



Module Manual

Master of Science

Mechanical Engineering and Management

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Program description

Content

Nowadays engineers work not only as designers or as problem solvers in technical issues, but also fill management positions and have to make strategic and operative decisions. In addition to profound and specialized knowledge in diverse engineering fields, engineers also need a basic understanding in economics and business studies. Graduates, who already bring along both, specialized knowledge in engineering as well as a basic understanding of economic sciences, have excellent prospects in the labor market.

The international master study course "Mechanical Engineering and Management" gives students with a bachelor's degree in mechanical engineering or similar the opportunity to build up an individual profile within two specializations.

In the first specialization students gain basic knowledge in management, business administration, accounting as well as in specialized management topics, such as corporate management, human resources or logistics.

For the second specialization students can choose between three main topics: Materials, Mechatronics, or Product Development and Production. Because of the material behavior and its great impact on product design and manufacturing, the Materials specialization represents a bridge between natural science and engineering science. The Mechatronics specialization represents an interdisciplinary field between mechanics, electronics and computer science. The last specialization, Product Development and Production, includes the computation as well as the manufacturing of products. Therefore not only the structure of the master study course is interdisciplinary, but also its specializations.

Career prospects

The international master study course "Mechanical Engineering and Management" prepares graduates for a wide range of job profiles in international operating companies and in service providers, such as consulting. They are able to work as a facilitator between technical and business sectors and to take leading positions as technical and executive managers with budget and personnel responsibilities. The program is designed to be diverse and allows graduates to work in a variety of different industrial sectors (especially in mechanical engineering) and with different products and services. Graduates may decide for direct entry into companies or to take up academic careers, e.g. Ph.D. studies, in universities or other research institutions.

Learning target

Graduates of the program are able to transfer the individually acquired specialized knowledge to new unknown topics, to grasp, to analyze and to scientifically solve complex problems of their discipline. They can find missing information and plan as well as execute theoretical studies.

They are able to work independently in fields of mechanical engineering and management as well as in their interface. They can use their interdisciplinary understanding to evaluate and to critically question results and findings in management and mechanical engineering. Based upon these they can also make decisions and draw further conclusions. They are able to act methodically, to organize smaller projects, to select scientific methods and to advance these further, if necessary. They're also qualified to work on challenging projects by considering and verifying existing information in two of these specializations:

- Management
- Materials
- Mechatronics
- Product Development and Production

In the following the learning target is divided in knowledge, skills, social skills and independence.

Knowledge

- Graduates have gained specialized interdisciplinary knowledge with broad theoretical and methodical foundations. This includes especially the compulsory courses in the first semester, in which they learn about Robotics, Computer Aided Design and Computation and Multiphase Materials.
- They have a fundamental understanding of business administration as well as special knowledge about diverse topics, such as marketing, intercultural communication or project management. They can describe different methods and current research in these fields.
- They are able to explain principles, methods and applications in detail of two engineering specializations. The engineering specializations are Materials, Mechatronics and Product Development and Production.
- They have gained basic knowledge in non-technical topics. Non-native German speaking graduates also learned the fundamentals of German language.
- They know the state of the art in their chosen specializations and can give an overview of applications in industry and research.

Skills

For all specializations

- Graduates are able to use their interdisciplinary understanding to solve complex problems through integrative linking. They can identify implications between economy and technology, mediate between these sectors and perform operative and strategic tasks.
- They are able to transfer their theoretical knowledge into practice, analyse management problems in complex corporate situations as well as to choose between advanced methods and procedures of material science, mechatronics or computation and production and to use them for complex problems.
- They can estimate and evaluate future technologies, materials, methods and scientific findings and are able to research independently (qualified for Ph.D. studies).

Management specialization

- Graduates of the Management specialization are able to evaluate necessary business and financial key figures and to make decisions based on these.
- They are able to use diverse methods and techniques of management and business administration successfully for different tasks.

Materials specialization

- Graduates of the Materials can identify new application fields of materials and make choices between different materials in consideration of functions, cost and quality.
- They can calculate several material parameters and make constructive decisions upon these calculations.

Mechatronics specialization

- Graduates of the Mechatronics specialization can solve mechatronic tasks as well as design tasks systematically and methodically.
- They are able to use their knowledge about current methods, automation and simulation to analyze systems, evaluate the findings and to choose between different strategies to solve the task.

Product Development and Production specialization

- Graduates of the Product Development and Production specialization can choose between diverse manufacturing and production processes in consideration of

geometry, failure control and cost.

- They are able to design, calculate and simulate according to the current state of the art.

Social Skills

- Graduates are able describe techniques, methods and findings of their work verbally and in written form in English.
- They can communicate with experts of their chosen disciplines and in their interdisciplinary interface as well as with lay persons about advanced contents and issues in English. They can also react appropriately to questions and comments.
- They are able to work in team. For this they can define, distribute and integrate subtasks and arrange team meetings. They can interact socially and are capable of taking leading positions.

Autonomy

- Graduates are capable of finding necessary information, extending their knowledge in technical, economic and social topics and putting these into context with their knowledge.
- They can systematically reflect the non-technical consequences of their work and can put their actions into socio-economic context.
- They can estimate their own strengths and weaknesses as well as possible consequences of their actions. They can compensate deficits and extend their knowledge independently as far as necessary.
- They can work self-organized and self-motivated in different research fields and find, analyze and define concrete problems within (lifelong learning).

Program structure

The course is designed modular and is based on the university-wide standardized course structure with uniform module sizes (multiples of six credit points (CP)). The course combines the engineering and management disciplines and allows the deepening in two of four specializations. The students can broadly personalize their studies due to high number and variety of elective courses.

In the common core skills, students take the following modules:

- Computer Aided Design and Computation (6 CP)
- Multiphase Materials (6 CP)
- Robotics (6 CP)
- Management elective courses (at least one module) or alternatively an internship or an additional technical course (18 CP)
- Nontechnical elective complementary courses (catalog) (6 CP) , of that 4 CP are intended for German classes

Students specialize by selecting two of the following areas, each covering 18 credit points. Students have to choose the Management specialization. Solely students of the Northern Institute of Technology have to choose two engineering specializations:

- Management (18 CP)
- Materials (18 CP)
- Mechatronics (18 CP)
- Product Development and Production (18 CP)

Within each area of specialization students can choose within a catalogue of modules (each 6 CP).

Students write also a master thesis and one additional scientific project work.

- Research Project (12 CP)
- Master thesis (30 CP)

Core qualification

The core qualification provides the basic fundamentals for the four specializations and also includes a catalogue of nontechnical elective complementary courses. For all three engineering specializations (Materials, Mechatronics, Product Development and Production) a compulsory module is included. As preparation for the Management specialization students choose at least one up to three modules from the catalogue. Alternatively they can also choose an additional engineering module and an internship. In total three modules need to be chosen.

Module M1197: Multiphase Materials				
Courses				
Title	Typ	Hrs/wk	CP	
Applied Computational Methods for Material Science (L1626)	Problem-based Learning	3	3	
Structure and Properties of Composites (L0513)	Lecture	2	3	
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	Non			
Recommended Previous Knowledge	TBD			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				Students can
				- explain the complex relationships of the mechanics of composite materials, the failure mechanisms and physical properties.
				- assess the interactions of microstructure and properties of the matrix and reinforcing materials.
				- explain e.g. different fiber types, including relative contexts (e.g. sustainability, environmental protection).
				They know different methods of modeling multiphase materials and can apply them.
Skills				Students are capable of
				- using standardized methods of calculation and modeling using the finite element method in a specified context to use discretization, solver, Programming with Python, Automated control and evaluation of parameter studies and examples to calculate of elastic mechanics like tensile, bending, four point bend, crack propagation, J -Integral, Cohesive zone models, Contact.
				- determining the material properties (elasticity, plasticity, small and large deformations, modeling of multiphase materials).
				- to calculate and evaluate the mechanical properties (modulus, strength) of different materials.
				- Approximate sizing using the network theory of the structural elements implement and evaluate.
				- selecting appropriate solutions for mechanical material problems: Solution of inverse problems (neural networks, optimization methods).
Personal Competence				
Social Competence				Students can,
				- arrive at work results in groups and document them.
	- provide appropriate feedback and handle feedback on their own performance constructively.			
Autonomy	Students are able to,			
	- assess their own strengths and weaknesses			
	- assess their own state of learning in specific terms and to define further work steps on this basis guided by teachers.			
	They are able to fill gaps in as well as extent their knowledge using the literature and other sources provided by the supervisor. Furthermore, they can meaningfully extend given problems and pragmatically solve them by means of corresponding solutions and concepts.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	1,5 h written exam in S. a. P. of Composites			
Assignment for the Following Curricula	Materials Science: Core qualification: Compulsory			
	Mechanical Engineering and Management: Core qualification: Compulsory			

Course L1626: Applied Computational Methods for Material Science	
Typ	Problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Norbert Huber
Language	DE/EN
Cycle	WiSe
Content	<p>Finite Element Method (discretisation, solver, programming with Python, automatized control and analysis of parametric studies)</p> <p>Examples of elastomechanics (tension, bending, four-point-bending, crack propagation, J-integral, cohesive zone models, contact)</p> <p>Material behaviour (elasticity, plasticity, small and finite deformations, modelling of multiphase materials)</p> <p>Solution of inverse problems (artificial neural networks, optimization)</p>
Literature	<p>Alle Vorlesungsmaterialien und Beispiellösungen (Input-Dateien, Python Scripts) werden auf Stud.IP zur Verfügung gestellt.</p> <p>All lecture material and example solutions (input files, python scripts) will be made available in Stud.IP.</p>

Course L0513: Structure and Properties of Composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> - Microstructure and properties of the matrix and reinforcing materials and their interaction - Development of composite materials - Mechanical and physical properties - Mechanics of Composite Materials - Laminate theory - Test methods - Non destructive testing - Failure mechanisms - Theoretical models for the prediction of properties - Application
Literature	<p>Hall, Clyne: Introduction to Composite materials, Cambridge University Press</p> <p>Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press</p> <p>Mallick: Fibre-Reinforced Composites, Marcel Dekker, New York</p>

Module M0563: Robotics				
Courses				
Title	Typ		Hrs/wk	CP
Robotics: Modelling and Control (L0168)	Lecture		3	3
Robotics: Modelling and Control (L1305)	Recitation Section (small)		2	3
Module Responsible	Prof. Uwe Weltin			
Admission Requirements				
Recommended Previous Knowledge	Fundamentals of electrical engineering Broad knowledge of mechanics Fundamentals of control theory			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<i>Knowledge</i> Students are able to describe fundamental properties of robots and solution approaches for multiple problems in robotics. <i>Skills</i> Students are able to derive and solve equations of motion for various manipulators. Students can generate trajectories in various coordinate systems. Students can design linear and partially nonlinear controllers for robotic manipulators.			
Personal Competence				
<i>Social Competence</i>				
<i>Autonomy</i>				
	Students are able to work goal-oriented in small mixed groups. Students are able to recognize and improve knowledge deficits independently. With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following Curricula	Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: Elective Compulsory International Production Management: Specialisation Production Technology: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechanical Engineering and Management: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory			

Course L0168: Robotics: Modelling and Control	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	WiSe
Content	Fundamental kinematics of rigid body systems Newton-Euler equations for manipulators Trajectory generation Linear and nonlinear control of robots
Literature	Craig, John J.: Introduction to Robotics Mechanics and Control, Third Edition, Prentice Hall. ISBN 0201-54361-3 Spong, Mark W.; Hutchinson, Seth; Vidyasagar, M. : Robot Modeling and Control. WILEY. ISBN 0-471-64990-2

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

Module M1262: Selected Topics of Management and Law
Courses

Title	Type	Hrs/wk	CP
Empirical Business Research Methods (L1756)	Lecture	2	2
Advanced Research Seminar (L0936)	Seminar	2	2
Innovation Debates (L1711)	Problem-based Learning	2	2
International Law for Engineers (Seminar) (L1750)	Seminar	2	2
International Law for Engineers (lecture) (L1749)	Lecture	2	2
Accounting (L1712)	Lecture	2	2
Accounting (L1713)	Recitation Section (large)	2	2
Module Responsible	Prof. Dieter Krause		
Admission Requirements	none		
Recommended Previous Knowledge	see lecture description		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students are able to express their extended knowledge and discuss the connection of different special fields or application areas of business management Students are qualified to connect different special fields with each other <i>Skills</i> <ul style="list-style-type: none"> Students can apply specialized solution strategies and new scientific methods in selected areas Students are able to transfer learned skills to new and unknown problems and can develop own solution approaches Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to develop their knowledge and skills by autonomous election of courses.		
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the Following Curricula	Mechanical Engineering and Management: Core qualification: Elective Compulsory		

Course L1756: Empirical Business Research Methods

Type	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 min
Lecturer	Dr. Katrin Reber
Language	EN
Cycle	SoSe
Content	Understanding how research works is essential for both students and practitioner of management. The business research process comprises idea and theory development, problem definition, the search for information, collecting and analyzing data, interpreting and communicating outcomes and their implications. Information needs to be accurate, objective and reliable to become a foundation of managerial decision making.
Literature	<ul style="list-style-type: none"> Keller, G. Managerial Statistics 9th International Edition (hieraus würde ich auch die ein oder andere Übungsaufgabe nehmen) ISBN10: 1111534632 Keller, G. Statistics for Management and Economics, 10th ed ISBN10: 1285425456 allgemein für BRM: Cooper, D., Blumberg, B., Schindler, P. Business Research Methods, 4th Edition

Course L0936: Advanced Research Seminar	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32; Study Time in Lecture 28
Examination Form	Hausarbeit
Examination duration and scale	10-15 Seiten
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	SoSe
Content	In this course students will be taught to understand the research process and to interpret scientific papers as a preparation to starting their own scientific initiatives (e.g. Master-Thesis work). Students will work in groups and individually. Each group is expected to work out a presentation summarizing aspects of the research process (including practical examples) and to present and discuss it in class. Further, students will work out a written seminar paper.
Literature	<p>Sekaran and Bougie (2010); Research methods for business: a skill-building approach; Wiley, Chichester</p> <p>Booth, Wayne C. et al. (2008); The craft of research; The University Press of Chicago, Chicago & London</p> <p>Punch, Keith F. (2005); Introduction to social research – quantitative and qualitative approaches; Sage Publications, London</p> <p>Bryman and Bell (2011); Business research methods; Oxford Univ. Press, Oxford</p> <p>Bell, Judith (2010); Doing your research project: a guide for first-time researchers in education, health and social science; Open University Press, Maidenhead</p>

