HECTOR SCHOOL
Technology Business School of the KIT

Karlsruher Institut für Technologie

Course Guide Book Intake 2020/2021

Executive Master Program
Energy Engineering & Management

Contents

Contact & Imprint

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Curriculum may be subject to change.

1 Foreword

Added value of a Master of Science in "Energy Engineering and Management" for prospective executives from the utilities industries

Energy for tomorrow!

In the near future, more than seven billion people worldwide will need to be supplied with energy. At the KIT Energy Center, researchers from a wide range of disciplines develop innovative concepts, expertise and solutions for a safe, economically efficient and environmentally compatible energy supply based on societally acceptable energy mixes – including chemical fuels as a major component. This entails unique interdisciplinary cooperation amongst scientists, engineers and economists, combining topics and making use of joint sophisticated equipment and facilities for their research. Consequently, comprehensive state-of-the-art know-how for the energy sector is continually generated. For external partners from industry, this means that the KIT Center can provide novel single-source solutions in energy technology with a focus on chemical fuels and energy systems analysis. Moreover, the KIT center is well placed to act as a competent contact to politics, industry and society regarding energy solutions for Germany and the EC in general.

In this project, the HECTOR School of Engineering and Management proposes to tap KIT Center expertise and make it available to industry by providing a channel for educational transfer of research results and associated know-how. In launching the program "Energy Engineering and Management", the HECTOR School is bringing together the scientific expertise of the Energy Centre at KIT to create an application-oriented course of further study. The course is to make the latest energy research findings, in particular in the field of renewables, available to applicants working in the energy sector.

The general aims of the course are essentially already defined by the target group- future executives: developing methodological and personal competencies by communicating fundamental, specialist and interdisciplinary know-how and skills. Graduates of the course will be empowered to make an important contribution in their future careers to solving the enormous challenges associated with converting European and global energy systems to sustainable foundations. This part-time course of study is aimed in particular at young executives from Germany and other KIC InnoEnergy co-location centers; 50 % of its intake will consist of international students.

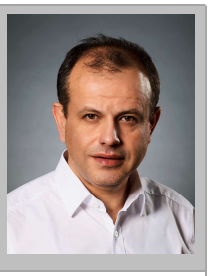
The transfer of state of the art research knowledge to students and industry executives – by means of an English-taught, part-time executive program is expected to help generate future technology leaders and ultimately to serve as a trigger for innovation within European Community utilities industries.

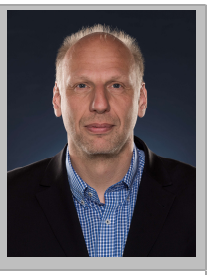
Prof. Dr.-Ing. Marc Hiller Prof. Dr.-Ing. Dimosthenis Trimis

Program Directors of Energy Engineering and Management

2 Program Directors

Title/ Name	Prof. Dr.-Ing. Marc Hiller	
Phone	+49 (0) 721- 608 42474	
E-Mail	***Marc.Hiller@kit.edu***	
Affiliation	Institute of Electrical Engineering, Karlsruhe Institute of Technology (KIT)	
Current Position	Full Professor and head of "Power Electronic Systems" group	
Vita	1998	Diploma in Electrical Engineering at the Technical University Darmstadt
	1999	R&D Design Engineer for Traction Converters, Siemens AG, Erlangen, Germany
	1999-2004	PhD student at the Institute for Power Electronics and Control, Prof. Marquardt, University of Federal Armed Forces Munich, Germany
	2008	PhD in Electrical Engineering
	2005-2015	Project manager and Head of Power section development, Research & Development, Low and Medium Voltage Converters for Energy and Industrial applications, Siemens AG, Nürnberg, Germany
	2015-present	Full Professor for Power Electronic Systems at the Institute of Electrical Engineering, KIT, Karlsruhe, Germany
	2018-present	Head of Application Groups at the Battery Technical Center of the KIT
Fields of Interest	▪ Power Electronics for Drives and Grid Applications ▪ Energy storage Systems ▪ Power Hardware-in-the-Loop Applications	
Memberships & Awards	1998	Best Graduate Student Technical University Darmstadt in Electrical Engineering
	2005	VDE/ETG Best Paper Award 2005
	2009	Inventor of the year 2009, Siemens AG, Germany
	Since 2016	Member of Scientific Committee, European Power Electronics Association (EPE)
	Since 2017	Member of Steering Committee, International Power Electronics Conference Japan (IPEC)

Title/ Name	Prof. Dr.-Ing. Dimosthenis Trimis	
Phone	+49 (0) 721- 608 42570	
E-Mail	***Dimosthenis.Trimis@kit.edu***	
Affiliation	Engler-Bunte-Institute, section of Combustion Technology, KIT Engler-Bunte-Ring 1, 76131 Karlsruhe	
Current Position	Head of the Chair of Combustion Technology at the Karlsruhe Institute of Technology, KIT	
Vita	1995 PhD (Dr.-Ing.) University of Erlangen 1992 – 2000 Scientific assistant at the Institute of Fluid Mechanics, University of Erlangen-Nuremberg 1996 – 1997 Head of Research Group Combustion Technology at the Institute of Fluid Mechanics, University of Erlangen-Nuremberg 1998 – 2006 Head of Research Division E2 Flows with chemical reactions at the Institute of Fluid Mechanics, University of Erlangen-Nuremberg 2006 - 2012 Head of the Chair of Gas and Heat Technology at the TU Bergakademie Freiberg Since 2012 Head of the Chair of Combustion Technology at the Karlsruhe Institute of Technology	
Fields of Interest	▪ *currently under revision* ▪ … ▪ … ▪ … ▪ …	
Memberships & Awards	*Currently under revision*	

Title/ Name	Prof. Dr. Stefan Nickel	
Phone	+49 (0) 721- 608 43381	
E-Mail	***Stefan.Nickel@kit.edu***	
Affiliation	Institute of Operations Research: Discrete Optimization and Logistics, Karlsruhe Institute of Technology (KIT) Englerstr. 11, 76131 Karlsruhe, Germany	
Current Position	Head of the Chair: Discrete Optimization and Logistics at the IOR	
Vita	1995-1999 Assistant Professor, University of Kaiserslautern	

	Since 1999 Associate Professor, University of Kaiserslautern 2003-2009 Chair in Operations Research and Logistics, University of Saarbrücken Since 2009 Chair in Discrete Optimization and Logistics, KIT
Fields of Interest	• Modelling location decisions in Supply Chain Management • Multi-periodic design and optimization of distribution networks • Optimization methods in in-house logistics • Optimization methods in health care
Memberships & Awards	• INFORMS • European Working Group on Locational Decisions (EWGLA) • College on Locational Analysis (COLA) • Gesellschaft für Operations-Research e.V. (GOR) • Mathematical Programming Society (MPS)

3 Study Plan

3.1 Overall Program Objectives and Qualification Targets

All six executive master programs of the HECTOR School of KIT have the following qualification objectives in common:

1. Enabling the graduates to operate in an analytical and scientifically sound way
2. Enabling the graduates to independently apply and further develop methods and technologies in the areas of research and development
3. Enabling the graduates to perform successful, self-dependent, and innovative work, which is related to their occupational fields in their respective areas of the specialization
4. Enabling the graduates to work on complex topics in the pursued specialization
5. Enabling the graduates to apply methods both in economic and in management-related issues
6. Enabling the graduates to assume leadership positions in the field of their chosen specialization, also in international contexts

3.2 Qualification Objectives for Energy Engineering and Management

The specific qualification objectives for the executive master program EEM are the following:

1. The graduates have a comprehensive overview of and a thorough understanding of current and future systems for energy supply and their technological components. They are able to comprehend energy systems and their components in their complex interactions and to analyze and evaluate them quantitatively.
2. They are familiar with fossil and renewable energy sources and their opportunities and limitations, and are able to actively participate in the successful implementation of sustainable energy systems and evaluate these regarding economic, availability and security aspects. In particular, the associated environmental and socio-economic effects are recognized by the graduates and can be implemented in overall models.
3. Graduates are able to analyze and evaluate technological problems in the context of energy transformation, transport, storage and distribution under economics aspects.
4. They are able to thoroughly understand the approach in the internal and external financial reporting and to apply it in the corporate context.
5. Furthermore, they are familiar with approaches to preparing and optimizing a company's strategic decisions.
6. They have mastered the essential skills of project management in an international context and, through their interdisciplinary training, can actively integrate those from various fields, hierarchical

levels and cultural backgrounds and thus prepare and implement decisions concerning corporate strategy.

7. They are able to understand approaches of marketing, innovation management and intrapreneurship, and legal issues in the technological context, to recognize and evaluate relationships and thus, to evaluate the effectiveness of strategies. Based on this analysis, recommendations for action can be derived.

3.3 Program Structure and Curriculum

Excellence in Technology Management: Six Executive Master Programs are offered by the HECTOR School of Engineering and Management. The school – named after Dr. h.c. Hans-Werner Hector, the co-founder of the software company SAP – is run in cooperation with four University Departments. The programs are offered in

- Energy Engineering and Management (EEM)
- Financial Engineering (FE)
- Information Systems Engineering and Management (ISEM)
- Management of Product Development (MPD)
- Mobility Systems Engineering and Management (MSEM)
- Production and Operations Management (POM)

The concurrently taught Executive Master Program is designed for working professionals. Block lectures scheduled at intervals allow participants to continue with demanding careers while acquiring new skills. The lectures are scheduled to take place over a period of 15 months. Courses are divided into 10 intensive modules of 14 days each following a timetable of monthly intervals. Each participant will take the same sequence of courses throughout the program. The two-week block lectures allow a complete immersion into the academic environment without long interruption of existing work-related responsibilities. The program officially begins in October of each year and is completed with a Master Thesis.

