L0430)	Practical Course	3	3	
<b>Module Responsible</b>	Prof. Stefan Heinrich			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Basic knowledge of solids processes and particle technology			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>	After completion of the module the students will be able to describe and explain processes for solids processing in detail based on microprocesses on the particle level. Students are able to choose process steps and apparatuses for the focused treatment of solids depending on the specific characteristics. They furthermore are able to adapt these processes and to simulate them.			
<i>Knowledge</i>				
<i>Skills</i>				
<b>Personal Competence</b>	Students are able to present results from small teamwork projects in an oral presentation and to discuss their knowledge with scientific researchers. Students are able to analyze and solve problems regarding solid particles independently or in small groups.			
<i>Social Competence</i>				
<i>Autonomy</i>				
<b>Workload in Hours</b>	Independent Study Time 96, Study Time in Lecture 84			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	None	Written elaboration	fünf Berichte (pro Versuch ein Bericht) à 5-10 Seiten
<b>Examination</b>	Written exam			
<b>Examination duration and scale</b>	120 minutes			
<b>Assignment for the Following Curricula</b>	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation B - Industrial Bioprocess Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Process Engineering: Core Qualification: Compulsory			

**Course L0051: Advanced Particle Technology II**

<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	1
<b>CP</b>	1
<b>Workload in Hours</b>	Independent Study Time 16, Study Time in Lecture 14
<b>Lecturer</b>	Prof. Stefan Heinrich
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	See interlocking course
<b>Literature</b>	See interlocking course

**Course L0050: Advanced Particle Technology II**

<b>Typ</b>	Lecture
<b>Hrs/wk</b>	2
<b>CP</b>	2
<b>Workload in Hours</b>	Independent Study Time 32, Study Time in Lecture 28
<b>Lecturer</b>	Prof. Stefan Heinrich
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Exercise in form of "Project based Learning"</li> <li>• Agglomeration, particle size enlargement</li> <li>• advanced particle size reduction</li> <li>• Advanced theorie of fluid/particle flows</li> <li>• CFD-methods for the simulation of disperse fluid/solid flows, Euler/Euler methods, Descrete Particle Modeling</li> <li>• Treatment of simulation problems with distributed properties, solution of population balances</li> </ul>
<b>Literature</b>	Schubert, H.; Heidenreich, E.; Liepe, F.; Neeße, T.: Mechanische Verfahrenstechnik. Deutscher Verlag für die Grundstoffindustrie, Leipzig, 1990.  Stieß, M.: Mechanische Verfahrenstechnik I und II. Springer Verlag, Berlin, 1992.

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<b>Course L0430: Experimental Course Particle Technology</b>	
<b>Typ</b>	Practical Course
<b>Hrs/wk</b>	3
<b>CP</b>	3
<b>Workload in Hours</b>	Independent Study Time 48, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Stefan Heinrich
<b>Language</b>	DE/EN
<b>Cycle</b>	WiSe
<b>Content</b>	<ul style="list-style-type: none"> <li>• Fluidization</li> <li>• Agglomeration</li> <li>• Granulation</li> <li>• Drying</li> <li>• Determination of mechanical properties of agglomerats</li> </ul>
<b>Literature</b>	<p>Schubert, H.; Heidenreich, E.; Liepe, F.; Neeße, T.: Mechanische Verfahrenstechnik. Deutscher Verlag für die Grundstoffindustrie, Leipzig, 1990.</p> <p>Stieß, M.: Mechanische Verfahrenstechnik I und II. Springer Verlag, Berlin, 1992.</p>