Course L1711: Innovation Debates	
Typ	Problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32; Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	3 Präsentationen der schriftlichen Ausarbeitung à 20 Minutes
Lecturer	Dr. Daniel Ehls
Language	EN
Cycle	WiSe
Content	<p>Scientific knowledge grows continuously but also experiences certain alignments over time. For example, early cultures had the believe of a flat earth while latest research has a spherical earth model. Also in social science and business management, from time to time certain concepts that have even been the predominant paradigm are challenged by new observations and models. Consequently, certain controversies emerge and build the base for advancing theory and managerial practice. With this lecture, we put ourselves in the middle of heated debates for informed academics and practitioners of the day after tomorrow.</p> <p>The lecture targets several controversies in the domain of technology strategy and innovation management. By the classical academic method and the novel problem based learning format of a structured discussion, a given controversy is scrutinized. On selected topics, students will discuss a dispute and gain a thorough understanding. Specifically, based on a brief introduction of a motion, a affirmative constructive as well as a negative constructive is presented by two different student groups. Each presentation is followed by a response of the other group and questions from the class. Topics range from latest theories and concepts for value capture, to the importance of operating within a global marketplace, to cutting edge approaches for innovation stimulation and technology management. Consequently, this lecture deepens the knowledge in technology strategy and innovation management (TIM), enables a critical thinking and thought leadership.</p>
Literature	<ol style="list-style-type: none"> 1. Course notes and materials provided before the lecture 2. Leiblein/ Ziedonis (2011): Technology Strategy and innovation management. Edward Elgar Publishing Ltd (optional)

Course L1750: International Law for Engineers (Seminar)	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Hausarbeit
Examination duration and scale	10-20 Seiten
Lecturer	Markus A. Meyer-Chory
Language	EN
Cycle	SoSe
Content	<p>Necessary & recommended knowledge:</p> <p>necessary: passed test of International Law for Engineers in winter semester welcome but not necessary: any general lectures on law, national or international</p> <p>Contents:</p> <ul style="list-style-type: none"> • Specific law and specifics of systematic on engineers international rights • selected international engineer-specifics cases of: labor law, product liability, trademark law, copyright law, competition law, patent law, industrial law, corporate law • Exercises on and examination of advanced relevant cases • Excursions to courts, legal departments of companies and law firms <p>Qualifying targets:</p> <p>learning of and become acquainted with:</p> <ul style="list-style-type: none"> • engineer-specific international cases • theoretical legal functions of national and international advanced legal rules • improving of use of engineer relevant legal rules • further improvement of methodical treatment of engineer-specific cases • written exercises on subjects of international engineers law <p>group exercises on international cases</p>
Literature	Will be announced at the beginning of the course.

Course L1749: International Law for Engineers (lecture)	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Markus A. Meyer-Chory
Language	EN
Cycle	WiSe
Content	<p>Recommended knowledge:</p> <p>welcome but not necessary - any general lectures on law, national or international</p> <p>Contents:</p> <p>General law, fundamental content and basics of systematic on engineers specific international rights</p> <p>Law system of selected internationally engineer-specifics law i.e.: labor law, product liability, trademark law, copyright law, competition law, patent law, industrial law, corporate law</p> <p>Exercises on and examination of relevant cases</p> <p>Qualifying targets:</p> <p>learning of and become acquainted with:</p> <ul style="list-style-type: none"> • engineer-specific international cases • theoretical legal functions of national and international basic legal rules • searching and use of engineer relevant legal rules • improvement of methodical treatment of engineer-specific cases
Literature	Will be announced at the beginning of the course.

Course L1712: Accounting	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Hausarbeit
Examination duration and scale	10-20 Seiten
Lecturer	Dr. Uwe Kagelmann
Language	EN
Cycle	WiSe
Content	<p>Course objective:</p> <p>To provide a theoretical and a practical insight into the area of financial and management accounting.</p> <p>Approach:</p> <p>Illustration of theoretical concepts combined with case studies and business examples.</p> <p>The exercise is based on the development of a financial business plan for your own business idea. This financial business plan is developed in a team of 3-5 students and presented as well as discussed in the class.</p> <ol style="list-style-type: none"> I. Introduction to Cost Terms and Concepts II. Standard Costing and Variance Analysis III. Financial Accounting and Reporting (Financial Statement, Income Statement, Cash Flow) IV. Information for Decision Making V. Performance Management: Planning, Budgeting & Forecasting
Literature	<p>Literature: Business Accounting and Finance 3e</p> <p>ISBN-13: 9781408018378 / ISBN-10: 1408018373; Catherine Gowthorpe, Oxford Brookes University, 576pp, Published by Cengage Learning, ©2011</p>

Course L1713: Accounting	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Hausarbeit
Examination duration and scale	10-20 Seiten
Lecturer	Dr. Uwe Kagelmann
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1282: Selected Topics of Materials, Mechatronics, and Product Development and Production
Courses

Title	Typ	Hrs/wk	CP
Fatigue & Damage Tolerance (L0310)	Lecture	2	3
Joining of Polymer-Metal Lightweight Structures (L0500)	Lecture	2	2
Joining of Polymer-Metal Lightweight Structures (L0501)	Laboratory Course	1	1
Lightweight Design Practical Course (L1258)	Problem-based Learning	3	3
Metallic Materials for Aircraft Applications (L0514)	Lecture	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	see lecture description		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students are able to express their extended knowledge and discuss the connection of different special fields or application areas of Materials, Mechatronics and Product Development and Production Students are qualified to connect different special fields with each other <i>Skills</i> <ul style="list-style-type: none"> Students can apply specialized solution strategies and new scientific methods in selected areas Students are able to transfer learned skills to new and unknown problems and can develop own solution approaches Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to develop their knowledge and skills by autonomous election of courses.		
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the Following Curricula	Mechanical Engineering and Management: Core qualification: Elective Compulsory		

Course L0310: Fatigue & Damage Tolerance

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

Course L0500: Joining of Polymer-Metal Lightweight Structures	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Sergio Amancio Filho
Language	EN
Cycle	WiSe
Content	<p>Recommended Previous Knowledge:</p> <p>Fundamentals of Materials Science and Engineering</p> <p>Basic Knowledge of Science and Technology of Welding and Joining</p> <p>Contents:</p> <p>The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-metal lightweight structures used in engineering applications. A general understanding of the principles of the consolidated and new technologies and its main fields of applications is to be accomplished through theoretical and practical lectures:</p> <p>Theoretical Lectures:</p> <ul style="list-style-type: none"> - Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology - Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics - Mechanical Fastening of Polymer-Metal Hybrid Structures - Adhesive Bonding of Polymer-Metal Hybrid Structures - Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures - Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures <p>Laboratory Exercises (will be offered at Helmholtz-Zentrum Geesthacht as a 2-3 days compact course)</p> <ul style="list-style-type: none"> - Joining Processes: Introduction to state-of-the-art friction-based spot welding and joining technologies (Friction Riveting, Friction Spot Joining and Injection Clinching Joining) - Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints <p>Learning Outcomes:</p> <p>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymer-metal lightweight structures as well as their application fields.</p>
Literature	<ul style="list-style-type: none"> • Lecture Notes and selected papers • J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International • J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers • D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook • D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited

Course L0501: Joining of Polymer-Metal Lightweight Structures	
Typ	Laboratory Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Sergio Amancio Filho
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1258: Lightweight Design Practical Course	
Typ	Problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Dieter Krause
Language	DE/EN
Cycle	SoSe
Content	<p>Development of a sandwich structure made of fibre reinforced plastics</p> <ul style="list-style-type: none"> • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests • manufacturing of the structure in the composite lab • Testing of the developed structure • Concept presentation • Self-organised teamwork
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005. • Puck, A., „Festigkeitsanalyse von Faser-Matrix-Laminaten“, Hanser, München, Wien, 1996. • R&G, „Handbuch Faserverbundwerkstoffe“, Waldenbuch, 2009. • VDI 2014 „Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund“ • Ehrenstein, G. W., „Faserverbundkunststoffe“, Hanser, München, 2006. • Klein, B., „Leichtbau-Konstruktion“, Vieweg & Sohn, Braunschweig, 1989. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986. • Wiedemann, J., „Leichtbau Band 2: Konstruktion“, Springer, Berlin, Heidelberg, 1986. • Backmann, B.F., „Composite Structures, Design, Safety and Innovation“, Oxford (UK), Elsevier, 2005. • Krause, D., „Leichtbau“, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012. • Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials“, Hamburg, TUHH - TuTech Innovation GmbH, 2005.

Course L0514: Metallic Materials for Aircraft Applications	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Joachim Albrecht
Language	EN
Cycle	SoSe
Content	<p>Titanium and Titanium alloys: Extraction and melting, phase diagrams, physical properties.</p> <p>CP-Titanium and Alpha alloys: Processing and microstructure, properties and applications.</p> <p>Alpha+Beta alloys: Processing and microstructure, properties and applications.</p> <p>Beta alloys: Processing and microstructure, properties and applications</p> <p>Nickel-base Superalloys: Optimization of creep resistance for gas turbine engines, microstructural constituents and influence of alloying elements, thermomechanical treatment and resulting properties, long time stability at high temperatures</p>
Literature	<p>G. Luetjering, J.C. Williams: Titanium, 2nd ed., Springer, Berlin, Heidelberg, 2007, ISBN 978-3-540-71397</p> <p>C.T. Sims, W.C. Hagel: The Superalloys, John Wiley & Sons, New York, 1972, ISBN 0-471-79207-1</p>

Module M1192: Selected Topics of Business Administration (IPM)
Courses

Title	Type	Hrs/wk	CP
Corporate Finance (L0107)	Lecture	2	2
Project Management Methods (L0710)	Lecture	1	2
Human Resource Management and Organization Design (L0108)	Lecture	2	2
Module Responsible	Prof. Christian Ringle		
Admission Requirements	NITHH students are not allowed to participate in this course since Finance and Investment is an element of their management studies curriculum at NITHH.		
Recommended Previous Knowledge	Basic Knowledge of Principles and Concepts in Business Administration		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	The students will be able to <ul style="list-style-type: none"> describe complex and interrelated constructs in the fields of management of organizations, strategic and human resource management, project management and corporate finance analyze the substantial aspects of organizations and organizational theories describe the fields of personnel planning, acquisition and personnel development name characteristics and critical success factors of projects discuss typical phases in projects, corresponding tasks and challenges explain and derive fiscal and financial figures describe the role of finance within an international organization discuss theories and models in the field of finance and investment 		
<i>Skills</i>	The students will be able to <ul style="list-style-type: none"> apply theoretical approaches and models of human resource management, organizational design, project management and corporate finance discuss practical problems based on theoretical knowledge with case studies analyze case studies and new practical developments apply project management techniques to complex business cases systematically implement project management techniques to international projects evaluate theories and models of corporate finance critically analyze the capital structure of an organization 		
Personal Competence <i>Social Competence</i>	The students will be able to <ul style="list-style-type: none"> have fruitful professional discussions; present their results in written form and by oral presentations 		
<i>Autonomy</i>	The students will be able to <ul style="list-style-type: none"> acquire knowledge in a specific context independently and to map this knowledge onto other new complex problem fields. improve their overall management skills (starting with a structured analysis of the business problem, via developing suitable solutions, to appropriately communicating/presenting solutions developed). 		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Examination	Written exam		
Examination duration and scale	180 minutes		
Assignment for the Following Curricula	Mechanical Engineering and Management: Core qualification: Elective Compulsory		

Course L0107: Corporate Finance	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Ringle
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction to corporate finance and financial management of the multinational firm • 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) • 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) • Capital structure (e.g., equity financing and stocks, debt financing and corporate bonds, leasing and off-balance-sheet financing) • Options and futures (e.g., call and put options, warrants and convertibles, financial risk management with derivatives) • Financing and financial planning of the multinational firm (e.g., financial statement analysis, short and long-term financial planning, cash and credit management) • International corporate finance (e.g., foreign exchange exposure and management, international portfolio investments, international mergers and acquisitions)
Literature	<p>Brealey, R.A./Myers, S.C./Marcus, A.J. (2009): Fundamentals of Corporate Finance, 6e, Boston: McGraw-Hill.</p> <p>Brealey, R.A./Myers, S.C./Allen, F. (2011): Principles of Corporate Finance, 10e, New York: McGraw-Hill.</p> <p>Berk, J./DeMarzo, P. (2011): Corporate Finance, 2e, Boston: Pearson.</p> <p>Eun, C.S./Resnick, B.G. (2012): International Financial Management, 6e, New York: McGraw-Hill.</p> <p>Robin, J.A. (2010): International Corporate Finance, New York: McGraw-Hill.</p> <p>Ross, S.A./Westerfield, R.W./Jaffe, J. (2009): Corporate Finance, 9e, New York: McGraw-Hill.</p> <p>Ross, S.A./Westerfield, R.W./Jaffe, J. (2010): Corporate Finance: Core Principles and Applications, 3e, New York: McGraw-Hill.</p>

Course L0710: Project Management Methods	
Typ	Lecture
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Carlos Jahn
Language	EN
Cycle	SoSe
Content	The course gives the participants an overview about project management as a crossover discipline. It focuses on tasks, techniques and tools which enable effective and efficient planning, implementation and controlling of projects.
Literature	<p>Project Management Institute (2008): A guide to the project management body of knowledge (PMBOK® Guide). 4. Aufl. Newtown Square, Pa: Project Management Institute.</p> <p>Haberfellner, R. et al. (2002): Systems Engineering - Methodik und Praxis. 11. Aufl. Verlag Industrielle Organisation.</p>

Course L0108: Human Resource Management and Organization Design	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Ringle
Language	EN
Cycle	SoSe
Content	<p>Advanced topics of</p> <ul style="list-style-type: none"> • The Study of Organizations and Organizational Theories • The processes of developing organizational structures for multinational firms • Analysis and Design of Work • Strategic Management of the Human Resource Function in international business • Human Resource Planning and Recruitment in the global environment • Managing performance measurement, compensation and benefits of international corporations • Employee Development • Employee Separation and Retention
Literature	<p>Dessler, G.: Human Resource Management, 12/e, Boston: Pearson, 2010.</p> <p>Gibson, J.L./ Ivancevich, J.M./ Donnelly, J.H./ Konopaske, R.: Organizations: Behavior, Structure, Processes, 13/e, Boston: McGraw-Hill, 2009.</p> <p>Jones, G. R.: Organizational Theory, Design, and Change, 7/e, Boston: Pearson, 2013.</p> <p>Mondy, R. W.: Human Resource Management, 12/e, Boston: Pearson, 2012.</p> <p>Noe, R.A./ Hollenbeck, J.R./ Gerhart, B./ Wright, P.M.: Human Resource Management: Gaining a Competitive Advantage, 7/e, New York: McGraw-Hill, 2010.</p>