Semester	Subject	Type of Module	Name of Module	Course	Credits
1	Management	MM1	Marketing and Information	1. Designing and Selling Solutions (incl. Negotiation Training)	6
				2. Information Systems Management	
				3. Big Data Methods	
				4. Legal Aspects of Information	
	Engineering	EM1	Renewables	1. Introduction and Scope of EEM, Energy Systems	6
				2. Wind and Water Power	
				3. Solar and Geothermal Power	
	Engineering	EM2	Thermal Energy Conversion	1. Technical Combustion/ Heat and Mass Transfer	6
				2. Thermal Power Plants incl. Coal and Gas Power Plants	
				3. Turbo Machinery	
				4. Carbon Capture and Storage	
				5. Energy from Biomass	
	Management	MM2	Finance and Value	1. Management Accounting	6
				2. Financial Accounting	
				3. Strategic Financial Management	
				4. Case Studies	
2	Management	MM3	Decisions and Risk	1. Decision Modeling	6
				2. Risk Aware Decisions	
				3. Interactive Decisions	
				4. Robust and Stochastic Optimization	
	Engineering	EM3	Electricity Generation and Energy Storage	1. Power Generators	6
				2. Batteries and Fuel Cells	
				3. Hydrogen Technology and Thermal Storage	
				4. Photovoltaics	
				5. Power Electronics	
	Engineering (elective)	EM4	Smart Networks and Energy Distribution	1. Introduction to Power Systems / High Voltage Engineering	6
				2. Components of Power Systems	
				3. Transmission and Distribution	

Semester	Subject	Type of Module	Name of Module	Course	Credits
				4. Smart Grids and Emerging Technologies	
	Management	MM4	Corporate Innovation and Intrapreneurship	1. Corporate Entrepreneurship	6
				2. Entrepreneurial Leadership	
				3. Strategic Innovation Management	
				4. Opportunity Development – Design Thinking	
				5. Exploring the Opportunity: Technology and Markets	
				6. Pitching Business Ideas	
				7. Creating Value through Business Models	
				8. New Product Development and Service Innovation	
				9. Measuring Innovation: Innovation Balanced Scorecard	
				10. Pitching Business Models	
3	Engineering (elective)	EM5	Energy Economics	1. Energy Markets	6
				2. European Network Regulations	
				3. Energy Systems Analysis	
				4. Energy Efficiency (Supply and Demand Side)	
				5. Integration of Decentralized Energy Systems	
	Management	MM5	Strategy and People	1. Strategic Management	6
				2. Managerial Economics	
				3. Business Organization and Corporate Law	
				4. Strategic Human Resource Management	
				5. Leadership and Conflict Management	
		Thesis	Master Thesis (maximum 9 months)		30

Tab. 3-1 Study Plan EEM

3.4 Academic Calendar Intake 2020

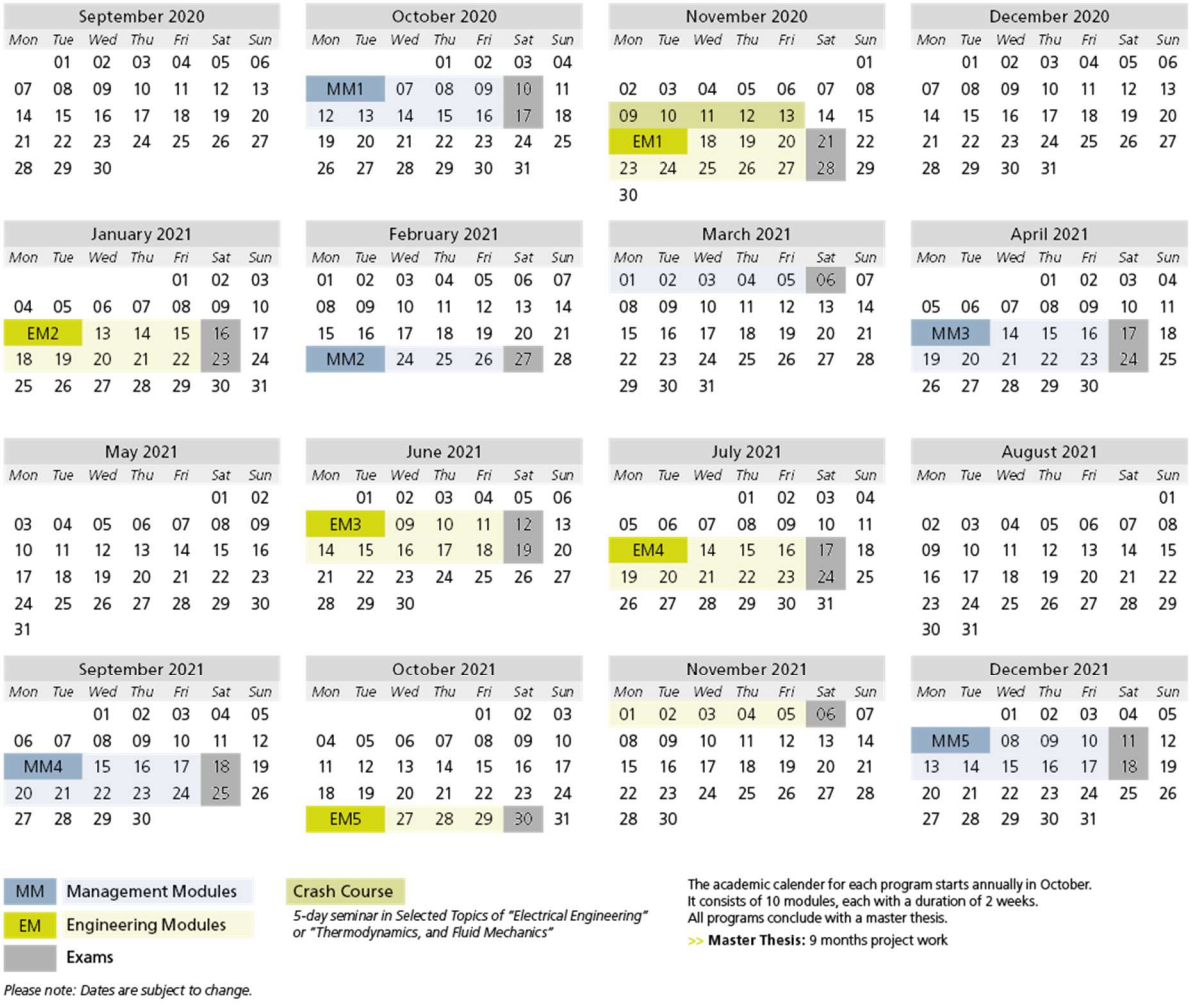


Figure 1: Academic Calendar Intake 2020

Selection of Elective Focus Area in Engineering Subject (SPO §19, par. 3)

The Study and Examination Regulations foresee elective focus areas within the subject of Engineering. However, in Energy Engineering and Management there are no focus areas and the elective modules EM4 and EM5 are identical for all students.

3.5 Teaching Structure

HECTOR School's programs are more than typical MBA programs. The primary goal is to enable young professionals to take a holistic approach when managing highly interdependent processes. Leadership for engineers in today's fast changing and complex environment implies technological and organizational responsibilities and requires economical accountability and Human Resource Management know-how. Therefore, all programs comprise five Management Modules where the participants are provided with general knowledge in Finance, Accounting, Marketing, Multi-Project Management and International Law so they can consider commercial consequences of business decisions.

The engineering emphasis of each Master Program is laid on five Engineering Modules adapted to each specialization. The lectures in the Master-specific field provide insight into the newest research topics. They convey current and state-of-the-art methodology necessary to master the scope of innovative technologies. These engineering lectures also comprise the theoretical background necessary to model and analyze key decision problems within the specific master program.

Workshops and case studies allow ample opportunity to explore the direct applications of the modules simulating the real business environment. The programs conclude with a Master Thesis, which allows the participants to work on a research project reflecting their own company's needs and its specific business environment. The final title bestowed after having successfully completed the programs is the M.Sc. of the Karlsruhe Institute of Technology (KIT).

3.6 Examination Structure

3.6.1 General Information

Examinations take place on both Saturdays during the module. Examinations can be written, oral or controls of success of another kind (e.g. a documentation of a case study). You may find the detailed information about the examination type in each lecture description. The examinations usually take place in rooms at the International Department. The exact location and dates will be communicated at the beginning of the module. Attendance in lecture is mandatory, strong participation is highly recommended. If students are unable to participate in the exam an official excuse (written) must be issued, prior to exam start.

3.6.2 Examination Process

Each student must show his identification card at exam start. The results of the exams are announced right after the examination if it is an oral exam and about four to six weeks after the examination if it is a written exam. The exam results can be find after each module on a transcript, which will be uploaded into a personal folder on HECTOR School SharePoint.

3.6.3 Exam Review

An exam review will be provided at the first Monday of the next module, where students may get an insight into the exams and have the opportunity to ask questions. There is no possibility to contest the exam if not attended the exam review. Participants need to bring their Student ID to the exam review. For further information, please see the General Study and Examination Regulations (see 8.4).

3.7 Lecturers

3.7.1 Management Modules

Name	Institute
Program Director	
Prof. Dr. Stefan Nickel	Institute for Operations Research, KIT
Module Supervisors	
Prof. Dr. Martin Klarmann	Institute of Economic Information and Marketing, KIT
Prof. Dr. Stefan Nickel	Institute for Operations Research, KIT
Prof. Dr. Petra Nieken	Institute of Management, KIT
Prof. Dr. Martin E. Ruckes	Institute for Finance, Banking and Insurance, KIT
Prof. Dr. Jordi Vinaixa Serra	ESADE Barcelona
Lecturers in Alphabetical Order	
Miguel Angel Heras	ESADE
Prof. Dr. Elena Bou	ESADE
Prof. Dr. Kerstin Fehre	Vlerick Business School
Xavier Ferrás	ESADE
Prof. Dr. Oliver Grothe	Institute for Operations Research, KIT
Prof. Dr. Anja Kern	Cooperative State University, DHBW Mosbach
Prof. Dr. Amy Leaverton	ESADE
Dr.-Ing. Tobias Kunkel	Institute of Human and Industrial Engineering (ifab), KIT
Prof. Dr. Alexander Mädche	Institute of Information Systems and Marketing (IISM), KIT
Gerald Oerter	Focus Sales, Consulting Gerald Oerter
Prof. Dr. Clemens Puppe	Institute of Economics, KIT
Prof. Dr. Steffen Rebennack	Institute of Operations Research, KIT
Prof. Dr. Martin Schulz	German Graduate School of Management and Law, GGS
Prof. Dr. Enric Segarra Costa	ESADE
Dr. Marcel Sinske	Institute of Operations Research, KIT
Prof. Dr. Indra Spiecker gen. Döhmann	Department of Law, Goethe Universität Frankfurt am Main
Dr. Jan-Oliver Strych	Institute for Finance, Banking and Insurance, KIT
Prof. Dr. Luis Vives	ESADE
Prof. Dr. Ivanka Visnjic	ESADE