Module M1813: Agile learning with agile methods				
Courses				
Title	Typ	Hrs/wk	CP	
Agile Data Science for industrial Engineers (L3009)	Project-/problem-based Learning	3	6	
<b>Module Responsible</b>	Prof. Kathrin Fischer			
<b>Admission Requirements</b>	None			
<b>Recommended Previous Knowledge</b>	Scientific Writing			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
<i>Knowledge</i>	The students know: <ul style="list-style-type: none"> <li>• Basic principles of agile work</li> <li>• Roles within agile project management based on Scrum</li> <li>• Structure and workflows of agile project groups</li> <li>• Basic functions/classes/methods of data science in python</li> <li>• Selected libraries of data science in Python</li> </ul>			
<i>Skills</i>	The students are able to: <ul style="list-style-type: none"> <li>• Plan and carry out a project based on the Scrum philosophy, in detail:                             <ul style="list-style-type: none"> <li>◦ Define and allocate roles in Scrum</li> <li>◦ Plan Scrum sprints based on self-defined work packages (planning)</li> <li>◦ Carry out Scrum sprints</li> <li>◦ Complete, analyse and evaluate Scrum sprints (review and retrospective)</li> <li>◦ Present project results</li> </ul> </li> <li>• Use established tools of collaborative work</li> <li>• Writing simple scientific scripts for data science in Python collaboratively</li> <li>• Record the methods and results</li> </ul>			
<b>Personal Competence</b>				
<i>Social Competence</i>	The students are able to: <ul style="list-style-type: none"> <li>• Work in heterogenic project groups and accept their defined roles based on the scrum philosophy</li> <li>• Commit to group intern time management necessities</li> <li>• Manage scope adjustments under time pressure</li> <li>• Realize and judge the importance of individual commitments for collaborative work</li> <li>• Communicate with stakeholders of their group project</li> </ul>			
<i>Autonomy</i>	The students are able to: <ul style="list-style-type: none"> <li>• Evaluate work packages regarding their practicability and commit to working on these individually</li> <li>• Evaluate their own skills regarding their contribution to a given project</li> <li>• Harmonize their own time management to the group intern time management</li> </ul>			
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42			
<b>Credit points</b>	6			
<b>Course achievement</b>	<b>Compulsory</b>	<b>Bonus</b>	<b>Form</b>	<b>Description</b>
	Yes	10 %	Group discussion	
<b>Examination</b>	Written elaboration			
<b>Examination duration and scale</b>	Approx. 5 - 10 pages per person			
<b>Assignment for the Following Curricula</b>	International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Logistics: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			

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<b>Course L3009: Agile Data Science for industrial Engineers</b>	
<b>Typ</b>	Project-/problem-based Learning
<b>Hrs/wk</b>	3
<b>CP</b>	6
<b>Workload in Hours</b>	Independent Study Time 138, Study Time in Lecture 42
<b>Lecturer</b>	Prof. Kathrin Fischer
<b>Language</b>	DE
<b>Cycle</b>	WiSe
<b>Content</b>	<p>Within this course, the fundamentals of Python for Data Science are taught and applied on a collaborative level.</p> <p>The course starts with an introduction to Python which is held in workshop format, and an introduction to collaborative work and agile project management.</p> <p>During this course different projects will be carried out in project groups, following the scrum philosophy.</p> <p>The course is dedicated to programming beginners, so no prior knowledge of Python is required. However, also students with programming experience are welcome to participate.</p> <p>For the exam, teams are required to write a report on the group projects and their results.</p>
<b>Literature</b>	Schwaber, K. & Sutherland, J. (2020): The Scrum Guide. Online Ressource

**Thesis**

Module M-002: Master Thesis			
Courses			
Title	Typ	Hrs/wk	CP
<b>Module Responsible</b>	Professoren der TUHH		
<b>Admission Requirements</b>	<ul style="list-style-type: none"> <li>According to General Regulations §21 (1):</li> </ul> <p>At least 60 credit points have to be achieved in study programme. The examinations board decides on exceptions.</p>		
<b>Recommended Previous Knowledge</b>			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>	<p><i>Knowledge</i></p> <ul style="list-style-type: none"> <li>The students can use specialized knowledge (facts, theories, and methods) of their subject competently on specialized issues.</li> <li>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.</li> <li>The students can place a research task in their subject area in its context and describe and critically assess the state of research.</li> </ul> <p><i>Skills</i></p> <p>The students are able:</p> <ul style="list-style-type: none"> <li>To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in question.</li> <li>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.</li> <li>To develop new scientific findings in their subject area and subject them to a critical assessment.</li> </ul> <p><b>Personal Competence</b></p> <p><i>Social Competence</i></p> <p>Students can</p> <ul style="list-style-type: none"> <li>Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structured way.</li> <li>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.</li> </ul> <p><i>Autonomy</i></p> <p>Students are able:</p> <ul style="list-style-type: none"> <li>To structure a project of their own in work packages and to work them off accordingly.</li> <li>To work their way in depth into a largely unknown subject and to access the information required for them to do so.</li> <li>To apply the techniques of scientific work comprehensively in research of their own.</li> </ul>		
<b>Workload in Hours</b>	Independent Study Time 900, Study Time in Lecture 0		
<b>Credit points</b>	30		
<b>Course achievement</b>	None		
<b>Examination</b>	Thesis		
<b>Examination duration and scale</b>	According to General Regulations		
<b>Assignment for the Following Curricula</b>	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		

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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