Module M1292: Marketing and Communication

Courses

Title	Type	Hrs/wk	CP
Business-to-Business Marketing (L0762)	Lecture	2	2
Case Studies of Marketing and Communication (L1760)	Recitation Section (small)	1	2
Intercultural Management and Communication (L0846)	Lecture	2	2
Module Responsible	Prof. Christian Lütthje		
Admission Requirements	None		
Recommended Previous Knowledge	No specific knowledge required. Bachelor-level knowledge in business administration with some insights into marketing and international management is helpful.		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	The students will develop a thorough understanding of the following: <ul style="list-style-type: none"> • Selling to organizations and industrial buyers • Overview of basic strategic decisions in B2B markets • Relevant theories, methods and tools for operational B2B marketing (Marketing Mix) • Relevant theories for intercultural communication • Communication theories (verbal, non-verbal communication, role of formality, interpretation of cues such as symbols) • The nature of "culture" is and its impact on human interaction • Approaches for managing cultural diversity 		
<i>Skills</i>	The students will be able to apply this knowledge to: <ul style="list-style-type: none"> • choosing appropriate cooperation forms when selling to business organizations; • decide about different target markets, ways of market entry, and timing strategies; • develop appropriate value-propositions to customers; • place, price and communicate industrial products with the help state-of-the-art B2B marketing tools; • interpret symbols, rituals and gestures appropriately in an intercultural context • managing cultural diversity across the employees of a company • communicating appropriately with customers in different regional markets • apply the theoretical knowledge to business cases or real examples • apply the theoretical knowledge to interpret research studies 		
Personal Competence <i>Social Competence</i>	The students will be able to <ul style="list-style-type: none"> • have fruitful professional discussions; • present and defend the results of their work in a group of students; • work successfully in multi-cultural teams; • communicate and collaborate successfully and respectfully with others, also on an intercultural basis. 		
<i>Autonomy</i>	The students will be able to acquire knowledge in the specific context of marketing and intercultural communication. This will enable them to make independent and well-founded decisions and to leverage this knowledge to solve new complex problems.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Examination	Written exam		
Examination duration and scale	120 min		
Assignment for the Following Curricula	Mechanical Engineering and Management: Core qualification: Elective Compulsory		

Course L0762: Business-to-Business Marketing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Lühje
Language	EN
Cycle	WiSe
Content	<p>Contents</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"> • The importance, specific characteristics and developments of B2B markets today • Organizational buying behavior and the corporate buying process • B2B marketing strategies regarding modes and time of market entry with focus on innovative industrial products • Types of project-related cooperation in the B2B project business • 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 • Marketing in complex value chains: Solving the problem of direct customers' unwillingness to adopt innovative products by directly addressing indirect customers <p>Knowledge</p> <p>The students will develop a thorough understanding of:</p> <ul style="list-style-type: none"> • How organizations and firms buy • How marketing can be performed in complex value chains • Promising market and competitive strategies in B2B markets • Modes of cooperation in B2B markets • Marketing-Mix decisions in B2B marketing (communication, pricing, distribution) <p>Skills</p> <ul style="list-style-type: none"> • analyzing the advantages and disadvantages of different target market, market entry, timing and allocation strategies; • identifying and systematically address relevant partners when selling to business organizations; • developing context-specific market-entry and timing strategies; • making appropriate decisions for the pricing and communication of industrial products; • applying the theoretical knowledge to business cases or real examples <p>Social Competence</p> <p>The students will be able to</p> <ul style="list-style-type: none"> • having fruitful professional discussions; • presenting and defending the results of their work in groupwork; <p>Self-reliance</p> <ul style="list-style-type: none"> • acquiring knowledge in the specific context independently and to map this knowledge onto other new complex problem fields. <p>Assessment</p> <p>Written examination & Class participation in interactive elements (presentations, homework)</p>
Literature	<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, 3rd 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 L1760: Case Studies of Marketing and Communication	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	WiSe
Content	<p>This course aims at deepening and applying the subjects taught in the lectures "Business-to-Business Marketing" and "Intercultural Communication". Students work on case studies in teams comprising 2-3 people. The case will enable the student teams to analyze problems, to discuss theoretical frameworks and scientific results, to evaluate decisions made in companies and/or to develop own ideas for solutions. Each of these cases is related to a specific topic that has been tackled in the other two lectures of this module. The cases can comprise scientific studies or specific company examples (e.g. how company X built up a new salesforce; how company Y designed a successful communication campaign for other countries, how research study Z contributes to the understanding of intercultural differences). The student teams receive material (e.g. scientific articles, press articles) and work with this material to complete presentation documents. The results will be illustrated and discussed in a short presentation.</p>
Literature	<p>Die Materialien werden jedes Semester neu zusammengestellt, um die ausgewählten Fälle aktuell zu halten.</p> <p>Will be newly compiled each semester to keep the cases up-to-date and fresh.</p>

Course L0846: Intercultural Management and Communication	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Rajnish Tiwari
Language	EN
Cycle	WiSe
Content	<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"> • Understanding "culture" and its impact on human interaction • Verbal and non-verbal communication • High and low context communication • Role of formality and non-formality in communication • Varying interpretations of symbols, rituals & gestures • Managing diversity in domestic settings
Literature	<ul style="list-style-type: none"> • Bartlett, C.A. / Ghoshal, S. (2002): Managing Across Borders: The Transnational Solution, 2nd edition, Boston • Deresky, H. (2006): International Management: Managing Across Borders and Cultures, 3rd edition, Upper Saddle River • French, R. (2010): Cross-cultural Management in Work Organisations, 2nd edition, London • Hofstede, G. (2003): Culture's Consequences : Comparing Values, Behaviors, Institutions and Organizations across Nations, 2nd edition, Thousand Oaks • Hofstede, G. / Hofstede, G.J. (2006): Cultures and Organizations: Software of the mind, 2nd edition, New York

Module M0524: Nontechnical Elective Complementary Courses for Master	
Module Responsible	Dagmar Richter
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence <i>Knowledge</i>	<p>The Nontechnical Academic Programms (NTA)</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 teaching architecture, in its teaching and learning arrangements, in teaching areas and by means of teaching offerings in which students can qualify by opting for specific competences and a competence level at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.</p> <p>The Learning Architecture</p> <p>consists of a cross-disciplinary study offering. The centrally designed teaching offering ensures that courses in the nontechnical academic programmes 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>Teaching and Learning Arrangements</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>Fields of Teaching</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>The Competence Level</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>Specialized Competence (Knowledge)</p> <p>Students can</p> <ul style="list-style-type: none"> • explain specialized areas in context of the relevant non-technical disciplines, • outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area, • different specialist disciplines relate to their own discipline and differentiate it as well as make connections, • sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representation in the specialized sciences are subject to individual and socio-cultural interpretation and historicity, • Can communicate in a foreign language in a manner appropriate to the subject. <p><i>Skills</i></p> <p>Professional Competence (Skills)</p> <p>In selected sub-areas students can</p> <ul style="list-style-type: none"> • apply basic and specific methods of the said scientific disciplines, • question a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline, • to handle simple and advanced questions in aforementioned scientific disciplines in a successful manner, • justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.
Personal Competence	

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

Courses

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

Module M0809: Computer Aided Design and Computation				
Courses				
Title		Typ	Hrs/wk	CP
Computer Aided Design and Computation (L0525)		Lecture	2	3
Computer Aided Design and Computation (L0527)		Recitation Section (small)	2	3
Module Responsible	Dr. Stephan Lippert			
Admission Requirements				
Recommended Previous Knowledge	- Mechanical parts and basic operations of manufacturing techniques			
	- Basic knowledge in mathematics, physics, and statics			
	- Mechanics I (statics, mechanics of materials) and mechanics II (hydrostatics, kinematics, dynamics)			
	- Mathematics I, II, III (in particular differential equations)			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	- Understanding of the capabilities and limitations of 3D-CAD-Systems, PDM systems, and computer aided simulation Tools			
	- General knowledge of the finite element method in combination with a basic theoretical and methodology basis			
	- Basic understanding of the structural optimizations potential and fields of application			
	- Hands-on practice with an exemplary 3D-CAD-system to demonstrate basic modeling techniques as well as interfaces for concurrent finite element analysis			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following Curricula	Mechanical Engineering and Management: Core qualification: Compulsory			

Course L0525: Computer Aided Design and Computation	
Type	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Stephan Lippert, Prof. Dieter Krause, Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	<p>Part 1: Computer aided design (Prof. Dr.-Ing. D. Krause)</p> <ul style="list-style-type: none"> • Introduction to integrated product development • 3D-CAD-systems and CAD-interfaces • Introduction to PDM-systems • Additional computer aided engineering/simulation tools (FEA, DMU, VR) <p>Part 2: Introduction to the Finite Element Method (Dr.-Ing. S. Lippert)</p> <ul style="list-style-type: none"> • General overview on the finite element method • Displacement method • Isoparametric elements • Numerical integration • Applications • Programming of elements (Matlab, hands-on sessions) <p>Part 3: Structural Optimization Methods (Prof. Dr.-Ing. C. Emmelmann)</p> <ul style="list-style-type: none"> • Introduction to structural optimization theory • Fields of application for structural optimization and commercial software tools <p>This module relies heavily on the interconnection of theory and the application of commercial software systems via live demonstrations as well as hands-on sessions in a PC-pool.</p>
Literature	<p>Lee, K.: Principles of CAD / CAM / CAE Systems, Addison Wesley</p> <p>Bathe, K.-J.: Finite element procedures, Prentice Hall</p> <p>Christensen, P.W.; Klarbring, A.: An introduction to structural optimization; Springer</p>

Course L0527: Computer Aided Design and Computation	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Stephan Lippert, Prof. Dieter Krause, Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1285: Internship MEM
Courses

Title	Typ	Hrs/wk	CP
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge of German language		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> • Students are able to describe business structures and processes • They can summarise and present the contents of the project(s) they worked on during the internship <i>Skills</i> <ul style="list-style-type: none"> • Students are able to transfer knowledge and methods learned from the project on other applications • They are able to plan their work and their procedure • During their project, they can make decisions, justify them and based upon these they can draw conclusions on future work Personal Competence <i>Social Competence</i> <ul style="list-style-type: none"> • Students know and understand social structures of companies and are able to integrate themselves into these • They can discuss their work with colleagues and respond adequately to critique • They can work in teams, undertake tasks and comply with the time schedule <i>Autonomy</i> <ul style="list-style-type: none"> • Students know their interests, strengths and weaknesses. Based on this, they can find a suitable position for an internship, apply for it and explain their competences to others. 			
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0		
Credit points	6		
Examination	Written elaboration (accord. to Internship Regulations)		
Examination duration and scale	see internship guidelines		
Assignment for the Following Curricula	Mechanical Engineering and Management: Core qualification: Elective Compulsory		

Module M1283: Research Project MEM
Courses

Title	Typ	Hrs/wk	CP
Module Responsible	Dozenten des Studiengangs		
Admission Requirements	None		
Recommended Previous Knowledge	Subjects of the Master program and the chosen specialisation.		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students can explain the project as well as their autonomously gained knowledge and relate it to current issues of their field of study. They can explain the basic scientific methods they have worked with. <i>Skills</i> <p>The students are able to autonomously solve a limited scientific task under the guidance of an experienced researcher. They can justify and explain their approach for problem solving; they can draw conclusions from their results, and then can find new ways and methods for their work. Students are capable of comparing and assessing alternative approaches with their own with regard to given criteria.</p> Personal Competence <i>Social Competence</i> <p>The students are able to condense the relevance and the structure of the project work, the work procedure and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to their peers and supervisors.</p> <i>Autonomy</i> <p>The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.</p>			
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0		
Credit points	12		
Examination	Project (accord. to Subject Specific Regulations)		
Examination duration and scale	see FSPO		
Assignment for the Following Curricula	Mechanical Engineering and Management: Core qualification: Compulsory		

Specialization Management

Graduates of the Management specialization learn to use their knowledge in management and business topics for the planning of production processes and projects. Furthermore they have extended knowledge in special topics, such as human resources, entrepreneurship or logistics. Graduates are able to evaluate the necessary business and financial key figures and to make decisions based on these. They are able to put their theoretical knowledge into practice and to analyze complex questions in business administration. They learn diverse methods and techniques of management and business administration and are able to use them successfully for different tasks.

Students have to choose the Management specialization. Solely students of the Northern Institute of Technology have to choose two engineering specializations.

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

Course L0849: Technology Management	
Typ	Problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	<p>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.</p> <p>This lecture is part of the Module Technology Management and can not separately choosen.</p>
Literature	Leiblein, M./Ziedonis, A.: Technology Strategy and Inoovation Management, Elgar Research Collection, Northhampton (MA) 2011

Course L0850: Technology Management Seminar	
Typ	Problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Aspects of and Cases in combination with the content of the lecture.
Literature	see lecture Technology Management.

Module M1255: International Production Management and Enterprise Resource Planning: CERMEDES AG				
Courses				
Title	Typ		Hrs/wk	CP
International Production Management and Enterprise Resource Planning: CERMEDES AG (L1232)	Seminar		2	6
Module Responsible	Prof. Christian Ringle			
Admission Requirements	None, but limited number of students: 25			
Recommended Previous Knowledge	Basic knowledge in business administration			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i>	Students will be able to <ul style="list-style-type: none"> describe complex and interrelated business processes along the supply chain explain business processes and their implementation in SAP (based on a model company) summarize process and project management techniques of Enterprise Resource Planning-(ERP)-Software implementation describe the functioning and use of ERP-Software along the supply chain discuss the integrative role of ERP-Systems The students will be able to <ul style="list-style-type: none"> design business processes along the supply chain of a firm implement the process of ERP-Software, i.e. customizing an SAP system use ERP-Software, i.e. operatively run an SAP system critically evaluate ERP-Software along the theoretical requirements for optimally designing a business process 			
Personal Competence <i>Social Competence</i> <i>Autonomy</i>	The students will be able to <ul style="list-style-type: none"> have fruitful professional discussions; present and defend the results of their work; communicate and collaborate successfully and respectfully with others in teams. The students will be able to <ul style="list-style-type: none"> acquire knowledge in a specific context independently and to map this knowledge onto other new complex problem fields. 			
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28			
Credit points	6			
Examination	Written elaboration			
Examination duration and scale	12 pages per student; 3 months			
Assignment for the Following Curricula	Mechanical Engineering and Management: Specialisation Management: Elective Compulsory			

Course L1232: International Production Management and Enterprise Resource Planning: CERMEDES AG	
Typ	Seminar
Hrs/wk	2
CP	6
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Lecturer	Prof. Christian Ringle
Language	EN
Cycle	SoSe
Content	<p>The course consists of three parts:</p> <p>During the first part of the course, participants are provided with insights into the market for ERP-Software and are provided with knowledge on how ERP-implementation projects proceed and how these projects should ideally be managed from a theoretical and practical perspective. Participants are introduced into the basic functioning of ERP-Software referring to the most common system (SAP). Participants gain a basic understanding of implementing organizational data, master data and processes into the system.</p> <p>The second part of the course involves working on a seminar thesis which takes place parallel to the first rather lecture-type sessions. Participants are in teams invited to design a theoretical concept for the functioning of certain business units within the firm (e.g. procurement, production, sales and distribution). Their concept should then be incorporated into both, a seminar thesis to be handed in and a first short presentation to be held in the seminar in the middle of the semester.</p> <p>During the third part of the course, participants implement their theoretical concept into the ERP-System, i.e. they customize the SAP system according to the theoretical requirements defined. In the context of this process, the participants are encouraged to critically evaluate the software options in light of a theoretically ideal design of business functions and processes. This third part of the course is designed in the form of mini-presentations by each team of participants giving an overview of the progress and critical evaluations made in implementing the theoretical concept into the system.</p> <p>Students will gain...</p> <ul style="list-style-type: none"> ... insights into the ERP-Market ... insights into the process (& project management) of ERP-Software implementation ... insights into the functioning and use of ERP-Software ... an understanding of business processes and their implementation in SAP (production) ... an understanding of the integrative role of ERP-Systems ...the ability to operatively run SAP & critically evaluate the functioning of the system!
Literature	<ul style="list-style-type: none"> • Agrawal, A. (2009): Customizing Materials Management Processes in SAP ERP Operations, Galileo Press: Boston. • Arif, N./Tauseef, S. (2011): Integrating SAP ERP Financials, Galileo Press: Boston. • Chudy, M./Castedo, L. (2010): Sales and Distribution in SAP ERP - Practical Guide, Galileo Press: Boston. • Dickersback, J. T./Keller, G. (2011): Production Planning and Control with SAP ERP, Galileo Press: Boston. • Franz, M. (2010): Project Management with SAP Project System, Galileo Press: Boston. • Hoppe, M./Gulyassy, F. (2009): Materials Planning with SAP, Galileo Press: Boston. • Veeriah, N. (2011): Customizing Financial Accounting in SAP, Galileo Press: Boston. • Veeriah, N. (2012): Financial Accounting in SAP, Galileo Press: Boston.