3.7.2 Engineering Modules

Name	Institute
Program Directors & Module Supervisors	
Prof. Dr.-Ing. Hans-Jörg Bauer	Institute of Thermal Turbomachinery, KIT
Prof. Dr.-Ing. Marc Hiller	Electrotechnical Institute (ETI), KIT
Prof. Dr.-Ing. Dimosthenis Trimis	Engler-Bunte-Institute Division of Combustion Technology, KIT
Lecturers in Alphabetical Order	
Dr. Thomas Ackermann	Energynautics GmbH
Dr. rer. pol. Armin Ardone	Institute for Industrial Production (IIP), KIT
Siegfried Bajohr	Engler-Bunte-Institute, Fuel Technology, KIT
Dr. Christoph Dörnemann	Amprion GmbH
Prof. Dr.-Ing. Martin Doppelbauer	Electrotechnical Institute (ETI), KIT
Prof. Dr. Helmut Ehrenberg	Institute for Applied Materials – Energy Storage Systems, KIT
Dr. Thomas Fluhrer	Transnet BW
Dr. rer. pol. Massimo Genoese	Institute for Industrial Production (IIP), KIT
Thomas Hammer	Siemens AG
Prof. Dr.-Ing. Marc Hiller	Electrotechnical Institute, KIT
PD Dr. Patrick Jochem	Institute for Industrial Production, KIT
Prof. Dr.-Ing. Thomas Jordan	Institute for Nuclear and Energy Technologies, KIT
Dr. Alexander Jung	Voith Hydro Holding GmbH & Co. KG
Prof. Dr. Dogan Keles	DTU – Technical University of Denmark
Prof. Dr. Thomas Kohl	Institute for Applied Geosciences, KIT
Prof. Dr.-Ing. Thomas Kolb	Engler-Bunte-Institute, Division of Combustion Technology, KIT
Prof. Dr. Uli Lemmer	Light Technology Institute, KIT
Dr.-Ing. Marc Linder	Deustches Zentrum für Luft und Raumfahrt (DLR)
Prof. Dr. rer. nat. habil. Ulrich Maas	Institute of Technical Thermodynamics, KIT
Prof. Dr. Kay Mitusch	Institute for Economic Policy Research, KIT
Dr. Patrick Plötz	Fraunhofer Institute for Systems and Innovation Research, ISI
Prof. Dr.-Ing. Michael Powalla	Light Technology Institute, KIT
Dr. Frieder Scheiba	Institute for Applied Materials – Energy Storage Systems, KIT
Prof. Dr. Frank Schilling	Institute for Applied Geosciences, KIT
Prof. Dr. Hartmut Schmeck	Institute of Applied Informatics and Formal Description Methods, KIT
Prof. Dr.-Ing. Thomas Schulenberg	Institute for Nuclear and Energy Technologies, KIT

Name	Institute
Dr. Hanno Stagge	TenneT TSO GmbH
Prof. Dr.-Ing. Robert Stieglitz	Institute for Neutron Physics and Reactor Technology, KIT

4 Description of the Management Modules

4.1 Marketing and Information

Module Name			
Marketing and Information			
Semester	Subject	Module Supervisor	Credit Points for Module
1	Management	Prof. Dr. Martin Klarmann	6
Module Content			
Information becomes more and more important as a source of value creation for companies. This module looks at how information can be used to improve business performance in today's business environment. In the first week, the module looks at information-related topics in general, covering issues such as the implementation of information systems, the analysis of (big) data, and legal requirements surrounding the use of (customer) data in firms. In the second week, the module covers how to design and sell customer solutions. These hybrid offerings of products and services require careful analyses of customer information to work.			
Learning Results (LR)			
Participants will know: • How to set up effective information systems • Key issues surrounding the analysis of (big) data and machine learning • The boundaries to the use of information and data set by the legal environment • How to create value from information using customer solutions • How to empirically test hypotheses about sources of value creation using conjoint analysis			
Workload			
Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module)			

Controls of Success In MM 1 (4.1)	Modality of Examination	Performance and Duration of Examination	Prerequisites for Exam-participation	Examination Period	Graded
4.1.1 Designing and Selling Solutions	Examination of another kind	Presentation of Case Study, approx. 15 minutes per candidate	None	During course	Yes
4.1.2 Information Systems Management	Examination of another kind	Presentation of Case Study, approx. 15 minutes per candidate	None	During course	Yes
4.1.3 Big Data Methods	Study Achievement	None	None	-	No

4.1.4 Legal Aspects of Information	Study Achievement	None	None	-	No
Grading: The module grade shall be considered proportionally to the credits assigned to the courses.					

4.1.1 Designing and Selling Solutions

Course Name			
Designing and Selling Solutions			
Semester	Module Type	Allocated to the following Module	Lecturers
1	Compulsory (course is assigned to student by examination board)	Marketing and Information	Prof. Dr. Martin Klarmann Dr. Sven Feurer Gerald Oerter
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture	Total 90h, hereof 37,5h contact hours, 52,5h homework and self-studies	3

Overall Course Objectives

The course seeks to familiarize participants with the necessary techniques to design and sell solutions (i.e., hybrid offerings of services and products) that provide extra value to customers. These techniques are especially suited for markets where low-cost competitors from emerging markets offer products that are comparable in their performance to those of European manufacturers

Learning Targets

At the end of the course:

- Participants are able to develop customer value propositions for new offerings
- Participants can set value-based prices
- Participants can test hypotheses about what creates customer value using conjoint analysis
- Participants are able to program simple online questionnaires
- Participants are able to use Python to create experimental designs, analyze regression models, and produce simple visuals
- Participants are prepared for price negotiations in B2B markets
- Participants know the basic elements of customer-centric strategies

Course Content

- Value Creation (Monday)
- Solution Design (Tuesday)
- Value Appropriation (Wednesday)
- Negotiation for Value (Thursday)
- Customer Centricity (Friday)

Literature

Anderson, J., Kumar, N., & Narus, J. A. (2007). Value merchants: Demonstrating and documenting superior value in business markets.

Fader, P. (2012). Customer centricity: Focus on the right customers for strategic advantage. Wharton digital press.

Homburg, C., Schäfer, H., & Schneider, J. (2012). Sales excellence: Systematic sales management. Springer Science & Business Media.

Osterwalder, A., Pigneur, Y., Bernarda, G., & Smith, A. (2015). Value proposition design. Wiley.

Prerequisites for participation in course
No prerequisites
Modality of Exam
See 4.1

4.1.2 Information Systems Management

Course Name			
Information Systems Management			
Semester	Module Type	Allocated to the following Module	Lecturers
1	Compulsory (course is assigned to student by examination board)	Marketing and Information	Prof. Dr. Stefan Morana
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lectures and exercises	Total 36h, hereof 15h contact hours, 21h homework and self-studies	1,2

Overall Course Objectives
The primary objective of the course is to enable participants to understand the importance of the resource information in business and society as well as to manage information system from a socio-technical perspective. Thereby, participants of the course will be able to play a vital role at the intersection of technical and business issues, being able to bridge the gap between company's customers and end users, Line-of-Business experts and IT experts.
Learning Targets
Participants: ▪ understand the need for managing the resource information ▪ understand key concepts and implications of information systems (IS) ▪ get an overview on the different phases of the IS lifecycle ▪ know methods and techniques in order to successfully create value with IS.

Course Content
The course will cover the following topics ▪ Management of the resource information in organizations ▪ Introduction into the concept of IS from a socio-technical perspective ▪ Importance and special characteristics of the IS life cycle ▪ Methods and techniques for executing the pre-implementation, implementation, and post-implementation phases The lectures will be accompanied by hands-on exercises that will be used to review the presented material and enhance understanding.
Literature
Relevant literature will be distributed with the course materials.
Prerequisites for participation in course
No prerequisites required.
Modality of Exam
See 4.1

4.1.3 Big Data Methods

Course Name			
Big Data Methods			
Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Marketing and Information	Prof. Dr. Oliver Grothe
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture	Total 28,8h, hereof 12h contact hours, 16,8h homework and self-studies	0,96
Overall Course Objectives			
The primary objective of the course is to enable participants to understand the importance of limited information content in real data and implications for how precise we can learn from data. Furthermore, the students learn how to apply linear and slightly non-linear regression techniques using Python and also apply classification techniques.			
Learning Targets			
Participants: ▪ know what Big Data stands for.			

▪ understand basic statistical concepts of statistical learning. ▪ have a first profound understanding of regression and classification techniques. ▪ know and apply methods for the validation of results from data.
Course Content
The course will cover the following topics ▪ statistical inference ▪ statistical learning ▪ introduction to regression and classification techniques ▪ introduction to evaluation techniques The lectures will be completed by hands-on programming and data analysis exercises in Python that will be used to review the presented material and enhance understanding.
Literature
Relevant literature will be distributed with the course materials.
Prerequisites for participation in course
No prerequisites required.
Modality of Exam
See 4.1

4.1.4 Legal Aspects of Information

Course Name			
Legal Aspects of Information			
Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Marketing and Information	Prof. Dr. Indra Spiecker gen. Döhmann
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture	Total 25,5h, hereof 10,5h contact hours, 14,7h homework and self-studies	0,84
Overall Course Objectives			

The fundamental knowledge of the law governing the distribution of information supports participants in the adaptation of business strategies in today's digitalized business world. The participants will be enabled to identify and solve relevant problems from the areas of data and privacy protection in relation to business activities.

Learning Targets

Participants

- Know relevant legal argumentation skills and the general structure of laws
- Know relevant principles and argumentations in data protection law, also in comparison with U.S. law
- Understand the difference between EU and national law and its implications for data protection law
- Are able to identify relevant legal problems in data protection law and solve small cases.
- Find and discuss different legal solutions on the basis of general legal argumentation skills to data protection law problems

Course Content

Managers and project leaders involved in the development, installment and management of digitalized products and services need a basic knowledge of data protection law in order to avoid costly decisions. This is even more important as the new EU-wide data protection regulation (GDPR) provides for heavy sanctions against privacy violators enforced by independent agencies and data subjects alike.

The lecture deals with the basics of data protection law as structured within the EU: What are relevant data protection regulations? In what respect is (EU) law influencing the national regulatory systems? What are the core issues regulated within the EU-General Data Protection Regulation? What do businesses dealing in digitalized worlds have to be aware of? The lecture aims at a general understanding of the mechanisms of European data protection law with some excursions into U.S. law. Students will learn what to pay attention to when personal data is involved in business transactions. This knowledge, however, can only be rightly understood and applied, if students are aware of the general legal argumentation structures. Therefore, these will be dealt with, also.

Literature

- Simitis/Hornung/Spiecker gen. Döhmann (Eds.), Kommentar Datenschutzrecht, 2019
- Tinnefeld/Buchner/Petri, Einführung in das Datenschutzrecht, 2017

Prerequisites for participation in course

Basic knowledge/practical experience in European Law as well as data protection law would be helpful but is not required

Modality of Exam

See 4.1

4.2 Finance and Value

Module Name			
Finance and Value			
Semester	Subject	Module Supervisor	Credit Points for Module
1	Management	Prof. Dr. Martin E. Ruckes	6

Module Content

The module "Finance and Value" consists of three courses related to the creating of value in business environments: Management Accounting, Financial Accounting, and Strategic Financial Management. Applying the acquired knowledge in case studies round out the module.

The module shows how value is created in businesses by the careful quantitative assessment of the business environment and the identification of valuable opportunities, a thoughtful system of implementing business opportunities that coordinates activities by providing clear metrics for value creation, and the thorough understanding about how business decision translate into financial statements, often the firm's most important channel of communication to outside stakeholders.