Module M0855: Marketing (Sales and Services / Innovation Marketing)				
Courses				
Title	Typ		Hrs/wk	CP
Marketing (Innovation Marketing / Sales and Services) (L0862)	Problem-based Learning		5	6
Module Responsible	Prof. Christian Lütjhe			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none"> Module International Business Basic understanding of business administration principles (strategic planning, decision theory, project management, international business) Bachelor-level Marketing Knowledge (Marketing Instruments, Market and Competitor Strategies, Basics of Buying Behavior) Understanding of differences in the market introduction of Products and Services Understanding the differences between B2B and B2C marketing Understanding of the importance of managing innovation in global industrial markets Good English proficiency; presentation skills 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i>	Students will have gained a deep understanding of <ul style="list-style-type: none"> Specific characteristics in the marketing of innovative industrial goods and services The importance of product-related and independent services Approaches for analyzing the current market situation and the future market development The gathering of information about future customer needs and requirements Concepts and approaches to integrate lead users and their needs into product and service development processes Approaches and tools for ensuring customer-orientation in the development of new products and innovative services Marketing mix elements that take into consideration the specific requirements and challenges of innovative products and services Pricing methods for new products and services The organization of complex sales forces and personal selling Communication concepts and instruments for new products and services 			
<i>Skills</i>	Based on the acquired knowledge students will be able to: <ul style="list-style-type: none"> Design and to evaluate decisions regarding marketing and innovation strategies Analyze markets by applying market and technology portfolios Conduct forecasts and develop compelling scenarios as a basis for strategic planning Translate customer needs into concepts, prototypes and marketable offers and successfully apply advanced methods for customer-oriented product and service development Use adequate methods to foster efficient diffusion of innovative products and services Choose suitable pricing strategies and communication activities for innovations Make strategic sales decisions for products and services (i.e. selection of sales channels) Apply methods of sales force management (i.e. customer value analysis) 			
Personal Competence <i>Social Competence</i>	The students will be able to <ul style="list-style-type: none"> have fruitful discussions and exchange arguments develop original results in a group present results in a clear and concise way carry out respectful team work 			
<i>Autonomy</i>	The students will be able to <ul style="list-style-type: none"> Acquire knowledge independently in the specific context and to map this knowledge on other new complex problem fields. Consider proposed business actions in the field of marketing and reflect on them. 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	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			

Course L0862: Marketing (Innovation Marketing / Sales and Services)	
Typ	Problem-based Learning
Hrs/wk	5
CP	6
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Lecturer	Prof. Christian Lüthje
Language	EN
Cycle	SoSe
Content	<p>I. Introduction</p> <ul style="list-style-type: none"> • Innovation and service marketing (importance of innovative products and services, model, objectives and examples of innovation marketing, characteristics of services, challenges of service marketing) <p>II. Methods and approaches of strategic marketing planning</p> <ul style="list-style-type: none"> • patterns of industrial development, patent and technology portfolios <p>III. Strategic foresight and scenario analysis</p> <ul style="list-style-type: none"> • objectives and challenges of strategic foresight, scenario analysis, Delphi method <p>IV. Mapping Techniques</p> <ul style="list-style-type: none"> • Perceptual Maps, Gap Model <p>V. User innovations</p> <ul style="list-style-type: none"> • Role of users in the innovation process, user communities, user innovation toolkits, lead users analysis <p>VI. Product and Service Engineering</p> <ul style="list-style-type: none"> • Conjoint Analysis, Kano, QFD, Morphological Analysis, Blueprinting <p>VII. Pricing</p> <ul style="list-style-type: none"> • Basics of Pricing, Value-based pricing, Pricing models <p>VIII. Sales Management</p> <ul style="list-style-type: none"> • Basics of Sales Management, Assessing Customer Value, Planning Customer Visits <p>XI. Communications</p> <ul style="list-style-type: none"> • Diffusion of Innovations, Communication Objectives, Communication Instruments
Literature	<p>Kotler, P., Keller, K. L. (2006). Marketing Management, 12 th edition, Pearson Prentice Hall, New Jersey</p> <p>Bo Edvardsson et. al. (2006) Involving Customers in New Service Development, London</p> <p>Joe Tidd & Frank M. Hull (Editors) (2007) Service Innovation, London</p> <p>Von Hippel, E.(2005). Democratizing Innovation, Cambridge: MIT Press</p> <p>Crawford, M., Di Benedetto, A. (2008). New products management, 9th edition, McGraw Hill, Boston et al., 2008</p>

Module M1263: Quantitative Research Methods			
Courses			
Title	Typ	Hrs/wk	CP
Quantitative Research Methods (L1714)	Project Seminar	3	6
Module Responsible	Prof. Christian Ringle		
Admission Requirements	None, but the course is limited to 20 students		
Recommended Previous Knowledge	Basic knowledge in business administration		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i>	The students will be able to <ul style="list-style-type: none"> describe complex and interrelated constructs in the fields of marketing, management of organizations, strategic and human resource management discuss underlying theories of research models explain strategies of research problem analysis describe the functioning and use of quantitative research methods discuss strengths and weaknesses of quantitative research methods The students will be able to <ul style="list-style-type: none"> deal with complex empirical problems collect empirical data, apply multivariate techniques to the data collected using standard software, and critically evaluate and interpret results gained work with common statistical software programs (like R, Smart PLS and SPSS) address research questions with quantitative research methods 		
Personal Competence <i>Social Competence</i> <i>Autonomy</i>	The students will be able to <ul style="list-style-type: none"> have fruitful professional discussions; present and defend the results of their work; communicate and collaborate successfully and respectfully with others in teams. The students will be able to <ul style="list-style-type: none"> acquire knowledge in a specific context independently and to map this knowledge onto other new complex problem fields. read and understand statistical literature 		
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42		
Credit points	6		
Examination	Project		
Examination duration and scale	30 pages; 5 months		
Assignment for the Following Curricula	Mechanical Engineering and Management: Specialisation Management: Elective Compulsory		

Course L1714: Quantitative Research Methods	
Typ	Project Seminar
Hrs/wk	3
CP	6
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42
Lecturer	Prof. Christian Ringle
Language	EN
Cycle	WiSe/SoSe
Content	<p>Participants will understand the use, requirements, advantages and disadvantages of quantitative methods. Examples illustrate the application of quantitative methods and their use to address business related problems.</p> <p>The course involves three parts:</p> <p>The first part of the course focuses on an introduction of quantitative research methods.</p> <p>The second part of the course involves working on a seminar thesis. Participants are in teams invited to describe selected quantitative research methods and to address simple research questions with the described method. Students are expected to write a short (empirical) paper that applies methods learned in this course to a research question of their choice.</p> <p>The third part is the final presentations of the results from the group work. Participants will present their own small research projects and discuss the results in the plenum. Participants are invited to join the discussions as a part of the final grade.</p>
Literature	<p>Participants will be provided with a course handout in the form of ppt-slides which can be downloaded in advance. In the course, the participants will obtain a specific list of relevant literature. Some generally recommended are:</p> <ul style="list-style-type: none"> • Dalgaard, P. (2008). Introductory statistics with R. Springer Science & Business Media. • Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). Multivariate data analysis (Vol. 6). Upper Saddle River, NJ: Pearson Prentice Hall. • Hair Jr, J. F., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2013). A primer on partial least squares structural equation modeling (PLS-SEM). Sage Publications.

Module M0978: International Logistics and Transport Systems

Courses

Title		Type	Hrs/wk	CP
Mobility of Goods, Logistics, Traffic (L1165)		Lecture	2	2
International Logistics and Transport Systems (L1168)		Problem-based Learning	3	4
Module Responsible	Prof. Heike Flämig			
Admission Requirements	none			
Recommended Previous Knowledge	<ul style="list-style-type: none">• Introduction to Logistics and Mobility• Foundations of Management• Legal Foundations of Transportation and Logistics			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i>	<p>Students are able to...</p> <ul style="list-style-type: none">• give definitions of system theory, (international) transport chains and logistics in the context of supply chain management• explain trends and strategies for mobility of goods and logistics• describe elements of integrated and multi-modal transport chains and their advantages and disadvantages• deduce impacts of management decisions on logistics system and traffic system and explain how stakeholders influence them• explain the correlations between economy and logistics systems, mobility of goods, space-time-structures and the traffic system as well as ecology and politics			
<i>Skills</i>	<p>Students are able to...</p> <ul style="list-style-type: none">• Design intermodal transport chains and logistic concepts• apply the commodity chain theory and case study analysis• evaluate different international transport chains• cope with differences in cultures that influence international transport chains			
Personal Competence <i>Social Competence</i>	<p>Students are able to...</p> <ul style="list-style-type: none">• develop a feeling of social responsibility for their future jobs• give constructive feedback to others about their presentation skills• plan and execute teamwork tasks			
<i>Autonomy</i>	<p>Students are able to improve presentation skills by feedback of others</p>			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	60 minutes			
Assignment for the Following Curricula	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	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Heike Flämig
Language	EN
Cycle	SoSe
Content	<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"> 1. A conceptual systems model 2. Elements of integrated and multi-modal transportation chains 3. interaction of transport and traffic, demand and supply on different layers of the transport system 4. Global Issues in Supply Chain Management 5. Global Players and networks 6. Logistics and corporate social responsibility (CSR) 7. Methods and data for assessment of international transport chains 8. Influence of cultural aspects on international transport chains 9. New solutions using different focuses of the transport and logistics system
Literature	<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 Logistikklexikon, 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	
Typ	Problem-based Learning
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heike Flämig
Language	EN
Cycle	SoSe
Content	<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>
Literature	<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 M1034: Technology Entrepreneurship				
Courses				
Title		Type	Hrs/wk	CP
Creation of Business Opportunities (L1280)		Problem-based Learning	3	4
Entrepreneurship (L1279)		Lecture	2	2
Module Responsible	Prof. Christoph Ihl			
Admission Requirements	None			
Recommended Previous Knowledge	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.			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> Wissen (subject-related knowledge and understanding):</p> <ul style="list-style-type: none"> • develop a working knowledge and understanding of the entrepreneurial perspective • understand the difference between a good idea and scalable business opportunity • understand the process of taking a technology idea and finding a high-potential commercial opportunity • understand the components of business models • understand the components of business opportunity assessment and business plans <p><i>Skills</i></p> <ul style="list-style-type: none"> • Fertigkeiten (subject-related skills): <ul style="list-style-type: none"> ◦ identify and define business opportunities ◦ assess and validate entrepreneurial opportunities ◦ create and verify a business model of how to sell and market an entrepreneurial opportunity ◦ formulate and test business model assumptions and hypotheses ◦ conduct customer and expert interviews regarding business opportunities ◦ prepare business opportunity assessment ◦ create and verify a plan for gathering resources such as talent and capital ◦ pitch a business opportunity to your classmates and the teaching team 			
Personal Competence				
<i>Social Competence</i>				
<i>Autonomy</i>				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Project			
Examination duration and scale	Group project work (approx. 30 pages) and oral examination (15 min plus discussion)			
Assignment for the Following Curricula	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			

Course L1280: Creation of Business Opportunities	
Typ	Problem-based Learning
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl
Language	EN
Cycle	SoSe
Content	<p>This course is supposed to provide intense hands-on experiences with the entrepreneurial process, tools and concepts discussed in the lecture "Entrepreneurship" and additional online material. At the beginning of the class, students form teams to search for and create a scalable and repeatable business opportunity. Rather than writing a comprehensive business plan or designing the perfect product, both of which are highly difficult and risky investments in the uncertain front end of any business idea, we follow a lean startup approach. Student teams will have to think about all the parts of building a business and apply the tools of business model design and customer & agile development in order to optimize the search for and creation of a business opportunity. Students will start by mapping the assumptions regarding each of the parts in their business model and then devote significant time on testing these hypotheses with customers and partners outside in the field (customer development). Based on the gathered information, students should realize which of their assumptions were wrong, and figure out ways how to fix it (learning events called "pivots"). The goal is to proceed in an iterative and incremental way (agile development) to build prototypes and (minimum viable) products. Throughout the course, student teams will present their lessons-learned (pivots) and how their business models have evolved based on their most important pivots.</p>
Literature	<p>Blank, Steve (2013). Why the lean start-up changes everything. Harvard Business Review 91.5 (2013): 63-72.</p> <p>Blank, Steven Gary, and Bob Dorf. The startup owner's manual: the step-by-step guide for building a great company. K&S Ranch, Incorporated, 2012.</p> <p>Ries, Eric (2011). The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses. Random House LLC, 2011.</p>

Course L1279: Entrepreneurship	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl
Language	EN
Cycle	SoSe
Content	<p>This course introduces the fundamentals of technology entrepreneurship including its economic and cultural underpinnings. It highlights the differences between mere business ideas and scalable and repeatable business opportunities. It is designed to familiarize students with the process that technology entrepreneurs use to create business opportunities and to start companies. It involves taking a technology idea and finding a high-potential commercial opportunity, gathering resources such as talent and capital, figuring out how to sell and market the idea, and managing rapid growth. The course also discusses relevant concepts and tools from entrepreneurial strategy, such as disruptive innovations, technology adoption cycles and intellectual property, as well as from entrepreneurial marketing, such as product positioning and differentiation, distribution, promotion and pricing. Particular emphasis will be put on business model design and customer development proposed in the lean startup approach. All in all, the course is supposed to create the entrepreneurial mindset of looking for technology opportunities and business solutions, where others see insurmountable problems. This mindset of turning problems into opportunities can well be generalized from startups to larger companies and other settings.</p>
Literature	<p>Byers, T.H.; Dorf, R.C.; Nelson, A.J. (2011). Technology Ventures: From Idea to Enterprise. 3rd ed. McGraw-Hill, 2011.</p> <p>Hisrich, P.; Peters, M. P.; Shepherd, D. A. (2009). Entrepreneurship, 8th ed., McGraw-Hill, 2009.</p> <p>Osterwalder, A.; Yves, P. (2010). Business model generation: a handbook for visionaries, game changers, and challengers. John Wiley & Sons, 2010.</p>