Using the knowledge acquired in the courses in case studies reveals how to apply important business concepts to real world situations.

Learning Results (LR)

After successful completion of the module, participants

- are able to analyze business environments and to identify and finance value creating business opportunities,
- are in a position to implement business opportunities by designing an internal accounting system that coordinates the firm's business activities,
- understand how business decisions are communicated to outside stakeholders via a system of financial statements.

Workload

Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module)

Controls of Success In MM 2 (4.2)	Modality of Examination	Performance and Duration of Examination	Prerequisites for exam-participation	Examination Period	Graded
4.2.1 Management Accounting	Written examination	120 minutes	none	At the end of the module	Yes
4.2.2 Financial Accounting					
4.2.3 Strategic Financial Management					

4.2.4 Case Studies	Examination of another kind	Presentation of Case Study, Approx. 15 minutes per candidate	Written draft and Presentation of Case Study	During course	Yes
Grading: The module grade shall be considered proportionally to the credits assigned to the courses.					

4.2.1 Management Accounting

Course Name			
Management Accounting			
Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Finance and Value	Prof. Dr. Anja Kern
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 54h, hereof 22,5h contact hours, 31,5h homework and self-studies	1,8

Overall Course Objectives

Participants get an overview of accounting and controlling topics. They understand specific accounting and controlling topics, they are able to apply these to assignments and they are able to position these in the context of their own work.

Learning Targets

Participants gain an understanding of key concepts and techniques of management accounting, are able to use relevant costs for decision making, and are in the position to purposeful apply instruments for planning and control.

Course Content

Participants will learn about:

- Product costing concepts
- Cost allocation: between departments and from activities to products
- Job costing
- Process costing
- Short-term decision making, cost-volume-profit analysis
- Strategic investment decisions
- Budgeting and variance analysis
- Responsibility accounting
- Performance management

Literature

Cost Management by M. Wouters, F. Selto, R. Hilton, and M. Maher, 2012, McGraw-Hill Higher Education, ISBN-13 9780077132392
Prerequisites for participation in course
Knowledge about principles of financial accounting as well as discounting of future cash flows is desirable, but not obligatory required.
Modality of Exam
See 4.2

4.2.2 Financial Accounting

Course Name			
Financial Accounting			
Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Finance and Value	Dr. Jan-Oliver Strych
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 54h, hereof 22,5h contact hours, 31,5h homework and self-studies	1,8

Overall Course Objectives

The course objective is to understand and critically assess financial statements. Participants know about the main principles and concepts of financial accounting used to prepare the balance sheet and income statement. Financial statements are analyzed to reveal profitability, identify cash flows and track the operating cycle.

Learning Targets

Participants are able to

- understand the balance sheet, income statement and statement of cash flow.
- track corporate decision-making into financial statements.
- apply financial statement analysis.

Course Content

This course provides participants with an understanding of the key financial statements and its underlying accounting principles. It is shown how investment and financing decisions affect the balance sheet and the income statement. Financial statement analysis is applied to measure a firm's liquidity, operational efficiency, and profitability.

Literature

Penman, S.H. (2013): Financial Statement Analysis and Security Valuation, 5th ed., McGraw Hill. Hawawini, G. and Viallet, C. (2011): Finance for Executives, 4th ed., South-Western Publishing.
Prerequisites for participation in course
No prerequisites.
Modality of Exam
See 4.2

4.2.3 Strategic Financial Management

Course Name			
Strategic Financial Management			
Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Finance and Value	Prof. Dr. Martin E. Ruckes
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 54h, hereof 22,5h contact hours, 31,5h homework and self-studies	1,8

Overall Course Objectives

The course objective is to understand the main principles of finance and thereby be able to analyze corporate investment and financing decisions, such as

- valuation of risky cash flows and its application to corporate investments,
- financing choices and firm valuation.

Learning Targets

Participants

- are placed in a position to judge corporate investment projects from a financial point of view.
- gain a thorough comprehension of the main principles of business finance.
- are able to assess the value of business enterprises.

Course Content

This course begins with an overview of the environment in which financial decisions occur and of the financial information available. Investment rules, such as the net present value rule are applied to value securities and to capital budgeting. It follows the valuation of risky cash flow streams resulting from corporate projects or entire firms. After discussing the instruments of long-term financing, the decision to payout capital are addressed.

Literature

Hawawini, G. and Viallet, C. (2015): Finance for Executives, 5th ed., South-Western Publishing
Prerequisites for participation in course
No prerequsites required.
Modality of Exam
See 4.2

4.2.4 Case Studies

Course Name			
Case Studies			
Semester	Module Type	Allocated to the following Module	Lecturers
1	Compulsory (course is assigned to student by examination board)	Finance and Value	Prof. Dr. Martin E. Ruckes Dr. Jan-Oliver Strych
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Group Projects	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6

Overall Course Objectives
Practice the valuation of a firm by applying concepts and methods from finance and accounting.
Learning Targets
Participants: ▪ perform business analysis to identify the firm's profit drivers and key risks, ▪ use financial data and other information to evaluate the current and past performance of the firm ▪ forecast a firm's future in terms of cash flows and/or earnings to practice a firm valuation under a pessimistic or optimistic view.
Course Content
▪ The case study centers around the valuation of a company and its equity using publicly available information. ▪ It is a group project where group assignments are available at the sharepoint. ▪ Each group makes a case for buying or selling the company's stock. This is done by performing a firm valuation and presenting it in class.
Literature
▪ Recent annual report of ase companies

▪ Presentation of case companies
Prerequisites for participation in course
▪ Participation in the course *Financial Accounting* and *Strategic Financial Management* is mandatory. ▪ Knowledge from both courses is necessary to perform the case study.
Modality of Exam
See 4.2

4.3 Decisions and Risk

Module Name			
Decisions and Risk			
Semester	Subject	Module Supervisor	Credit Points for Module
2	Management	Prof. Dr. Stefan Nickel	6

Module Content
The module has the goal to make the students familiar with different facets of quantitative decision making comprising general model building, risk assessment, random effects, and multiple agents. The module is divided into four courses: “Decision Modeling” serves as an elementary class (including software lab applications) targeting the development of basic quantitative modeling knowledge. Building upon this course, “Robust and Stochastic Optimization” and “Risk Aware Decisions” then focus on bridging the gap to reality by introducing different types of uncertainty and risk-awareness considerations into the models. Finally, “Interactive Decisions” analyzes from a game-theoretic point of view how decisions are made in the presence of multiple decision makers each focusing on individual interests.
Learning Results (LR)
Participants ▪ know and explain basic modelling techniques for quantitative decision making ▪ are capable of extending decision models to real world conditions involving different uncertainty representations (e.g., risk concepts, stochasticity) as well as practice-oriented features (e.g., industrial applications) ▪ apply decision support software systems to solve quantitative decision and optimization problems ▪ know and estimate game-theoretic effects in interactive decision making processes
Workload
Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module)

Controls of Success In MM 3 (4.3)	Modality of Examination	Performance and Duration of Examination	Prerequisites for exam-participation	Examination Period	Graded
4.3.1 Decision Modeling	Written examination	120 minutes	Study achievement: Case Study	At the end of the course week	Yes
4.3.2 Risk Aware Decision					
4.3.3 Interactive Decisions					
4.3.4 Robust and Stochastic Optimization					
Grading: The module grade shall be considered proportionally to the credits assigned to the courses.					

4.3.1 Decision Modeling

Course Name			
Decision Modeling (+Computer Tutorials)			
Semester	Module Type	Allocated to the following Module	Lecturer
2	Compulsory (course is assigned to student by examination board)	Decisions and Risk	Prof. Dr. Stefan Nickel
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lectures and exercises	Total 54h, hereof 22,5h contact hours, 31,5h homework and self-studies	1,8

Overall Course Objectives

The course has the goal to make the students familiar with theoretical and practical modelling techniques used for supporting quantitative decision making. Students gain knowledge in modeling systems behavior in specific industrial applications. Moreover, the usage of computers in practical applications of quantitative decision-making problems is highlighted in the software laboratory. An important benefit lies in the ability to assess and estimate general possibilities and fields of usage of decision support software for solving decision/optimization tasks in practice.

Learning Targets

Participants

- know and explain basic modelling techniques for quantitative decision making
- are able to formalize decision and optimization problems using decision support models
- are capable of extending decision models to real world conditions in order to achieve advanced models for industrial applications
- apply decision support software systems to solve quantitative decision and optimization problems
- know the limits of computer-supported problem solving based on complexity considerations

Course Content

Many real-life problems can be described and solved by decision support models. The course "Decision Modelling" tackles the modelling of decision and optimization problems by means of formal modelling methods and illustrates how these techniques can be utilized to solve real-world problems in business and industry applications. To this end, the course gives a concise discussion of modelling possibilities for quantitative decision making where the general goal is to design and operate a system under scarce resources.

With respect to a wide range of application possibilities, different modelling concepts are introduced with different focuses: mathematical programming as a general method for modelling and solving problems from different domains, queueing systems for analysing waiting times and lines in queueing networks, multi-criteria concepts as possibilities to integrate multiple stakeholders into the decision making process, and scheduling as a special example of application-driven modelling.

Additionally, the course consists of a software laboratory part where students get on hands with state-of-the-art IT tools for mathematical modelling, optimization, simulation, and decision support. Fundamental problems from supply chain management, logistics, and health care are first introduced and modelled theoretically; afterwards these models are solved for exemplary data

settings with computer software. As a result of the complexity of real-world settings, a final focus of the course is put on practical issues and limits of the presented modelling approaches as well as on a research outlook.
Literature
▪ Reid, Sanders: Operations Management - An integrated approach, Wiley, 2007 ▪ Chase, Aquilano, Jacobs: Production and Operations Management: Manufacturing and Services, 8th edition, McGraw-Hill, 1998 ▪ Vercellis: Business Intelligence - Data Mining and Optimization for Decision Making, Wiley, 2009 ▪ Barbosa-Póvoa, Corominas, Miranda: Optimization and Decision Support Systems for Supply Chains, Springer, 2017 ▪ Pinedo: Scheduling – Theory, Algorithms, and Systems, 2nd edition, Springer, 2012 ▪ Stidham: Optimal Design of Queueing Systems, CRC Press, 2009 ▪ Ehrgott: Multicriteria Optimization, Springer, 2000 ▪ Sarker, Newton: Optimization Modelling - A practical approach CRC Press, 2008
Prerequisites for participation in course
Firm knowledge of the basics of mathematics and statistics as taught in Bachelor and Master university programs is expected.
Modality of Exam
See 4.3

4.3.2 Risk Aware Decisions

Course Name			
Risk Aware Decisions (+Case Studies + Finance)			
Semester	Module Type	Allocated to the following Module	Lecturer
2	Compulsory (course is assigned to student by examination board)	Decisions and Risk	Dr.-Ing. Iris Heckmann
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lectures, exercises and case study	Total 36h, hereof 15h contact hours, 21h homework and self-studies	1,2
Overall Course Objectives			
Each process and decision in business is prone to uncertainty. Wrong assessments and misjudgments may lead to unforeseen developments, which may have important consequences when detected (too) late. Accordingly, uncertainty needs to be continuously monitored and managed. Along with an increasing number of relevant uncertainties, the importance given to risk considerations has grown significantly in the recent decades. As a result, we have observed this term being applied to many different areas. Particularly, in supply chain management, researchers have felt the need to somehow capture risk in optimization models built for supporting the decision-making processes. Due to the increasing complexity and interrelation of modern			

networks, the type and nature of uncertain developments together with the impact of an action have become hard or even impossible to predict. Additionally, major disruptions like the 2011 flooding in Thailand, the eruption of the Icelandic volcano, or labor strikes, revealed a lack of preparedness of managers towards uncertain developments in general.

The main goal of this course is to make the students familiar with the challenges related to the decision-making process under risk as well as to available decision-support models.

Learning Targets

According to the overall course objectives, participants' learning targets include the following aspects:

- Knowledge of real case situations and cascading conditions that are referred to as "risk"
- Understanding of the concept risk as it is used in different application domains
- Knowledge of different quantification metrics – their definition as well as advantages and disadvantages of their application
- Knowledge of basic risk-aware modelling principles used to formulate decision-support models

Course Content

The course is divided into two parts. During the first part the students are provided with a bundle of real cases that demonstrates how disruptive events can result in major disruptions all referred to as risk. By the means of these real case situations, we explain the diversity of cascading effects that evolve over time and over networks. Corresponding, we define concepts strongly related to the concept of risk, define the concept risk itself and offer first modelling principles that have the ability to capture risk. At the end of the first part, the students have a broad understanding of risk and accompanying concepts.

In the second part of the course, we introduce existing decision-support models and discuss their usefulness with respect to their level of risk-awareness. Models are introduced with different application focus, e.g. facility location and allocation models, inventory models, network flow models, and with varying underlying methodology, e.g. stochastic programs, robust and chance-constrained models.

Literature

- Bernstein, P.L. (1998). Against the Gods: The remarkable Story of Risk. New York: John Wiley.
- Breakwell, G.M. (2007). The psychology of risk. Cambridge: Cambridge University Press.
- Chopra, S. and P. Meindl (2004). Supply Chain Management. New York: Pearson Education Inc.
- Ericson, C.A. (2005). Hazard Analysis Techniques for System Safety. Hoboken, NJ: John Wiley & Sons, Inc.
- Sheffi, Y. (2005). The resilient enterprise: Overcoming Vulnerability for Competitive advantages, Vol 1 of MIT Press Books. Cambridge: MIT Press.
- Simchi-Levi, D. (2010). Operations rules. Cambridge: MIT Press.

Prerequisites for participation in course

Firm knowledge of the basics of mathematics and statistics as taught in Bachelor and Master university programs is expected.

Modality of Exam

See 4.3

4.3.3 Interactive Decisions

Course Name			
Interactive Decisions			
Semester	Module Type	Allocated to the following Module	Lecturer
2	Compulsory (course is assigned to student by examination board)	Decisions and Risk	Prof. Dr. Clemens Puppe
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lectures and exercises	Total 54h, hereof 22,5h contact hours, 31,5h homework and self-studies	1,8

Overall Course Objectives

The objective of the course is to provide a rigorous introduction to game theory and its many applications in economics and the management sciences. The participants should also be made aware of the limitations of the classical approaches to the modelling of strategic interaction and be introduced to recent developments in behavioral economics.

Learning Targets

Participants understand the fundamental concepts and formal results of game theory in a mathematically rigorous way. The participants are able to infer the behavioral implications of game theory and can apply basic game theoretic models and concepts in real life contexts.

Course Content

Dominated and dominant strategies, Nash equilibrium, Prisoners' dilemma, Dynamic games and game trees, Subgame-perfect equilibrium, Games of incomplete information, Expected utility theory, Bayesian Nash equilibrium, Auction theory, Experimental game theory, Ultimatum and dictator games, Behavioral economics, Level-k thinking.

Literature

- R. Gibbons, A Primer in Game Theory, 1992.
- D. Kreps, Notes on the Theory of Choice, 1988.
- R. Pindyck & D. Rubinfeld, Microeconomics, 9th Edition, 2018.

Prerequisites for participation in course

No formal prerequisites, but basic knoweldge of proabability theory and calculus will be helpful.

Modality of Exam

See 4.3

4.3.4 Robust and Stochastic Optimization

Course Name			
Robust and Stochastic Optimization			
Semester	Module Type	Allocated to the following Module	Lecturers
2	Compulsory (course is assigned to student by examination board)	Decisions and Risk	Prof. Dr. Steffen Rebennack Dr. Marcel Sinske
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lectures and exercises	Total 36h, hereof 15h contact hours, 21h homework and self-studies	1,2

Overall Course Objectives

The course provides an up-to-date treatment of important aspects of optimization under uncertainty by applying techniques from robust and stochastic optimization. There are some connections with almost all other courses.

Learning Targets

Participants

- learn to understand how uncertainty can effect decisions in optimization problems
- become able to decide when uncertainty should be modeled in optimization problems
- gain knowledge in modeling uncertainties with robust and stochastic optimization techniques
- understand the advantages and disadvantages of robust and stochastic optimization
- are able to interpret solutions obtained by robust or stochastic optimization problems

Course Content

Uncertain decision problems, robust optimization, interval uncertainty, polyhedral uncertainty, stochastic optimization, deterministic equivalent, extensive form, scenario-trees, scenario generation, value-of-the-stochastic-solution, multi-stage problem formulation, chance-constraints, stochastic dynamic programming.

Literature

- “Robust Optimization”, by Aharon Ben-Tal, Laurent El Ghaoui and Arkadi Nemirovski, Princeton Series in Applied Mathematics, 2009
- “Introduction to Stochastic Programming”, by John R. Birge and François Louveaux, Springer Series in Operations Research and Financial Engineering, 2nd ed. 2011

Prerequisites for participation in course

Basic knowledge about Operations Research and basic familiarity with elementary probability theory and statistics.

Modality of Exam

See 4.3

4.4 Corporate Innovation and Intrapreneurship

Module Name			
Corporate Innovation and Intrapreneurship			
Semester	Subject	Module Supervisor	Credit Points for Module
3	Management	Prof. Dr. Jordi Vinaixa Serra	6

Module Content

The module Corporate Innovation and Intrapreneurship takes place in Spain. All lectures take place at the ESADE (Escuela Superior de Administración y Dirección de Empresas) business school in Barcelona.

The module sees innovation as integrated system. The participants identify new models and concepts of the production of knowledge, Open Innovation, collaborative networks, the development of innovation networks and governance systems. Also the area Corporate Innovation is analyzed, the participants get to know various models of innovation and strategic focusing (linear models, etc.). The module conveys abilities for the realization of innovation regarding processes, modules and organizational structures. A further focus thereby is the measurement of innovation, indicators and Performance Measurement Systems. The participants rate and generate new approaches in order to allow innovations in an entrepreneurial context and calculate the efficiency of these approaches.

Learning Results (LR)

LR-1: Knowledge of the various approaches of innovation management as a whole including new models of knowledge creation, open innovation and joint networks.

LR-2: Various innovation models (linear models, open innovation, etc.) and applications based on suitable methods and processes (portfolio strategy, emphatic design, QFD, prototypes, etc.).

LR-3: Synthesis of the gained knowledge in innovation management based on case studies.

Control of Success

Written module examination of 90 minutes; the module grade is the grade of this examination.

Workload

Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module)

Controls of Success In MM 4 (4.4)	Modality of Examination	Performance and Duration of Examination	Prerequisites for exam-participation	Examination Period	Graded
4.4.1 Corporate Entrepreneurship	Written examination	90 minutes	None	At the end of the second course week	Yes
4.4.2 Entrepreneurial Leadership					

4.4.3 Strategic Innovation Management					
4.4.4 Opportunity Development: Design Thinking					
4.4.5 Exploring the Opportunity: Technology and Markets					
4.4.6 Pitching Business Ideas					
4.4.7 Creating Value through Business Models					
4.4.8 New Product Development and Service Innovation					
4.4.9 Measuring Innovation: Innovation Balanced Scorecard					
4.4.10 Pitching Business Models					
Grading: The module grade shall be considered proportionally to the credits assigned to the courses.					

4.4.1 Corporate Entrepreneurship

Course Name			
Corporate Entrepreneurship			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Prof. Dr. Jordi Vinaixa Serra
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Case Studies	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6
Overall Course Objectives			

This course seeks to acquaint and inspire the participants with the vibrant world of innovation and corporate entrepreneurship. In today's competitive landscape, companies try to compete and build a competitive advantage through innovation. This innovation has to give rise to new products and/or services that will be the basis of new business. This is what corporate entrepreneurship is all about.

Starting up a new business, either independent or within an already established company is an adventure that demands not only resourcefulness, but also hard work and persistence. The course zeros in on critical milestones and challenges faced by entrepreneurs and entrepreneurs in their start-up journey, from inception through growth and exit. It seeks to equip the participants in the Program with concepts, frameworks, and insights into the process of identifying an innovation based business idea and turning it into a successful new venture.

Through a wealth of cases, examples, and readings, we will explore the similarities and differences between entrepreneurs and entrepreneurs, and we will see if we can learn something from those that have establish and managed and independent new venture. We will work on the dimensions and dynamics of the entrepreneurial process; assist the participants in the identification of ideas for new ventures and the assessment of their potential to become real business opportunities; guide them through the ideas' development into successful business models; and equip them with knowledge and tools to develop the business plan of the new venture and to negotiate either with the company management, or with investors or with any other stakeholder that might control any of the resources needed for the project.

Learning Targets

Participants

- gain competencies of various innovation modules (linear modules, open innovation, etc.).
- learn the application on the basis of fit methods and processes (Portfolio Strategy, Emphatic Design, QFD, Prototypes, etc.)

Course Content

1. The Process of New Venture Creation
2. From the Idea to the Business Model
3. Opportunity Assessment. The Business Plan
4. Entrepreneurship and intrapreneurship: similarities and differences
5. Team Pitching of Business Ideas

Literature

- Kim, W.C. & Maubourgne, R. (2005). Blue Ocean Strategy: From Theory to Practice. California Management Review, 47 (3), 104-121.
- J. L. Keller (2005). *Manage Like an Entrepreneur*. Harvard Management Update (Art. Reprint U0501B).

Prerequisites for participation in course

No prerequisites required.