Module M0750: Economics			
Courses			
Title	Type	Hrs/wk	CP
International Economics (L0700)	Lecture	2	4
Main Theoretical and Political Concepts (L0641)	Lecture	2	2
Module Responsible	Prof. Kathrin Fischer		
Admission Requirements	None		
Recommended Previous Knowledge	Keine		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i>	The students know • the most important principles of individual decision making in a national and international context • different market structures • types of market failure • the functioning of a single economy (including money market, financial and goods markets, labor market) • the difference between and the interdependence of short and long run equilibria • the significance of expectations on the effects of economic policy • the various links between economies • different economic policies (trade, monetary, fiscal and exchange rate policy) and their effects on the home and foreign economies The students are able to model analytically or graphically <ul style="list-style-type: none"> • the most important principles of individual decision making in a national and international context • the market results of different market structures and market failure • the welfare effects of the market results • expectations hypothesis • the functioning of an economy (including money market, financial and goods markets, labor market) • links between economies • the effects of economic policies (trade, monetary, fiscal and exchange rate policies) 		
Personal Competence <i>Social Competence</i> <i>Autonomy</i>	The students are able <ul style="list-style-type: none"> • to anticipate expectations and decisions of individuals or groups of individuals. These may be inside or outside of the own firm. • to take these decisions into account while deciding themselves • to understand the behavior of markets and to assess the opportunities and risks with respect to the own business activities. With the methods taught the students will be able <ul style="list-style-type: none"> • to analyze empirical phenomena in single economies and the world economy and to reconcile them with the studied theoretical concepts. • to design, analyze and evaluate micro- and macroeconomic policies against the background of different models. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Examination	Written exam		
Examination duration and scale	2 hours		
Assignment for the Following Curricula	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	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Annette Olbrisch-Ziegler
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> • International Trade Theory and Policy: <ul style="list-style-type: none"> ◦ Comparative Advantage, the Ricardian Model ◦ The Heckscher-Ohlin Model ◦ The Standard Trade Model ◦ Intrasectoral Trade ◦ International Trade Policy • Open Economy Macroeconomics <ul style="list-style-type: none"> ◦ The Foreign Exchange Market ◦ Determinants of Prices, Interest Rates, Exchange Rates, Output in the Short Run ◦ Determinants of Prices, Interest Rates, Exchange Rates, Output in the Long Run ◦ Monetary and Fiscal and Exchange Rate Policies in Open Economies in the Long and the Short Run
Literature	Krugman/Obstfeld: International Economics, Longman, 9th ed. 2011 Mankiw/Taylor: Economics, South-Western 2008 Documents and notes handed out during the lecture.

Course L0641: Main Theoretical and Political Concepts	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Annette Olbrisch-Ziegler
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Introduction: Ten Principles of Economics • Microeconomics: <ul style="list-style-type: none"> ◦ Theory of the Household ◦ Theory of the Firm ◦ Competitive Markets in Equilibrium ◦ Market Failure: Monopoly and External Effects ◦ Government Policies • Macroeconomics: <ul style="list-style-type: none"> ◦ A Nation's Real Income and Production ◦ The Real Economy in the Long Run: Capital and Labour Market ◦ Money and Prices in the Long Run ◦ Aggregate Demand and Supply: Short-Run Economic Fluctuations ◦ Monetary and Fiscal Policy in the Short and the Long Run
Literature	Mankiw/Taylor: Economics, South-Western 2008 Pindyck/Rubinfeld: Microeconomics, Prentice Hall International , 7 th ed. 2010 Documents and notes handed out during the lecture.

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

Course L0851: Product Planning	
Typ	Problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	<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"> • Systematic scanning of markets for innovation opportunities • Understanding strengths/weakness and specific core competences of a firm as platforms for innovation • Exploring relevant sources for innovation (customers, suppliers, Lead Users, etc.) • Developing ideas for radical innovation, relying on the creativeness of employees, using techniques to stimulate creativity and creating a stimulating environment • Transferring ideas for innovation into feasible concepts which have a high market attractively
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010

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

Module M1035: Corporate Entrepreneurship & Growth

Courses

Title	Typ	Hrs/wk	CP
Entrepreneurial Finance (L1282)	Seminar	2	2
Intrapreneuship (L1281)	Seminar	3	4
Module Responsible	Prof. Christoph Ihl		
Admission Requirements	Limited number of students: 20		
Recommended Previous Knowledge	Basic knowledge in business economics and finance obtained in the compulsory modules and participation in the module “Technology Entrepreneurship” is highly recommended.		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<div>Knowledge</div> <div>Wissen (subject-related knowledge and understanding):<ul style="list-style-type: none">• understand similarities and differences between corporate and start-up entrepreneurship• recognize the distinct nature and specific elements of corporate entrepreneurship in the context of established and international organizations• understand the different forms of corporate entrepreneurship• understand their own managerial styles, attitudes and preferences for corporate versus start-up entrepreneurship• understand the pros and cons of different valuation methods• understand the interests of venture capital funds• understand the pros and cons of different growth and exit options</div> <div>Skills</div> <div>Fertigkeiten (subject-related skills):<ul style="list-style-type: none">• be able to apply an entrepreneurial approach to operations of a department or functional area within established organizations• assess the environment within established companies in terms of support or constraints for entrepreneurship• identify creative ways to overcome obstacles to entrepreneurship in established companies• be able to formulate corporate objectives and strategies that support entrepreneurial behavior• evaluate entrepreneurial opportunities in contexts of established corporations• develop concepts for new businesses out of established company contexts• value entrepreneurial opportunities in financial terms• apply different valuation methods• evaluate the attractiveness of financial contracts• design VC term sheets• design employee contracts in terms of financial compensation• design financial contracts and conduct financial negotiations• assess and justify possible growth and exit options</div> <div>Personal Competence</div> <div>Social Competence</div> <div>Sozialkompetenz (Social Competence):<ul style="list-style-type: none">• team work• communication and presentation• give and take critical comments• engaging in fruitful discussions</div> <div>Autonomy</div> <div>Selbständigkeit (Autonomy):<ul style="list-style-type: none">• autonomous work and time management• project management• analytical skills</div>		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Examination	Project		
Examination duration and scale	Group project work (approx. 30 pages) and oral examination (15 min plus discussion)		
Assignment for the Following Curricula	Global Innovation Management: Core qualification: Elective Compulsory International Production Management: Specialisation Management: Elective Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory		

Course L1282: Entrepreneurial Finance	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl
Language	EN
Cycle	WiSe
Content	<p>This course examines the elements of entrepreneurial finance, focusing on technology-based start-up ventures and the early stages of company development. The course addresses key questions relevant to both startup and corporate entrepreneurs: 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? This course will focus on the finance principles related to the risk & return of venture capital, the valuation of high growth companies, the capital structure specific to venture capital-backed companies, and investment decisions under uncertainty. Three main topics will be covered:</p> <p>(1) New business opportunity valuation: Most time will be devoted to the understanding and application of tools to value early stage business opportunities and high-growth companies versus mature companies. Standard tools for financial and liquidity planning as well as discounted cash flow valuation will be applied to startup situations. Furthermore, the venture capital method, analysis of comparables and the real options approach to valuation are introduced.</p> <p>(2) Financing and employment contracts: We will discuss the main sources of financing that entrepreneurs can choose from. Particular emphasis will be put on venture capital funds and their fund raising process. The design of financial contracts will be analyzed in terms of addressing information and incentive problems in uncertain environments. Employment contracts will be motivated as a compensation device to attract and retain key employees.</p> <p>(3) Growth and exit strategies: We will discuss entrepreneurs' option to grow or exit. Liquidity events are considered such as initial public offering, sale or merger as compared to independent growth as a private company. We also examine later stage options such as mezzanine financing and buy-outs and the specifics of international growth.</p> <p>Guest lecturers will present the latest trends in these areas. The ideal audience for the course will be students who are interested in technology entrepreneurship, either at startups or within larger organizations. It is also useful for those pursuing careers in corporate finance or valuation consulting.</p>
Literature	<p>Metrick, Andrew, and Ayako Yasuda. Venture Capital and the Finance of Innovation. Wiley, 2010.</p> <p>Leach, J., and Ronald Melicher. Entrepreneurial finance. Cengage Learning, 2011.</p> <p>Selected cases will be made available during class.</p>

Course L1281: Intrapreneurship	
Typ	Seminar
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl
Language	EN
Cycle	WiSe
Content	<p>In order to sustain competitive advantage, established firms must do more than lower costs, increase quality and better serve customers. They have to be faster, more flexible, more aggressive and more innovative while operating under resource constraints. In short, they must be more entrepreneurial. While most CEOs would subscribe to this point of view, yet few companies seem to be able to fully embrace the issues of corporate entrepreneurship, the subject matter of this course. This is an overview course on corporate entrepreneurship. It is not designed to cover all of the aspects of the corporation that affect the firm's organization, strategy and performance. Rather, it is designed to introduce students to the different forms, core concepts and analytical tools in corporate entrepreneurship in order to enable the creation of viable new businesses within the context of an established organization. The course will address the development of an internal culture, strategy and structure supportive to corporate entrepreneurship, the international dimension of corporate entrepreneurship as well as the analysis of potential synergies and barriers between potential new ventures and the existing organization. To achieve these goals, the course will combine (1) class lectures on key theoretical concepts, tools, and management approaches, (2) an in-depth case analysis of a classic Harvard Business School case, and (3) a real life case brought to the class room by actual company representatives upon which student teams develop their project work.</p>
Literature	<p>Morris, Michael, Donald Kuratko, and Jeffrey Covin. Corporate entrepreneurship & innovation. Cengage Learning, 2010.</p> <p>Christensen, Clayton M., and Ho Howard Yu. "Pitney Bowes Inc." Harvard Business School Case 607-034, November 2006.</p>

Module M1173: Applied Statistics				
Courses				
Title		Typ	Hrs/wk	CP
Applied Statistics (L1584)		Lecture	2	3
Applied Statistics (L1586)		Problem-based Learning	2	2
Applied Statistics (L1585)		Recitation Section (small)	1	1
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of statistical methods			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	Students can explain the statistical methods and the conditions of their use.			
<i>Skills</i>	Students are able to use the statistics program to solve statistics problems and to interpret and depict the results			
Personal Competence				
<i>Social Competence</i>	Team Work, joined presentation of results			
<i>Autonomy</i>	To understand and interpret the question and solve			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 minutes, 28 questions			
Assignment for the Following Curricula	Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Core qualification: Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory			

Course L1584: Applied Statistics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	<p>The goal is to introduce students to the basic statistical methods and their application to simple problems. The topics include:</p> <ul style="list-style-type: none"> • Chi square test • Simple regression and correlation • Multiple regression and correlation • One way analysis of variance • Two way analysis of variance • Discriminant analysis • Analysis of categorial data • Chossing the appropriate statistical method • Determining critical sample sizes
Literature	Applied Regression Analysis and Multivariable Methods, 3rd Edition, David G. Kleinbaum Emory University, Lawrence L. Kupper University of North Carolina at Chapel Hill, Keith E. Muller University of North Carolina at Chapel Hill, Azhar Nizam Emory University, Published by Duxbury Press, CB © 1998, ISBN/ISSN: 0-534-20910-6

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

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

Module M0543: Management, Organization and Human Resource Management
Courses

Title	Type	Hrs/wk	CP
Management, Organization and Human Resource Management (L0110)	Lecture	2	3
Management, Organization and Human Resource Management (L0111)	Seminar	2	3
Module Responsible	Prof. Christian Ringle		
Admission Requirements	None Limited number of students: 20		
Recommended Previous Knowledge	Module "Human Resource Management and Organizational Design" Knowledge of <ul style="list-style-type: none"> • The Study of Organizations and Organizational Theories • The processes of developing organizational structures for multinational firms • Analysis and Design of Work • Strategic Management of the Human Resource Function in international business • Human Resource Planning and Recruitment in the global environment • Managing performance measurement, compensation and benefits of international corporations • Employee Development • Employee Separation and Retention 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	The students are able to ... <ul style="list-style-type: none"> • explain the different organizational design and strategies in an international environment with a focus on selected forms of cooperation (e.g., virtual organizations, strategic alliances) to compete in global business; • map the need of organizational changes in light of new business lines, new strategies, altering employee attitudes and international competition; • describe the business process management and reengineering techniques in order to consolidate resources to meet international customer requirements profitably; • explain the meaning and importance of managing human resources in multinational companies and its relation to organizational designs and strategies; • explain the personnel recruitment and talent management strategies (e.g., personnel planning, employee testing, developing) throughout national and international organizations; • explain the models and approaches for appropriately measuring employee relations (e.g., job satisfaction models) including the development and estimation of causal models; • present the models and research methodologies used to forecast personnel requirements (e.g., forecasting procedures, linear programming, neural networks). 		
<i>Knowledge</i>			
<i>Skills</i>			
<i>Autonomy</i>			
Personal Competence	The students are able to... <ul style="list-style-type: none"> • have discussions (with international experts) in the fields of organization and human resource management, • respectfully work in teams, • strengthen their intercultural personal competencies by problem based-learning elements 		
<i>Social Competence</i>			

	fields. They will be able to improve their overall management skills (starting with a structured analysis of the business problem, via developing suitable solutions, to appropriately communicating/presenting solutions developed).
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	60 minutes
Assignment for the Following Curricula	International Production Management: Specialisation Management: Elective Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory

Course L0110: Management, Organization and Human Resource Management	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Ringle
Language	EN
Cycle	WiSe
Content	<p>This course focuses on multinational firms and advanced issues of management, organizations, and human resource management. Selected topics focus, for example, on:</p> <ul style="list-style-type: none"> • Organizational strategy and design in a global environment • International competition and organizational change • Organizational behavior • Competing in a global environment by cooperation (e.g., virtual organizations, strategic alliances) • Business process design and business process reengineering • International personnel recruitment and placement (e.g., personnel planning, employee testing) • Strategic employee compensation (e.g., strategic pay plans) of multinational firms and employee relations (e.g., employee satisfaction models) • Personnel planning methods • Workplace analysis using specific time measurement methods and approaches
Literature	<p>Bernardin, H.J.: Human Resource Management: An Experiential Approach, 4e, New York: McGraw-Hill, 2006.</p> <p>Cascio, W.: Managing Human Resources: Productivity, Quality of Work Life, Profits, 6e, New York: McGraw-Hill, 2002.</p> <p>French, W./Bell, C.H./Zawacki, R.A.: Organization Development and Transformation: Managing Effective Change, 5e, Chicago: McGraw-Hill, 1999.</p> <p>Hitt, M.A./Ireland, R.D./Hoskisson, R.E.: Strategic Management: Competitiveness and Globalization, Ohio: Cengage Learning, 2007.</p> <p>Lynch, R.: Strategic Management, 5e, Harlow: Prentice Hall, 2008.</p> <p>Robbins, S.P./Judge, T.A.: Organizational Behavior, 14e, Harlow: Prentice Hall, 2008.</p> <p>Spector, B.: Implementing Organizational Change: Theory and Practice, 3e, Harlow: Prentice Hall, 2006.</p> <p>Selected journal articles.</p>

Course L0111: Management, Organization and Human Resource Management	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Ringle
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> Analyze organizational strategies and structures of global firms Model and analyze business processes of international firms using standard software tools Personnel planning using operations research methodologies (e.g., forecasting procedures, linear programming, neural networks) Develop and measure causal models for analyzing the satisfaction of employees with different cultural backgrounds Workplace analysis using specific time measurement methods and approaches
Literature	<p>Cascio, W.: Managing Human Resources: Productivity, Quality of Work Life, Profits, 6e, New York: McGraw-Hill, 2002.</p> <p>French, W./Bell, C.H./Zawacki, R.A.: Organization Development and Transformation: Managing Effective Change, 5e, New York: McGraw-Hill, 1999.</p> <p>Robbins, S.P./Judge, T.A.: Organizational Behavior, 14e, Harlow: Prentice Hall, 2008.</p> <p>Spector, B.: Implementing Organizational Change: Theory and Practice, 3e, Harlow: Prentice Hall, 2006.</p> <p>Information on the appropriate literature depends on the topics and will therefore be updated each semester.</p>

Specialization Mechatronics

Graduates of the Mechatronics specialization are able to solve mechatronic tasks as well as design tasks systematically and methodically. They have knowledge about current methods, automation and simulation, are able to choose between different strategies and to use them independently for the development of new systems.