Modality of Exam

See 4.4

4.4.2 Entrepreneurial Leadership

Course Name			
Entrepreneurial Leadership			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Amy Leaverton
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Exercises	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6

Overall Course Objectives

- Self-Awareness: Introduce the importance of Self Awareness issues in today's global business environment in order to succeed as an entrepreneur.
- Framework for the Development of Leadership Skills: Consider a framework and specific skills for managing oneself and entrepreneurial teams in the midst of rapid change.
- The Art of Persuasion: Provide data via assessment tools and theoretical input for the participant to reflect upon and identify his/her own communication, influencing styles, and emotional Intelligence competencies, as well as those of others, and how to apply this knowledge to the creation and management of entrepreneurial teams.
- Move beyond general discussions of values to a focus on how specific values enable you and your team to deliver results with a specific focus on what it means to value teamwork

Learning Targets

Currently in revision

Course Content

Self-Awareness: Why is it so fundamental for leadership? Because we cannot presume to lead others if we do not have our own houses in order. If we have clarity on our strengths and weaknesses, we can reduce the chaos in our thinking; we can learn to delegate and stick to capitalizing on our strong points rather than waste energy on developing weak points. If we do this, we save up our energy for our biggest challenges: focusing on our team, our strategy, our innovation, and our networking with others in the business community. These should be any leader's strong points in addition to good communication skills, inspirational influence and emotional intelligence.

In order to lead entrepreneurial teams, good leaders need to be like good coaches; they need to be self-aware, to be coherent with their examples, in other words, a good example; they need to encourage people to take ownership of their dreams by guiding them through step by step successes in order to build their self-confidence, thus helping to clear away some of the barriers to reaching one's maximum potential. A good entrepreneurial leader is like a river's flow: She provides a constant influx of forward moving energy.

Literature

▪ The Fifth Discipline, Peter Senge ▪ The Leadership Mystique, Manfred Kets de Vries
Prerequisites for participation in course
Some experience and knowledge in marketing and finance are desirable, but not obligatory required.
Modality of Exam
See 4.4

4.4.3 Strategic Innovation Management

Course Name			
Strategic Innovation Management			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Elena Bou
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Exercises	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6
Overall Course Objectives			
This course presents ESADEs innovation framework going from the more holistic approach to its corporate dimension. It aims to equip students with an understanding of the main issues in the management of innovation and an appreciation of the relevant skills needed to manage innovation at both strategic and operational levels. It provides evidence of different approaches based on real world examples and experiences of leading organizations.			
Learning Targets			
Participants ▪ gain competencies of the various approaches of innovation management as a whole. ▪ get to know new modules of knowledge creation, open Innovation and shared networks. ▪ gain the competency to build innovation networks and leadership systems.			
Course Content			
1. Management & Innovation 2. Innovation in the firm: Innovation Paradigms			

3. Innovation in the firm: Strategy 4. Innovation in the firm: from the lab to the market 5. Innovation in the firm: organizing for innovation 6. Collaborative innovation: Open Innovation 7. Collaborative innovation: networks of innovation 8. Innovation Systems: macro perspectives
Literature
None
Prerequisites for participation in course
Some experience and knowledge in marketing and finance are desirable, but not obligatory required.
Modality of Exam
See 4.4

4.4.4 Opportunity Development – Design Thinking

Course Name			
Opportunity Development: Design Thinking			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Enric Segarra Costa
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Exercises	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6
Overall Course Objectives			
The aim of this program is first to take you out of your comfort zone and to train you to think in a different way to how the majority of us have been trained to cope with problems. To achieve that we will start by learning how to look at things differently (we will see the world through new glasses) and to break patterns and mental paradigms deeply rooted in our minds which under normal circumstances allow us to have a stable, comfortable, efficient and organized life but are not of much help – rather quite the reverse because they block, restrict and even strangle us, when the world surrounding us changes dramatically. Second, we will understand where companies get their ideas from (the six sources of ideas and hence of innovation) and we'll discover what the secret to spark imagination is!			

Third, we will learn how Design Thinking (a methodology broadly used by creative people and by a myriad of companies like P&G, GE, HP among others and being promoted by governments such as Finland, Singapore, etc, that we will use to complement the traditional Analytical Thinking) might help us to cope with business problems of any kind more creatively that converts trade-offs (all those situations for which we say there is no solution or that they are just impossible!) into trade-ons exploring a new range of unplanned possibilities.
Learning Targets
Participants synthesize on the basis of the acquired competencies innovation management on the basis of case studies.
Course Content
Because the world of business is no longer characterized by stable and predictable problems which lend themselves readily to analysis; a new set of skills is required to generate sustained growth. Today to be competitive and survive you have to be more creative than ever. Therefore, learning how to be creative is without doubt one of the great challenges we face. But we might wonder how?! Learning how creative people look at problems and constraints as challenges not as enemies (with excitement not with fear as the majority of us do), is the way and collaborative integrative thinking (not just analytical thinking), the lever for achieving that goal.
Literature
▪ GameStorming. A Playbook for Innovators, Rulebreakers and Changemakers. Dave Gray, Sunni Brown, James Macanufo. O'Reilly, July 2010. ▪ Purple Cow: Transform your business by being remarkable. Seth Godin. Portfolio a member of Penguin Group, 2009. ▪ The Back of the Napkin. Dan Roam. Penguin Group 2008.
Prerequisites for participation in course
None
Modality of Exam
See 4.4

4.4.5 Exploring the Opportunity: Technology and Markets

Course Name			
Exploring the Opportunity: Technology and Markets			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Xavier Ferrás

Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Exercises	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6

Overall Course Objectives

This course is aimed to understand the dynamics of innovation inside firms, as a phenomenon of continuous tension between market-pull and technology-push forces. Insights about market creation from new, disruptive technologies, will be provided.

Learning Targets

Participants will be able to

- understand the competitive environment and see how it shapes the corporate strategy from an innovation point of view.
- discuss the historical evolution of the innovation phenomenon, from techpush to market-driven approaches, and finally to systemic points of view.
- understand the logics of technological innovation and its interaction with market development, as a continuous learning process.
- discuss how to deal with disruptive technologies.

Course Content

- Features of the new competitive environment
- Expansion of the innovation phenomena (from technology-push and marketpull to ecosystem & evolutive economics approaches)
- The strategy loop: building upon technological competences or/and market needs
- Dynamics of technological innovation: Foster S-curves and its relationship with product development and market creation
- Dealing with disruption: how to build markets when they don't exist yet
- Innovation in market-driven industries and sources of new opportunities in mature industries

Literature

- Managing Technology and Innovation for Competitive Advantage, V.K Narayanan, Prentice Hall 2001.
- Mastering the Dynamics of Innovation: how companies can seize opportunities in the face of technological change. James M. Utterback. Harvard Business School Press, 1994.
- The Innovator's Dilemma. Clayton M. Christensen. Harper Business 2003.

Prerequisites for participation in course

Some experience and knowledge in marketing and finance are desirable, but not obligatory required.

Modality of Exam

See 4.4

4.4.6 Pitching Business Ideas

Course Name			
Pitching Business Ideas			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Prof. Dr. Jordi Vinaixa Serra
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Case Studies	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6
Overall Course Objectives			
To improve participant's presentation skills so they can obtain the resources required for the implementation of their project.			
Learning Targets			
Participants will have to present their ideas in a convincing way in order to obtain the resources required for the implementation of their project.			
Course Content			
Presentation of Business Models developed for the Business Ideas, worked out during the module.			
Literature			
K.D. Elsbach (2003), *How to Pitch a Brilliant Idea*, Harvard Business Review, 117-123.			
Prerequisites for participation in course			
Some experience and knowledge in marketing and finance are desirable, but not obligatory required.			
Modality of Exam			
See 4.4			

4.4.7 Creating Value through Business Models

Course Name			
Creating value Through Business Models			
Semester	Module Type	Allocated to the following Module	Lecturer

3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Luis Vives
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Exercises	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6

Overall Course Objectives
The course zeros in on critical milestones and challenges faced by entre/intrapreneurs in the process of business model development. It seeks to equip you with concepts, frameworks, and insights that allow you to create business models anew or diagnose and transform existing ones.
Learning Targets
Currently in revision
Course Content
This course seeks to acquaint and inspire you with the vibrant world of business models. Creating, transforming, and competing through business models demands not only resourcefulness, but also hard work and persistence, as well as an ongoing alignment with a company's strategy and efforts to organize essential activities accordingly. Thus, business models as a domain of knowledge and entrepreneurial and executive action lie at the intersection of Strategy, Organization, and Entrepreneurship.
Literature
▪ Vives, L. & Svejenova, S. (2012, forthcoming). Business Models: Towards an Integrative Framework. Management Research ▪ McGrath, R. G. (2011). "When your business model is in trouble", Harvard Business Review, Vol. 89, No. 1/2, pp. 96-98 ▪ Kim, W.C. & Mauborgne, R. 2005. Blue Ocean Strategy: How to Create Uncontested Market Space and Make Competition Irrelevant. Harvard Business Press
Prerequisites for participation in course
Some experience and knowledge in marketing and finance are desirable, but not obligatory required.
Modality of Exam
See 4.4

4.4.8 New Product Development and Service Innovation

Course Name			
New Product Development and Service Innovation			
Semester	Module Type	Allocated to the following Module	Lecturer

3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Ivanka Visnjic
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Case Studies	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6

Overall Course Objectives

The aim of the course is to enhance participants' understanding of innovations of companies that offer services or solutions (product-service bundles). The focus on service and product/service providers is motivated by the fact that traditional innovation courses mainly take a perspective of 'pure' product providers and their innovation practices, thereby neglecting dominant service part of the economy (services account for more than 70% of economic activity globally).

Learning Targets

The learning approach will be a combination of theoretical presentations (e.g. participants will learn about new technological trends that lead towards service driven economy), application of recently developed frameworks (e.g. we will learn to apply frameworks that help understand ecosystem-driven innovation approach or experiential service design) and we will discuss recent developments and cases and test our thinking in a number of exercises.

The teaching approach is designed to foster active, experiential learning in the classroom. Interested participants will be challenged to expand their knowledge beyond class-work through self-directed learning based on recommended readings.

Course Content

We will be discussing most recent innovation practices in the world that is increasingly turning towards services.

Where does innovation potential come from?

Global, technology led trends and impact on service-driven firms

Understand innovations of consumer service providers (e.g. Google)

- Innovating design of experiential services
- Digitalization and 'smart services'

Understand innovations of complex service and solution providers (e.g. IBM)

- Servitization of product firms

Business model and service innovations in the ecosystem

Literature

- Cusumano, M. "Staying Power: Six Enduring Principles for Managing Strategy and Innovation in an Uncertain World", Oxford University Press, 2010.
- Chesbrough, H. "Open Services Innovation: Rethinking Your Business to Grow and Compete in a New Era", John Wiley and Sons, 2011

Prerequisites for participation in course

Some experience and knowledge in marketing and finance are desirable, but not obligatory required.
Modality of Exam
Written module examination of 90 minutes; the module grade is the grade of this examination.
Prerequisites for participation at exam and/ or for acquisition of credit points
No prerequisites required.

4.4.9 Measuring Innovation: Innovation Balanced Scorecard

Course Name			
Measuring Innovation: Innovation Balanced Scorecard			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Miguel Angel Heras
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Exercises	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6

Overall Course Objectives

At a time of great economic volatility, the key priority of any management team is the excellent, flexible and consistent implementation of the company's strategy, in particular its innovation strategy. According to a recent survey, 84% of executives consider innovation as a key lever for future recovery.

Different studies have shown that less than 10% of correctly formulated strategies are successfully implemented, and that the cause of business failure lies not in the design of the strategy but in its poor implementation. The logical conclusion is that execution is more important than a good vision. In this context, good implementation of innovation strategy through a system of strategic and operational indicators is vitally important.

Learning Targets

Participants

- develop the concept of a performance measurement system or scorecard as a tool for communicating and implementing an innovation strategy at all levels of an organization.
- study innovation strategy maps and examine how they fit into the general strategic map.
- develop the concept of a performance measurement system or scorecard as a tool for communicating and implementing an innovation strategy at all levels of an organization.
- study innovation strategy maps and examine how they fit into the general strategic map.

Course Content
▪ The need for measurement ▪ Implementation of innovation strategy ▪ The innovation pipeline ▪ The balanced scorecard for innovation ▪ Innovation strategy map ▪ Key performance indicators for innovation ▪ Strategic and operational innovation risk
Literature
▪ Davila, A, Epstein, M. and Shelton, R. (2006.), Making Innovation Work. How to manage it, Measure it and Profit from it. New Jersey, Prentice Hall. ▪ Kaplan, R.S. and Norton, D.P. (2008), The Execution Premium. Linking Strategy to Operations for Competitive Advantage. Boston, Massachusetts: Harvard Business School Publishing. ▪ Parmenter, D. (2010), Key Performance Indicators. Developing, Implementing, and Using Winning KPIs. New Jersey: John Wiley & Sons.
Prerequisites for participation in course
Some experience and knowledge in marketing and finance are desirable, but not obligatory required.
Modality of Exam
Written module examination of 90 minutes; the module grade is the grade of this examination.
Prerequisites for participation at exam and/ or for acquisition of credit points
No prerequisites required.

4.4.10 Pitching Business Models

Course Name			
Pitching Business Models			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Corporate Innovation and Intrapreneurship	Prof. Dr. Jorid Vinaixa Serra
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and Exercises	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6

Overall Course Objectives
To improve participant's presentation skills so they can obtain the resources required for the implementation of their project.
Learning Targets
Participants will have to present their ideas in a convincing way in order to obtain the resources required for the implementation of their project.
Course Content
Presentation of Business Models developed for the Business Ideas, worked out during the module.
Literature
K.D. Elsbach (2003), *How to Pitch a Brilliant Idea*, Harvard Business Review, 117-123.
Prerequisites for participation in course
Some experience and knowledge in marketing and finance are desirable, but not obligatory required.
Modality of Exam
Written module examination of 90 minutes; the module grade is the grade of this examination.
Prerequisites for participation at exam and/ or for acquisition of credit points
No prerequisites required.

4.5 Stragegy and People

Module Name			
Strategy and People			
Semester	Subject	Module Supervisor	Credit Points for Module
3	Management	Prof. Dr. Petra Nieken	6

Module Content

In today's rapidly changing business environments managers constantly face new challenges regarding business strategies while at the same time they have to ensure to keep their employees motivated and committed to the companies' goals. The majority of companies have explicitly HR driven strategies as the motivation of their employees, their commitment and their creativity are core factors for the company's success.

The module "Strategy and People" combines business strategy and corporate law with current challenges of managing organizations, human resource strategy, and leadership concepts. It introduces students to the overall process of strategic management such as strategy formulation, analysis and evaluation. Students learn how to identify and analyze sources of competitive advantage and formulate strategies for different company levels. In a second step, students get insights into business and corporate law including corporate governance and compliance issues that shape economic decisions. In a third step, strategic HR Management shows how strategic decisions are linked to HR practices as it is crucial that the employees understand and support the company's goals. Understanding how individuals and teams behave within a company and how incentive systems and performance measurement influence performance will be main topics of this module. The impact of digital transformation, global teams and diversity a well as selected leadership concepts will be discussed and practical training will be provided.

The module provides evidence based knowledge about core tasks of each manager. Game theoretic elements, behavioral approaches as well as evidence based management concepts and data-driven approaches provide a structured and rigorous framework that enables the students to apply tools and concepts to a wide variety of business situations. Case studies and class room experiments ensure a hands-on approach in handling complex information and datasets that guarantees a strong link to practice. After the course, students will be able to analyze and shape strategy as well as implement it while ensuring to keep their employees motivated in a fast changing environment.

Learning Results (LR)

LR 1: Understanding of central concepts of strategic management, strategy planning and implementation. Knowledge of corporate and business law and its impact on business strategy.

LR 2: Knowledge about the strong interaction between business strategy, human resources and business success. Understanding how incentive systems, corporate guidelines, and behavior influence the motivation and performance of the workforce.

LR 3: Detailed knowledge of business concepts, economic concepts, HR practices, and leadership concepts. Ability to use this knowledge in day-to-day management situations.

Workload

Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module)

Controls of Success In MM 5 (4.5)	Modality of Examination	Performance and Duration of Examination	Prerequisites for exam-participation	Examination Period	Graded
4.5.1 Strategic Management	Examination of another kind	Presentation of Case Study, approx. 15 minutes per candidate	None	During course	Yes
4.5.2 Managerial Economics	Study Achievement	None	None	-	No
4.5.3 Business Organization and Corporate Law	Written examination	60 minutes	None	At the end of the course week	Yes
4.5.4 Strategic Human Recourse Management	Examination of another kind	Presentation of Case Study, approx. 15 minutes per candidate	Case Study (group work)	During course	Yes
4.5.5 Leadership and Conflict Management	Study Achievement	None	None	-	No
Grading: The module grade shall be considered proportionally to the credits assigned to the courses.					

4.5.1 Strategic Management

Course Name			
Strategic Management			
Semester	Module Type	Allocated to the following Module	Lecturers
3	Compulsory (course is assigned to student by examination board)	Strategy and People	Prof. Dr. Kerstin Fehre
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours, 21h homework and self-studies	1,2
Overall Course Objectives			
Major course objectives are to explain the process of strategic management and to analyze business situations from the internal and external perspective. The formulation of strategies on the business unit and on the corporate level and the evaluation of strategic options based on competitive advantages are introduced and discussed. Furthermore, a major objective is to access existing business portfolios from a strategic perspective.			
Learning Targets			
Participants			

▪ are able to describe central concepts of strategic management alongside the ideal-typical strategy process. ▪ are able to undertake internal and external strategic analyses (e.g. SWOT Analysis) with the goal of strategy formulation. ▪ understand the classical concepts and sources of competitive advantages as well as their meaning for the formulation ofcompetitive and business strategies. ▪ are able to formulate strategies at a company level and at a business unit level. ▪ understand the central principles of strategy evaluation and strategy implementation as well as the classical concepts of change management.
Course Content
The course introduces the overall process of strategic management containing strategic analysis, strategy formulation, strategy evaluation based on competitive advantage, and portfolio strategy. The overall process is used as the structuring element, each step will be analyzed and explained in detail. In addition, students learn and experience the most important concepts of strategy formulation in oligopolies. A special emphasis is put on the integration, discussion and application of the frameworks. Several case studies will confirm the attained knowledge.
Literature
Robert M. Grant: Contemporary Strategy Analysis, Blackwell, 7th ed. 2010
Prerequisites for participation in course
No prerequisites required.
Modality of Exam
See 4.5

4.5.2 Managerial Economics

Course Name			
Managerial Economics			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Strategy and People	Prof. Dr. Clemens Puppe
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 18h, hereof 7,5h contact hours, 10,5h homework and self-studies	0,6
Overall Course Objectives			

The objective of the course is to provide a rigorous analysis of the basic determinants of labour supply and incentives at the workplace. Particular attention is given to recent developments in the application of behavioral economics to organisational design.
Learning Targets
Participants understand the fundamental concepts of microeconomic theory and behavioral economics relevant to organisational and contract design. The participants are able to infer the behavioral implications of the theoretical concepts and can apply them in real life contexts.
Course Content
Demand for leisure time and the structure of labor supply, symmetric versus asymmetric information models, efficiency wages, monetary versus non-monetary incentives, job market signalling.
Literature
▪ R. Gibbons, A Primer in Game Theory, 1992. ▪ R. Pindyck & D. Rubinfeld, Microeconomics, 9th Edition, 2018.
Prerequisites for participation in course
No formal prerequisites, but basic knoweldge of proabability theory and calculus will be helpful.
Modality of Exam
See 4.5

4.5.3 Business Organization and Corporate Law

Course Name			
Business Organization and Corporate Law			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Strategy and People	Prof. Dr. Martin Schulz
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lectures and case studies	Total 36h, hereof 15h contact hours, 21h homework and self-studies	1,2
Overall Course Objectives			
Participants ▪ will understand the relevance of law for business organizations and their stakeholders (also in cross border cases). ▪ gain insight into important forms of business organizations (including corporate governance aspects).			

▪ learn central issues of business law and corporate compliance (including managerial liability and legal risk management). ▪ will recognize the interdependence of corporate governance and business law within a globalized economy.
Learning Targets
Participants will understand the impact of law on entrepreneurial activities and become familiar with important forms of business organizations. They learn how to deal with corporate law issues and relevant aspects of corporate governance and compliance management (including cross border elements). Participants learn how to structure and communicate legal issues in international business law cases.
Course Content
This course provides an insight into important business law issues and legal risk management relevant to managerial practice including corporate governance and compliance issues. After outlining the German corporate legal framework, we will discuss some crucial issues of international and European business law, such as the law applicable to corporations engaged in cross-border activities. We will analyze typical cases in corporate practice with a special focus on the role and responsibility of managers. Key practical issues such as the choice of suitable business forms, corporate governance and compliance issues as well as the liability of shareholders and managers will also be discussed and analyzed.
Literature
▪ Kraakman, Reinier et al., The Anatomy of Corporate Law - A Comparative and Functional Approach, 3rd edition Oxford 2017. ▪ Schulz, Martin/ Wasmeier, Oliver. The Law of Business Organizations – A Concise Overview of German Corporate Law, Heidelberg 2012. ▪ Bagley, Winning Legally, How to use the law to create value, marshal resources and manage risk, Boston 2005.
Prerequisites for participation in course
A basic knowledge of German as well as basic knowledge of legal concepts (such as contracts) is helpful.
Modality of Exam
See 4.5

4.5.4 Strategic Human Resource Management

Course Name			
Strategic Human Resource Management			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Strategy and People	Prof. Dr. Petra Nieken
Recurrence	Mode of Teaching	Workload	Credit Points for Course

Each winter semester	Lectures, case study, project wirk, classroom experiment	Total 54h, hereof 22,5h contact hours, 31,5h homework and self-studies	1,8

Overall Course Objectives

The course aims at a fundamental understanding of the challenges of human resource management processes and their link to strategic decision making. It combines evidence based management concepts, behavioral economics, and data-driven approaches to provide a rigorous framework that enables students to apply HRM tools and practices. An overview of state-of-the art methods and research topics in HRM is provided.