The Mechatronics specialization is recommended to students who already bring along basic knowledge in measurement technology, control engineering and computer science.

Module M1106: Vibration Theory (GES)

Courses

Title	Typ	Hrs/wk	CP
Vibration Theory (GES) (L1423)	Lecture	2	3
Vibration Theory (GES) (L1433)	Recitation Section (large)	1	3
Module Responsible	Prof. Radoslaw Iwankiewicz		
Admission Requirements	Linear algebra, calculus, engineering/applied mechanics (especially kinematics and kinetics)		
Recommended Previous Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<p><i>Knowledge</i> The primary purpose of the study of Vibration Theory is to develop the capacity to understand vibrations and the capacity to analyse, measure, predict and control vibrations, which is needed by the engineers involved in the analysis and design of machines and their supporting structures, vehicles, aircraft, etc. The particular objectives of this course are to:</p> <ol style="list-style-type: none"> 1. Analyse mechanical structures taking into account the effects of dynamic loads. 1. Appreciate the importance of vibration in structures and mechanical devices. 2. Formulate and solve the equations of motion of mechanical systems. <p>Determine the natural frequencies and normal modes of complex mechanical systems.</p> <p><i>Skills</i> At the end of this course the student should be able to:</p> <ol style="list-style-type: none"> 1. Develop simple mathematical models for vibration analysis of complex systems; formulate and solve the equation of motion to determine the dynamic response. 2. Carry out the linearization of equations of motion. 1. Determine natural frequencies and normal modes of multi-degree-of-freedom and continuous systems (rods, shafts, taut strings, beams). 2. Carry out modal analysis to predict the dynamic response of linear mechanical systems to external excitations. 3. Analyse, in terms of eigenvalues, stability of time-invariant linear dynamic systems. 		
Personal Competence			
<i>Social Competence</i>			
<i>Autonomy</i>			
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42		
Credit points	6		
Examination	Written exam		
Examination duration and scale	2 hours: 2. MDOF systems: Newton- Euler and Lagrange's equations of motion. Linear systems: eigenvalue problem, general solution and stability. Linear MDOF systems: free and forced vibrations. Continuous systems. Energy methods or random vibrations.		
Assignment for the Following Curricula	Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory		

Course L1423: Vibration Theory (GES)	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Radoslaw Iwankiewicz
Language	EN
Cycle	WiSe
Content	<p>SYSTEMS WITH FINITE NUMBER OF DEGREES OF FREEDOM</p> <p>(MULTI- DEGREE-OF-FREEDOM SYSTEMS)</p> <ol style="list-style-type: none"> 1. Revision of the theory of single-degree-of -freedom systems. 2. Equations of motion of a single rigid body and of multi-body systems: <ol style="list-style-type: none"> 2.1. Newton- Euler equations 2.2. Lagrange's equations. 3. Linearization of equations of motion. 4. Linear equations of motion in a state-space form. Transformation of coordinates. 5. Linear systems: eigenvalue problem (eigenvalues and eigenvectors). 6. General solution for time-invariant linear systems and stability of those systems. 7. Linear systems: eigenvalue problem, free vibrations, natural frequencies, normal modes (mode shapes). 8. Forced vibrations of linear systems. <p>LINEAR CONTINUOUS SYSTEMS:</p> <ol style="list-style-type: none"> 9. Longitudinal vibrations of a rod and torsional vibrations of a shaft: <ol style="list-style-type: none"> 9.1. Eigenvalue problem, free vibrations, natural frequencies, normal modes (mode shapes). 9.2. Forced vibrations. 10. Transverse vibrations of a beam and of a taut string: <ol style="list-style-type: none"> 10.1. Eigenvalue problem, free vibrations, natural frequencies, normal modes (mode shapes). 10.2. Forced vibrations.
Literature	<ol style="list-style-type: none"> 1. S.S. Rao, Mechanical Vibrations, Addison-Wesley, 3rd edition, 1995. 2. C.F. Beards, Engineering Vibration Analysis with Application to Control Systems, Edward Arnold, 1995. 3. M. Geradin, D. Rixen, Mechanical Vibrations. Theory and Application to Structural Dynamics, J. Wiley, 1994. 4. K. Klotter, Technische Schwingungslehre I, II, Springer Verlag, 1981.

Course L1433: Vibration Theory (GES)	
Typ	Recitation Section (large)
Hrs/wk	1
CP	3
Workload in Hours	Independent Study Time 76, Study Time in Lecture 14
Lecturer	Prof. Radoslaw Iwankiewicz
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0752: Nonlinear Dynamics				
Courses				
Title	Typ		Hrs/wk	CP
Nonlinear Dynamics (L0702)	Lecture		4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none"> • Calculus • Linear Algebra • Engineering Mechanics 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	Students are able to reflect existing terms and concepts in Nonlinear Dynamics and to develop and research new terms and concepts.			
<i>Skills</i>	Students are able to apply existing methods and procedures of Nonlinear Dynamics and to develop novel methods and procedures.			
Personal Competence				
<i>Social Competence</i>	Students can reach working results also in groups.			
<i>Autonomy</i>	Students are able to approach given research tasks individually and to identify and follow up novel research tasks by themselves.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	2 Hours			
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Computational Science and Engineering: Specialisation Scientific Computing: 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 Endoprotheses: 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 Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory			

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

Module M0846: Control Systems Theory and Design

Courses

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

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

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

Module M0746: Microsystem Engineering

Courses

Title	Type	Hrs/wk	CP
Microsystem Engineering (L0680)	Lecture	2	4
Microsystem Engineering (L0682)	Problem-based Learning	1	1
Microsystem Engineering (L0681)	Recitation Section (small)	1	1
Module Responsible	Prof. Manfred Kasper		
Admission Requirements			
Recommended Previous Knowledge	Electrical Engineering Fundamentals		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<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.		
Personal Competence			
<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.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Examination	Written exam		
Examination duration and scale	zweistündig		
Assignment for the Following Curricula	Electrical Engineering: Core qualification: Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: 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: Specialisation System Design: 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: Elective Compulsory Microelectronics and Microsystems: Core qualification: Elective Compulsory		

Course L0680: Microsystem Engineering	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Manfred Kasper
Language	EN
Cycle	WiSe
Content	<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>
Literature	<p>M. Kasper: Mikrosystementwurf, Springer (2000)</p> <p>M. Madou: Fundamentals of Microfabrication, CRC Press (1997)</p>

Course L0682: Microsystem Engineering	
Typ	Problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Manfred Kasper
Language	EN
Cycle	WiSe
Content	<p>Examples of MEMS components</p> <p>Layout consideration</p> <p>Electric, thermal and mechanical behaviour</p> <p>Design aspects</p>
Literature	Wird in der Veranstaltung bekannt gegeben

Course L0681: Microsystem Engineering	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Manfred Kasper
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0913: CMOS Nanoelectronics with Practice

Courses

Title	Type	Hrs/wk	CP
CMOS Nanoelectronics (L0764)	Lecture	2	3
CMOS Nanoelectronics (L1063)	Laboratory Course	2	2
CMOS Nanoelectronics (L1059)	Recitation Section (small)	1	1
Module Responsible	Prof. Wolfgang Krautschneider		
Admission Requirements	None		
Recommended Previous Knowledge	Fundamentals of MOS devices and electronic circuits		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students can explain the functionality of very small MOS transistors and explain the problems occurring due to scaling-down the minimum feature size. Students are able to explain the basic steps of processing of very small MOS devices. Students can exemplify the functionality of volatile and non-volatile memories und give their specifications. Students can describe the limitations of advanced MOS technologies. Students can explain measurement methods for MOS quality control. <i>Skills</i> <ul style="list-style-type: none"> Students can quantify the current-voltage-behavior of very small MOS transistors and list possible applications. Students can describe larger electronic systems by their functional blocks. Students can name the existing options for the specific applications and select the most appropriate ones. Personal Competence <i>Social Competence</i> <ul style="list-style-type: none"> Students can team up with one or several partners who may have different professional backgrounds Students are able to work by their own or in small groups for solving problems and answer scientific questions. <i>Autonomy</i> <ul style="list-style-type: none"> Students are able to assess their knowledge in a realistic manner. The students are able to draw scenarios for estimation of the impact of advanced mobile electronics on the future lifestyle of the society. 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Computational Science and Engineering: Specialisation Information and Communication 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		

Course L0764: CMOS Nanoelectronics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Krautschneider
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Ideal and non-ideal MOS devices • Threshold voltage, Parasitic charges, Work function difference • I-V behavior • Scaling-down rules • Details of very small MOS transistors • Basic CMOS process flow • Memory Technology, SRAM, DRAM, embedded DRAM • Gain memory cells • Non-volatile memories, Flash memory circuits • Methods for Quality Control, C(V)-technique, Charge pumping, Uniform injection • Systems with extremely small CMOS transistors
Literature	<ul style="list-style-type: none"> • S. Deleonibus, Electronic Device Architectures for the Nano-CMOS Era, Pan Stanford Publishing, 2009. • Y. Taur and T.H. Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press, 2nd edition. • R.F. Pierret, Advanced Semiconductor Fundamentals, Prentice Hall, 2003. • F. Schwierz, H. Wong, J. J. Liou, Nanometer CMOS, Pan Stanford Publishing, 2010. • H.-G. Wagemann und T. Schönauer, Silizium-Planartechnologie, Grundprozesse, Physik und Bauelemente Teubner-Verlag, 2003, ISBN 3519004674

Course L1063: CMOS Nanoelectronics	
Typ	Laboratory Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Krautschneider
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1059: CMOS Nanoelectronics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Wolfgang Krautschneider
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0633: Industrial Process Automation				
Courses				
Title		Type	Hrs/wk	CP
Industrial Process Automation (L0344)		Lecture	2	3
Industrial Process Automation (L0345)		Recitation Section (small)	2	3
Module Responsible	Prof. Alexander Schlaefer			
Admission Requirements	None			
Recommended Previous Knowledge	mathematics and optimization methods principles of automata principles of algorithms and data structures programming skills			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<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.			
<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.			
Personal Competence				
<i>Social Competence</i>	The students work in teams to solve problems.			
<i>Autonomy</i>	The students can reflect their knowledge and document the results of their work.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 minutes			
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Computational Science and Engineering: Specialisation Scientific Computing: Elective Compulsory Computational Science and Engineering: Specialisation Systems Engineering and Robotics: Elective Compulsory International Production Management: Specialisation Production Technology: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Numerics and Computer Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory			

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

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

Module M0677: Digital Signal Processing and Digital Filters

Courses

Title		Type	Hrs/wk	CP
Digital Signal Processing and Digital Filters (L0446)		Lecture	3	4
Digital Signal Processing and Digital Filters (L0447)		Recitation Section (large)	1	2
Module Responsible	Prof. Gerhard Bauch			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none"> Mathematics 1-3 Signals and Systems Fundamentals of signal and system theory as well as random processes. Fundamentals of spectral transforms (Fourier series, Fourier transform, Laplace transform) 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	The students know and understand basic algorithms of digital signal processing. They are familiar with the spectral transforms of discrete-time signals and are able to describe and analyse signals and systems in time and image domain. They know basic structures of digital filters and can identify and assess important properties including stability. They are aware of the effects caused by quantization of filter coefficients and signals. They are familiar with the basics of adaptive filters. They can perform traditional and parametric methods of spectrum estimation, also taking a limited observation window into account.			
<i>Skills</i>	The students are able to apply methods of digital signal processing to new problems. They can choose and parameterize suitable filter structures. In particular, they can design adaptive filters according to the minimum mean squared error (MMSE) criterion and develop an efficient implementation, e.g. based on the LMS or RLS algorithm. Furthermore, the students are able to apply methods of spectrum estimation and to take the effects of a limited observation window into account.			
Personal Competence				
<i>Social Competence</i>	The students can jointly solve specific problems.			
<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.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Computer Science: Specialisation Intelligence Engineering: Elective Compulsory Electrical Engineering: Specialisation Information and Communication Systems: Elective Compulsory Electrical Engineering: Specialisation Control and Power Systems: Elective Compulsory Computational Science and Engineering: Specialisation Information and Communication Technology: Elective Compulsory Information and Communication Systems: Specialisation Communication Systems, Focus Signal Processing: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Microelectronics and Microsystems: Specialisation Microelectronics Complements: Elective Compulsory			

Course L0446: Digital Signal Processing and Digital Filters	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerhard Bauch
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> Transforms of discrete-time signals: <ul style="list-style-type: none"> Discrete-time Fourier Transform (DTFT) Discrete Fourier-Transform (DFT), Fast Fourier Transform (FFT) Z-Transform Correspondence of continuous-time and discrete-time signals, sampling, sampling theorem Fast convolution, Overlap-Add-Method, Overlap-Save-Method Fundamental structures and basic types of digital filters Characterization of digital filters using pole-zero plots, important properties of digital filters Quantization effects Design of linear-phase filters Fundamentals of stochastic signal processing and adaptive filters <ul style="list-style-type: none"> MMSE criterion Wiener Filter LMS- and RLS-algorithm Traditional and parametric methods of spectrum estimation
Literature	<p>K.-D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung. Vieweg Teubner.</p> <p>V. Oppenheim, R. W. Schaffer, J. R. Buck: Zeitdiskrete Signalverarbeitung. Pearson Studium A. V.</p> <p>W. Hess: Digitale Filter. Teubner.</p> <p>Oppenheim, R. W. Schaffer: Digital signal processing. Prentice Hall.</p> <p>S. Haykin: Adaptive filter theory.</p> <p>L. B. Jackson: Digital filters and signal processing. Kluwer.</p> <p>T.W. Parks, C.S. Burrus: Digital filter design. Wiley.</p>

Course L0447: Digital Signal Processing and Digital Filters	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Gerhard Bauch
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0552: 3D Computer Vision				
Courses				
Title		Typ	Hrs/wk	CP
3D Computer Vision (L0129)		Lecture	2	3
3D Computer Vision (L0130)		Recitation Section (small)	2	3
Module Responsible	Prof. Rolf-Rainer Grigat			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none"> Knowledge of the modules Digital Image Analysis and Pattern Recognition and Data Compression are used in the practical task Linear Algebra (including PCA, SVD), nonlinear optimization (Levenberg-Marquardt), basics of stochastics and basics of Matlab are required and cannot be explained in detail during the lecture. 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> Students can explain and describe the field of projective geometry.</p> <p><i>Skills</i> Students are capable of</p> <ul style="list-style-type: none"> Implementing an exemplary 3D or volumetric analysis task Using highly sophisticated methods and procedures of the subject area Identifying problems and Developing and implementing creative solution suggestions. <p>With assistance from the teacher students are able to link the contents of the three subject areas (modules)</p> <ul style="list-style-type: none"> Digital Image Analysis Pattern Recognition and Data Compression and 3D Computer Vision <p>in practical assignments.</p>			
Personal Competence				
<i>Social Competence</i>				
<i>Autonomy</i>				
	<p>Students can collaborate in a small team on the practical realization and testing of a system to reconstruct a three-dimensional scene or to evaluate volume data sets.</p> <p>Students are able to solve simple tasks independently with reference to the contents of the lectures and the exercise sets.</p> <p>Students are able to solve detailed problems independently with the aid of the tutorial's programming task.</p>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	60 Minutes, Content of Lecture and materials in StudIP			
Assignment for the Following Curricula	<p>Computer Science: Specialisation Intelligence Engineering: Elective Compulsory</p> <p>Computational Science and Engineering: Specialisation Systems Engineering and Robotics: Elective Compulsory</p> <p>Information and Communication Systems: Specialisation Communication Systems, Focus Signal Processing: Elective Compulsory</p> <p>Information and Communication Systems: Specialisation Secure and Dependable IT Systems, Focus Software and Signal Processing: Elective Compulsory</p> <p>Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory</p> <p>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</p> <p>Microelectronics and Microsystems: Specialisation Communication and Signal Processing: Elective Compulsory</p>			

Course L0129: 3D Computer Vision	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Rolf-Rainer Grigat
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Projective Geometry and Transformations in 2D und 3D in homogeneous coordinates • Projection matrix, calibration • Epipolar Geometry, fundamental and essential matrices, weak calibration, 5 point algorithm • Homographies 2D and 3D • Trifocal Tensor • Correspondence search
Literature	<ul style="list-style-type: none"> • Skriptum Grigat/Wenzel • Hartley, Zisserman: Multiple View Geometry in Computer Vision. Cambridge 2003.

Course L0130: 3D Computer Vision	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Rolf-Rainer Grigat
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Specialization Product Development and Production

Graduates of the Product Development and Production specialization have profound knowledge of different manufacturing and production processes and can choose between them in consideration of geometry, failure control and cost. They are able to design, calculate and simulate according to the current state of the art.

The Product Development and Production specialization is recommended to students who already have basic knowledge in design methods, calculation of components and different manufacturing processes.

Module M0604: High-Order FEM

Courses

Title	Type	Hrs/wk	CP
High-Order FEM (L0280)	Lecture	3	4
High-Order FEM (L0281)	Recitation Section (large)	1	2
Module Responsible	Prof. Alexander Düster		
Admission Requirements	None		
Recommended Previous Knowledge	Mathematics I, II, III, Mechanics I, II, III, IV Differential Equations 2 (Partial Differential Equations)		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<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.		
Personal Competence			
<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.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Examination	Written exam		
Examination duration and scale	120 min		
Assignment for the Following Curricula	Energy Systems: Core qualification: Elective Compulsory Computational Science and Engineering: Specialisation Scientific Computing: Elective Compulsory Materials Science: Specialisation Modelling: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory		

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

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

Module M0807: Boundary Element Methods				
Courses				
Title		Typ	Hrs/wk	CP
Boundary Element Methods (L0523)		Lecture	2	3
Boundary Element Methods (L0524)		Recitation Section (large)	2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	none			
Recommended Previous Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	The students possess an in-depth knowledge regarding the derivation of the boundary element method and are able to give an overview of the theoretical and methodical basis of the method.			
<i>Skills</i>	The students are capable to handle engineering problems by formulating suitable boundary elements, assembling the corresponding system matrices, and solving the resulting system of equations.			
Personal Competence				
<i>Social Competence</i>	-			
<i>Autonomy</i>	The students are able to independently solve challenging computational problems and develop own boundary element routines. Problems can be identified and the results are critically scrutinized.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Energy Systems: Core qualification: Elective Compulsory Computational Science and Engineering: Specialisation Scientific Computing: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory			

Course L0523: Boundary Element Methods	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> - Boundary value problems - Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines) - Applications
Literature	Gaul, L.; Fiedler, Ch. (1997): Methode der Randelemente in Statik und Dynamik. Vieweg, Braunschweig, Wiesbaden Bathe, K.-J. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

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

Module M1256: Rapid Production				
Courses				
Title	Type		Hrs/wk	CP
Rapid Production (L1128)	Lecture		2	3
Rapid Production (L1129)	Seminar		2	3
Module Responsible	Prof. Claus Emmelmann			
Admission Requirements	Bachelor			
Recommended Previous Knowledge	<ul style="list-style-type: none"> • Production Engineering • Fundamental of Material Science • Fundamentals of Mechanical Engineering Design 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i>	Students will be able to: <ul style="list-style-type: none"> • give an overview of Additive Manufacturing Technologies, namely • describe basics of Laser Technologies • discuss laser Additive Manufacturing, specifically • design Guidelines for Additive Manufacturing • describe the Digital Process Chain for Additive Manufacturing • discuss Quality Assurance for Additive Manufacturing • describe Product Development for Additive Manufacturing 			
<i>Skills</i>	The students will be able to: <ul style="list-style-type: none"> • give an overview of Potential and Challenges of Additive Manufacturing Technologies • show that Additive Manufacturing offers new possibilities for product development • show major differences between Additive Manufacturing and conventional manufacturing technologies • apply basic skills to develop and design Additive Manufacturing parts • design and build own Additive Manufacturing parts 			
Personal Competence <i>Social Competence</i>	Students are able to <ul style="list-style-type: none"> • interact within a team • organize workload in a team 			
<i>Autonomy</i>	Students are able to <ul style="list-style-type: none"> • develop and optimize a product with limited resources, based on defined requirements • present results skillfully 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	75 min			
Assignment for the Following Curricula	Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory			

Course L1128: Rapid Production	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	SoSe
Content	Learn the Basics of Additive Manufacturing, with focus on the Selective Laser Melting and Selective Laser Sintering. Understand the advantages the technologies offer for product development and what current challenges Additive Manufacturing faces. Get to know the design restrictions as well as basic knowledge about material characteristics, post processing and quality assurance. This lecture is part of the Module Rapid Production and cannot be chosen separately
Literature	Will be announced during the course

Course L1129: Rapid Production	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	SoSe
Content	<p>Intensify learning from the lecture, especially regarding design principles and product development by design of own Selective Laser Sintering parts.</p> <p>This seminar is part of the Module Rapid Production and cannot be chosen separately.</p>
Literature	Will be announced during the course

Module M1257: 3D Printing Laboratory				
Courses				
Title	Typ		Hrs/wk	CP
3D Printing Laboratory (L1701)	Laboratory Course		3	6
Module Responsible	Prof. Claus Emmelmann			
Admission Requirements	None			
Recommended Previous Knowledge	Rapid Production Computer Aided Design and Computation			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> Students will be able to give an overview over</p> <ul style="list-style-type: none"> • 3D printing based on fused deposition modeling, • printer setup and hardware components, • software and CAD data preparation, • and process parameters and quality aspects. <p><i>Skills</i> The students will be able to</p> <ul style="list-style-type: none"> • prepare CAD models for 3D printing, • calibrate and operate a 3D printer, • conduct designed experiments, • and find optimal printing parameters. <p>Personal Competence</p> <p><i>Social Competence</i> The students will be able to</p> <ul style="list-style-type: none"> • coordinate work in a team, • set up, monitor and adapt a project plan, • share information with team members, • deal with different personal knowledge backgrounds, • and handle team conflicts. <p><i>Autonomy</i> Without external support the students will be able to</p> <ul style="list-style-type: none"> • do literature research, • organize work according to a schedule, • conduct experiments, • and operate and troubleshoot a production machine. 			
Workload in Hours				
Credit points				
Examination				
Examination duration and scale				
Assignment for the Following Curricula	International Production Management: Core qualification: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory			

Course L1701: 3D Printing Laboratory	
Typ	Laboratory Course
Hrs/wk	3
CP	6
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	The 3D Printing lab consists of: <ul style="list-style-type: none"> · Preparation of CAD models for 3D printing, · Design of Experiments for 3D-printing · Hands-on operation of 3D printer · Printing parameter variation and detection of influences on the process
Literature	wird in der Veranstaltung bekannt gegeben

Module M1258: Laser Systems and Metallic Materials			
Courses			
Title	Type	Hrs/wk	CP
Laser Systems and Process Technologies (L1612)	Lecture	2	3
Structural Metallic Materials (L1702)	Lecture	2	3
Module Responsible	Prof. Claus Emmelmann		
Admission Requirements	Bachelor		
Recommended Previous Knowledge	Fundamentals of Materials Science I		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	Students can give an overview over laser systems for material processing, specifically: <ul style="list-style-type: none"> • beam sources, • transport and manipulation of Laser beams, • and laser Safety. They can also describe applications of laser systems in material processing, namely: <ul style="list-style-type: none"> • primary forming, • marking, • cutting, • joining, • and surface treatment. They can also explain the material science of technically relevant metals as for example <ul style="list-style-type: none"> • carbon steels, • micro alloyed steels • low- and high-alloyed steels, • stainless steels, • aluminium alloys, • and magnesium alloys. 		
<i>Skills</i>	After successful completion of this course, students should be able to <ul style="list-style-type: none"> • give an overview on current laser technology, • classify its applications in today's manufacturing processes, • evaluate economical and quality aspects, • find suitable laser systems for given tasks. 		
Personal Competence <i>Social Competence</i>	<ul style="list-style-type: none"> • Students are able to discuss their solutions to problems with others. They communicate in English. 		
<i>Autonomy</i>	<ul style="list-style-type: none"> • Students are able of checking their understanding of complex concepts by solving variants of concrete problems 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Examination	Written elaboration		
Examination duration and scale	approx. 20 pages		
Assignment for the Following Curricula	International Production Management: Core qualification: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory		

Course L1612: Laser Systems and Process Technologies	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Fundamentals of laser technology • Laser beam sources: CO₂-, Nd:YAG-, Fiber- and Diodelasers • Laser system technology: beam forming, beam guidance systems, beam motion and beam control • Laser-based manufacturing technologies: generation, marking, cutting, joining, surface treatment • Quality assurance and economical aspects of laser material processing • Markets and Applications of laser technology • Student group exercises
Literature	<ul style="list-style-type: none"> • Hügel, H. , T. Graf: Laser in der Fertigung : Strahlquellen, Systeme, Fertigungsverfahren, 3. Aufl., Vieweg + Teubner Wiesbaden 2014. • Eichler, J., Eichler. H. J.: Laser: Bauformen, Strahlführung, Anwendungen, 7. Aufl., Springer-Verlag Berlin Heidelberg 2010. • Steen W. M.; Mazumder J.: Laser material processing, 4th Edition, Springer-Verlag London 2010. • J.C. Ion: Laser processing of engineering materials: principles, procedure and industrial applications, Elsevier Butterworth-Heinemann 2005. • Gebhardt, A.: Understanding additive manufacturing, München [u.a.] Hanser 2011

Course L1702: Structural Metallic Materials	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Karl-Ulrich Kainer
Language	EN
Cycle	WiSe
Content	<p>Steels:</p> <ul style="list-style-type: none"> • Fundamentals of steels • Carbon steels: phase diagram, transformation behaviour, technical heat treatments • Low and high alloyed steels: influence of alloying elements on transformation and carbides • Micro alloyed steels • Corrosion and scaling resistant steels : Classification, composition and microstructure, properties and applications <p>Aluminium alloys:</p> <ul style="list-style-type: none"> • Alloy systems and groups • Non-age-hardenable Al-alloys: Processing and microstructure, Mechanical properties and applications • Age-hardenable Al-alloys: Processing and microstructure, Mechanical properties and applications <p>Titanium alloys</p> <ul style="list-style-type: none"> • Introduction into titanium materials, alloy systems and groups • Processing, microstructure and properties • Applications <p>Magnesium alloys</p> <ul style="list-style-type: none"> • Introduction into magnesium materials, Alloy systems and groups • Cast alloys, processing, microstructure and properties <p>Wrought alloys, processing, microstructure and properties</p>
Literature	<ul style="list-style-type: none"> • George Krauss, Steels: Processing, Structure, and Performance, 978-0-87170-817-5, 2006, • Hans Berns, Werner Theisen, Ferrous Materials: Steel and Cast Iron, 2008. http://dx.doi.org/10.1007/978-3-540-71848-2 • C. W. Wegst, Stahlschlüssel = Key to steel = La Clé des aciers = Chiave dell'acciaio = Liave del acero ISBN/ISSN: 3922599095 • Bruno C., De Cooman / John G. Speer: Fundamentals of Steel Product Physical Metallurgy, 2011, 642 S. • Harry Chandler, Steel Metallurgy for the Non-Metallurgist 0-87170-652-0, 2006, 84 S. • Catrin Kammer, Aluminium Taschenbuch 1, Grundlagen und Werkstoffe, Beuth, 16. Auflage 2009. 784 S., ISBN 978-3-410-22028-2 • Günter Drossel, Susanne Friedrich, Catrin Kammer und Wolfgang Lehnert, Aluminium Taschenbuch 2, Umformung von Aluminium-Werkstoffen, Gießen von Aluminiumteilen, Oberflächenbehandlung von Aluminium, Recycling und Ökologie, Beuth, 16. Auflage 2009. 768 S., ISBN 978-3-410-22029-9 • Catrin Kammer, Aluminium Taschenbuch 3, Weiterverarbeitung und Anwendung, Beuth, 17. Auflage 2014. 892 S., ISBN 978-3-410-22311-5 • G. Lütjering, J.C. Williams: Titanium, 2nd ed., Springer, Berlin, Heidelberg, 2007, ISBN 978-3-540-71397 • Magnesium - Alloys and Technologies, K. U. Kainer (Hrsg.), Wiley-VCH, Weinheim 2003, ISBN 3-527-30570-x • Mihriban O. Pekguleryuz, Karl U. Kainer and Ali Kaya "Fundamentals of Magnesium Alloy Metallurgy", Woodhead Publishing Ltd, 2013, ISBN 10: 0857090887

Specialization Materials

Graduates of the Materials specialization are able to work in development, manufacturing and application of materials. They can identify new application fields of materials and make choices between different materials in consideration of functions, cost and quality.

The Materials specialization is recommended to students who already have basic knowledge about different materials and know how to calculate with material properties.

Module M1150: Continuum Mechanics			
Courses			
Title	Typ	Hrs/wk	CP
Continuum Mechanics (L1533)	Lecture	2	3
Continuum Mechanics Exercise (L1534)	Recitation Section (small)	2	3
Module Responsible	Prof. Swantje Bargmann		
Admission Requirements	None		
Recommended Previous Knowledge	Mechanics I		
	Mechanics II		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	The students can explain the fundamental concepts to calculate the mechanical behavior of materials.		
<i>Skills</i>			
Personal Competence <i>Social Competence</i>			
<i>Autonomy</i>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Examination	Oral exam		
Examination duration and scale	30 min		
Assignment for the Following Curricula	Computational Science and Engineering: Specialisation Scientific Computing: Elective Compulsory		
	Materials Science: Specialisation Modelling: Elective Compulsory		
	Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory		
	Mechatronics: Technical Complementary Course: Elective Compulsory		
	Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory		
	Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory		
	Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory		
	Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory		
	Product Development, Materials and Production: Core qualification: Elective Compulsory		
	Theoretical Mechanical Engineering: Core qualification: Elective Compulsory		
	Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory		

Course L1533: Continuum Mechanics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Swantje Bargmann, Dr. Songyun Ma
Language	DE/EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • kinematics of undeformed and deformed bodies • balance equations (balance of mass, balance of energy, ...) • stress states • material modelling
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Course L1534: Continuum Mechanics Exercise	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Swantje Bargmann
Language	DE/EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • kinematics of undeformed and deformed bodies • balance equations (balance of mass, balance of energy, ...) • stress states • material modelling
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Module M1226: Mechanical Properties

Courses

Title	Type	Hrs/wk	CP
Mechanical Behaviour of Brittle Materials (L1661)	Lecture	2	3
Dislocation Theory of Plasticity (L1662)	Lecture	2	3
Module Responsible	Dr. Erica Lilleodden		
Admission Requirements	none		
Recommended Previous Knowledge	Basics in Materials Science I/II		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<p><i>Knowledge</i> Students can explain basic principles of crystallography, statics (free body diagrams, tractions) and thermodynamics (energy minimization, energy barriers, entropy)</p> <p><i>Skills</i> Students are capable of using standardized calculation methods: tensor calculations, derivatives, integrals, tensor transformations</p> <p><i>Social Competence</i> Students can provide appropriate feedback and handle feedback on their own performance constructively.</p> <p><i>Autonomy</i> Students are able to</p> <ul style="list-style-type: none"> - assess their own strengths and weaknesses - assess their own state of learning in specific terms and to define further work steps on this basis guided by teachers. - work independently based on lectures and notes to solve problems, and to ask for help or clarifications when needed 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	Materials Science: Core qualification: Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory		

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

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

Module M1144: Manufacturing with Polymers and Composites - From Molecule to Part				
Courses				
Title		Typ	Hrs/wk	CP
Manufacturing with Polymers and Composites (L0511)		Lecture	2	3
From Molecule to Composites Part (L1516)		Problem-based Learning	2	3
Module Responsible	Prof. Bodo Fiedler			
Admission Requirements	Non			
Recommended Previous Knowledge	Structure and Properties of Polymers Structure and Properties of Composites			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> Students are able to give a summary of the technical details of the manufacturing processes polymers and composites and illustrate respective relationships. They are capable of describing and communicating relevant problems and questions using appropriate technical language. They can explain the typical process of solving practical problems and present related results.</p> <p><i>Skills</i> The students can transfer their fundamental knowledge on civil engineering to the process of solving practical problems. They identify and overcome typical problems during the realization of projects in the context of civil engineering. Students are able to develop, compare, and choose conceptual solutions for non-standardized problems.</p> <p>Personal Competence</p> <p><i>Social Competence</i> Students are able to cooperate in small, mixed-subject groups in order to independently derive solutions to given problems in the context of civil engineering. They are able to effectively present and explain their results alone or in groups in front of a qualified audience. Students have the ability to develop alternative approaches to an engineering problem independently or in groups and discuss advantages as well as drawbacks.</p> <p><i>Autonomy</i> Students are capable of independently solving mechanical engineering problems using provided literature. They are able to fill gaps in as well as extend their knowledge using the literature and other sources provided by the supervisor. Furthermore, they can meaningfully extend given problems and pragmatically solve them by means of corresponding solutions and concepts.</p>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written elaboration			
Examination duration and scale	1,5 h			
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Specialisation Engineering Materials: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory			

Course L0511: Manufacturing with Polymers and Composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining Manufacturing of Composites: Hand Lay-Up; Pre-Preg; GMT, BMC; SMC, RIM; Pultrusion; Filament Winding
Literature	Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag Crawford: Plastics engineering, Pergamon Press Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag Åström: Manufacturing of Polymer Composites, Chapman and Hall

Course L1516: From Molecule to Composites Part	
Typ	Problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62; Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	<p>Students get the task in the form of a customer request for the development and production of a MTB handlebar made of fiber composites. In the task technical and normative requirements (standards) are given, all other required information come from the lectures and tutorials, and the respective documents (electronically and in conversation).</p> <p>The procedure is to specify in a milestone schedule and allows students to plan tasks and to work continuously. At project end, each group has a made handlebar with approved quality.</p> <p>In each project meeting the design (discussion of the requirements and risks) are discussed. The calculations are analyzed, evaluated and established manufacturing methods are selected. Materials are selected bar will be produced. The quality and the mechanical properties are checked. At the end of the final report created (compilation of the results for the "customers").</p> <p>After the test during the "customer / supplier conversation" there is a mutual feedback-talk ("lessons learned") in order to ensure the continuous improvement.</p>
Literature	Customer Request ("Handout")

Module M1151: Material Modeling				
Courses				
Title	Typ		Hrs/wk	CP
Material Modeling (L1535)	Lecture		2	3
Material Modeling (L1536)	Recitation Section (small)		2	3
Module Responsible	Prof. Swantje Bargmann			
Admission Requirements	None			
Recommended Previous Knowledge	mechanics I mechanics II continuum mechanics			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	The students can explain the fundamentals of multidimensional constitutive material laws The students can implement their own material laws in finite element codes. In particular, the students can apply their knowledge to various problems of material science and evaluate the corresponding material models. The students are able to develop solutions, to present them to specialists and to develop ideas further. The students are able to assess their own strengths and weaknesses and to define tasks themselves. They can solve exercises in the area of continuum mechanics on their own.			
<i>Knowledge</i>				
<i>Skills</i>				
Personal Competence				
<i>Social Competence</i>	The students are able to develop solutions, to present them to specialists and to develop ideas further.			
<i>Autonomy</i>	The students are able to assess their own strengths and weaknesses and to define tasks themselves. They can solve exercises in the area of continuum mechanics on their own.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the Following Curricula	Computational Science and Engineering: Specialisation Scientific Computing: Elective Compulsory Materials Science: Specialisation Modelling: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory			

Course L1535: Material Modeling	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Swantje Bargmann, Dr. Dirk Steglich
Language	DE/EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> fundamentals of finite element methods fundamentals of material modeling introduction to numerical implementation of material laws overview of modelling of different classes of materials combination of macroscopic quantities to material microstructure
Literature	D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge G. Gottstein., Physical Foundations of Materials Science, Springer

Course L1536: Material Modeling	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Swantje Bargmann, Dr. Ingo Scheider
Language	DE/EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • fundamentals of finite element methods • fundamentals of material modeling • introduction to numerical implementation of material laws • overview of modelling of different classes of materials • combination of macroscopic quantities to material microstructure
Literature	<p>D. Raabe: Computational Materials Science, The Simulation of Materials, Microstructures and Properties, Wiley-Vch</p> <p>J. Bonet, R.D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge</p> <p>G. Gottstein., Physical Foundations of Materials Science, Springer</p>

Module M1220: Interfaces and interface-dominated Materials

Courses

Title	Typ	Hrs/wk	CP
Nature's Hierarchical Materials (L1663)	Seminar	2	3
Interfaces (L1654)	Lecture	2	3
Module Responsible	Prof. Patrick Huber		
Admission Requirements	None		
Recommended Previous Knowledge	Fundamentals of Materials Science (I and II) and physical chemistry		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<p><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.</p> <p><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.</p> <p>Personal Competence</p> <p><i>Social Competence</i> The students are able to present solutions to specialists and to develop ideas further.</p> <p><i>Autonomy</i> The students are able to ...</p> <ul style="list-style-type: none"> • assess their own strengths and weaknesses. • define tasks independently. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	Materials Science: Specialisation Nano and Hybrid Materials: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory		

Course L1663: Nature's Hierarchical Materials

Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Gerold Schneider
Language	EN
Cycle	WiSe
Content	Biological materials are omnipresent in the world around us. They are the main constituents in plant and animal bodies and have a diversity of functions. A fundamental function is obviously mechanical providing protection and support for the body. But biological materials may also serve as ion reservoirs (bone is a typical example), as chemical barriers (like cell membranes), have catalytic function (such as enzymes), transfer chemical into kinetic energy (such as the muscle), etc. This lecture will focus on materials with a primarily (passive) mechanical function: cellulose tissues (such as wood), collagen tissues (such as tendon or cornea), mineralized tissues (such as bone, dentin and glass sponges). The main goal is to give an introduction to the current knowledge of the structure in these materials and how these structures relate to their (mostly mechanical) functions.
Literature	Peter Fratzl, Richard Weinkamer, Nature's hierarchical materials Progress, in Materials Science 52 (2007) 1263-1334 Journal publications

Course L1654: Interfaces	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber
Language	DE/EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Microscopic structure and thermodynamics of interfaces (gas/solid, gas/liquid, liquid/liquid, liquid/solid) • Experimental methods for the study of interfaces • Interfacial forces • wetting • surfactants, foams, bio-membranes • chemical grafting of interfaces
Literature	"Physics and Chemistry of Interfaces", K.H. Butt, K. Graf, M. Kappl, Wiley-VCH Weinheim (2006) "Interfacial Science", G.T. Barnes, I.R. Gentle, Oxford University Press (2005)

Module M1199: Advanced Functional Materials			
Courses			
Title	Typ	Hrs/wk	CP
Advanced Functional Materials (L1625)	Lecture	2	6
Module Responsible	Prof. Patrick Huber		
Admission Requirements	none.		
Recommended Previous Knowledge	Fundamentals of Materials Science (I and II)		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<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.		
Personal Competence			
<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"> • assess their own strengths and weaknesses. • define tasks independently. 		
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28		
Credit points	6		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	Materials Science: Core qualification: Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory 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		

Course L1625: Advanced Functional Materials	
Typ	Lecture
Hrs/wk	2
CP	6
Workload in Hours	Independent Study Time 152, Study Time in Lecture 28
Lecturer	Prof. Patrick Huber, Prof. Stefan Müller, Prof. Bodo Fiedler, Prof. Gerold Schneider, Prof. Jörg Weißmüller
Language	DE/EN
Cycle	WiSe
Content	1. Porous Solids - Preparation, Characterization and Functionalities 2. Fluidics with nanoporous membranes 3. Thermoplastic elastomers 4. Optimization of polymer properties by nanoparticles 5. Fiber composites in automotive 6. Modeling of materials based on quantum mechanics 7. Biomaterials
Literature	Wird in der Veranstaltung bekannt gegeben

Thesis

Module M-002: Master Thesis

Courses

Title	Typ	Hrs/wk	CP
Module Responsible	Professoren der TUHH		
Admission Requirements	<ul style="list-style-type: none"> According to General Regulations §24 (1): <p>At least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions.</p>		
Recommended Previous Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	<ul style="list-style-type: none"> The students can use specialized knowledge (facts, theories, and methods) of their subject competently on specialized issues. The students can explain in depth the relevant approaches and terminologies in one or more areas of their subject, describing current developments and taking up a critical position on them. The students can place a research task in their subject area in its context and describe and critically assess the state of research. 		
Skills	<p>The students are able:</p> <ul style="list-style-type: none"> To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in question. To apply knowledge they have acquired and methods they have learnt in the course of their studies to complex and/or incompletely defined problems in a solution-oriented way. To develop new scientific findings in their subject area and subject them to a critical assessment. 		
Personal Competence <i>Social Competence</i>	<p>Students can</p> <ul style="list-style-type: none"> Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structured way. Deal with issues competently in an expert discussion and answer them in a manner that is appropriate to the addressees while upholding their own assessments and viewpoints convincingly. 		
Autonomy	<p>Students are able:</p> <ul style="list-style-type: none"> To structure a project of their own in work packages and to work them off accordingly. To work their way in depth into a largely unknown subject and to access the information required for them to do so. To apply the techniques of scientific work comprehensively in research of their own. 		
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0		
Credit points	30		
Examination	according to Subject Specific Regulations		
Examination duration and scale	see FSPO		
Assignment for the Following Curricula	Civil Engineering: Thesis: Compulsory Bioprocess Engineering: Thesis: Compulsory Chemical and Bioprocess Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory Energy and Environmental Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Global Innovation Management: Thesis: Compulsory Computational Science and Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory International Production Management: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory Materials Science: Thesis: Compulsory Mechanical Engineering and Management: Thesis: Compulsory Mechatronics: Thesis: Compulsory Biomedical Engineering: Thesis: Compulsory Microelectronics and Microsystems: Thesis: Compulsory Product Development, Materials and Production: Thesis: Compulsory Renewable Energies: Thesis: Compulsory Naval Architecture and Ocean Engineering: Thesis: Compulsory		

Ship and Offshore Technology: Thesis: Compulsory Theoretical Mechanical Engineering: Thesis: Compulsory Process Engineering: Thesis: Compulsory Water and Environmental Engineering: Thesis: Compulsory
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