Learning Targets

Participants will be made familiar with relevant challenges of human resource management and selected aspects of leadership and will gain insight into current research on behavior in organizations. The course enables students to understand and analyze strategic situations regarding individual behavior and human resource development in organizations.

Course Content

Today the majority of companies have explicitly HR driven strategies as the motivation of their employees, their commitment and their creativity are core factors for the company's success. This course shows how strategic decisions are linked to HRM and covers various topics of human resource management and leadership in organizations. Evidence based management concepts, concepts from behavioral economics, and data-driven approaches will be complemented by classroom experiments and empirical research results based on company as well as laboratory data. By introducing participants to evidence-based HR-management, they become familiar with current attempts to measure the success of HR development instruments.

We will cover topics such as linking HRM processes to the company's strategy, career and talent management, performance appraisal systems, employee motivation, and company training. Participants will work in teams on case studies that are distributed before the course starts. These real-world examples offer insights into practical HR-issues and leadership problems and illustrate a variety of challenges of HR management.

Literature

- Cascio, W.F.: Managing Human Resources, McGraw-Hill, 2013
- Lazear, E. P. and M. Gibbs: Personnel Economics in Practice. John Wiley & Sons, 2015.
- Huselid, M.A., Becker, B.E. and Beatty, R.W. (2005): The workforce scorecard: Managing human capital to execute strategy. Harvard Business School Press.
- Northouse, Peter G. (2015): Leadership: Theory and Practice, SagePublications

Prerequisites for participation in course

No prerequisites required.

Modality of Exam

See 4.5

4.5.5 Leadership and Conflict Management

Course Name			
Leadership and Conflict Management			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Strategy and People	Dr.-Ing. Tobias Kunkel
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours, 21h homework and self-studies	1,2

Overall Course Objectives

Participants acquire a holistic understanding of the complexity of leadership behavior. They are able to critically reflect underlying mechanisms and assess the appropriateness of different leadership styles for different situations. In addition, they have an insight into the emergence of conflicts and know methods to solve them constructively.

Learning Targets

Participants

- know important psychological basics of social interaction and communication.
- acquire knowledge of different leadership approaches and are able to compare them critically.
- learn how to apply conflict solving methods.
- are encouraged to reflect on their own leadership behavior.

Course Content

- Fundamentals of social psychology
- Fundamentals of communication
- Leadership theories
- Methods and models for dealing with conflicts

Literature

- Aronson, E., Wilson, T. D. & Akert, R. M. (2013). *Social Psychology* (8. Aufl.). Boston: Pearson.
- Nerdinger, F. W., Blickle, G. & Schaper, N. (2014). *Arbeits- und Organisationspsychologie* (3. Aufl). Berlin, Heidelberg: Springer.
- Schulz von Thun, F. (2010). *Miteinander reden* (48. Aufl.). Reinbek: Rowohlt Taschenbuch-Verlag.
- Winkler, I. (2010). *Contemporary leadership theories. Enhancing the understanding of the complexity, subjectivity and dynamic of leadership*. Heidelberg, New York: Physica-Verlag.

Prerequisites for participation in course
Successful participation in the lecture „Project Management”.
Modality of Exam
See 4.5

5 Description of the Engineering Modules

5.1 Renewables

Module Name			
Renewables			
Semester	Subject	Module Supervisor	Credit Points for Module
1	Engineering	Prof. Dr.-Ing. Hans-Jörg Bauer	6

Module Content

The module starts with a general introduction to the challenges of energy supply, examining the historic and future developments of global energy requirements and existing primary energy sources and reserves. Aside from this, it provides an overview of the energy cascade, from the primary energy sources, through the various stages of energy conversion, the transportation and distribution of energy, to its ultimate use. Technical, ecological and socio-economic aspects are highlighted. The presentation of energy systems based on renewable sources of energy focuses on wind and hydroelectric power, as well as geothermal and solar thermal energy. For didactic reasons, systems based on other renewables, such as Photovoltaics and Biomass, are dealt with in other engineering modules. For the processes covered in this course, the supply of renewable primary energy provided by nature is first described, before investigating the individual technical features of the power plants. Wind energy plants serve as an example to convey the interdisciplinary nature of energy conversion plants, in which fluid mechanical, static mechanical, electrical and electronic considerations are all closely linked to systemic and economic aspects.

Learning Results (LR)

LR-1: Ability to understand and evaluate the complex system of renewable energy production and embed it in an overall energy production system.

LR-2: Development of a fundamental understanding of the complex relationships of energy supply and of the challenge of establishing a sustainable energy system.

LR-3: Understanding of the functioning of wind/water turbines and solar-thermal plants, their design and dimensioning.

Workload

Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module).

Controls of Success In EM 1 (5.1)	Modality of Examination	Performance and Duration of Examination	Prerequisites for Exam-participation	Examination Period	Graded
5.1.1 Introduction and Scope of EEM, Energy Systems	Study Achievement	None	None	-	No
5.1.2 Wind and Water Power	Written examination	60 minutes	None	At the end of the course week	Yes

5.1.3 Solar and Geothermal Power	Written examination	60 minutes	None	At the end of the course week	Yes
Grading: The module grade shall be considered proportionally to the credits assigned to the courses.					

5.1.1 Introduction and Scope of EEM, Energy Systems

Course Name			
Introduction and Scope of EEM, Energy Systems			
Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Renewables	Prof. Dr.-Ing. Hans-Jörg Bauer
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

The overarching goal is to make the students acquainted with the overall principles and challenges related to the energy supply of a modern society. It sets the scene for the subsequent courses and is mainly intended to give a general overview rather than a very deep knowledge about the energy system and its details. In this context the visit of KIT labs and power plants conveys to the students impression of the broad spectrum of energy science, technology and application.

Learning Targets

Participants

- get an introduction and general overview of the subject current energy supply.
- gain insights into the national, European and global energy needs, its supplies and transport.
- gain an understanding of conventional power houses and power houses on the basis of renewable energies.
- gain knowledge of the energy distribution and storage, power-heat-coupling and central and spread systems.

Course Content

Energy Supply: The Basics

- Energy sources: resources and reserves,
- Energy demand and “consumption” in D, EU and globally
- Importance of the energy system and its sustainability
- The energy cascade

Supply of electricity and heat: power plants

- Conventional thermal power plants (fossil, nuclear)

▪ Renewables: Hydro, incl. Wave and Tidal; Wind; Solar: CSP and PV; Geothermal; Biomass ▪ Cogeneration ▪ Distributed vs. centralized approaches Distribution and storage A look into the future: energy system quo vadis? Structure of the engineering modules of EEM The course also comprises a visit of KIT labs as well as conventional and/ or renewables based power plants.
Literature
▪ Bent Soerensen; Renewable Energy, 3rd Edition, Elsevier Academic Press; 2004# ▪ Aldo V. Da Rosa: Fundamentals of Renewable Energy Processes; Elsevier Academic Press, 2005
Prerequisites for participation in course
Basics from the bachelor education and practical experience gained during professional career are helpful, but not obligatory required.
Modality of Exam
See 5.1

5.1.2 Wind and Water Power

Course Name			
Wind and Water Power			
Semester	Module Type	Allocated to the following Module	Lecturers
1	Compulsory (course is assigned to student by examination board)	Renewables	Dr. Alexander Jung Dr. Thomas Ackermann
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 72h, hereof 30h contact hours 42h homework and self-studies	2,4
Overall Course Objectives			
WIND POWER The goal is to provide the students a view of the wind energy sector with different approaches: economical, business and technical. The economic and business views are generally enough. The technical view includes a general introduction to all the subsystems of a wind turbine and a wind farm, making special emphasis on electrical engineering subsystems and discussing			

the key technological points to be developed in the near future. The introduction to HOMER software makes possible the basic economic estimation of the performance of a wind farm.

WATERPOWER

The lecture is intended to give a broad perspective about the role of hydropower in the world, its contribution to electrical energy production and the future trends. The main types of hydropower units are described in order to gain a basic knowledge in their functionality and the possible modes of operation. Furthermore, the goals for the students are to understand the basics of the conversion of hydraulic energy into mechanical energy and to provide a physical understanding of the various physical phenomena that can occur during the operation of these machines (i.e. cavitation). The lecture also gives a global perspective about ocean energy and main types of machines which are used in this area. A final objective is to gain an insight into some monitoring and maintenance practices of hydropower machines.

Learning Targets

Participants

- gain a historic overview of the development of the usage of wind and water power
- gain knowledge of global and local wind systems (measurement and energy content), aerodynamic and electric systems, components of wind power plants and their characteristics, electric systems of wind power plants and current developments of modern wind power plants
- gain knowledge of the role of water power for the global electrical energy supply (electrical energy generation and demand) and for the electrical grid (control, stabilization and ancillary services provided by hydropower), energy storage with pumped storage technology, marine energy (ocean current, wave, tidal): solutions, role, competitiveness, market
- learn about current and future challenges of hydropower development (plants, units, components, control and operational strategies), different types of hydropower plants, types of the most commonly used hydropower machines and other major equipment like hydro generators, the basic physics describing the energy conversion in hydropower machinery
- gain knowledge of the characteristics of the operation of hydro machinery under various load conditions and the impact on the hydraulic and mechanical design of the components, equipment monitoring and maintenance strategies
- understand current economic, ecological and legal circumstances.

Course Content

WIND POWER

- Introduction to wind energy systems: Wind power industry; on-shore market and off-shore market; forecast of business opportunities.
- On-shore technology: A review of the main sectors.
- Off-shore technology: Fixed platform; floating platforms; connection to the electrical grid.
- Wind turbine components.
- Energy control: Mechanical control; fixed speed wind generators; variable speed wind generators; connection to the grid.
- Components: Electrical generator; power electronics (energy converters); technical options; filters; energy storage.
- Economic analysis: HOMER as a basic tool.

WATERPOWER

- Introduction to waterpower: Energy generation and demand; Conventional hydropower and ocean energy; historical review and perspectives.
- Basics of energy transfer: Head; discharge, power; efficiency; characteristic hill charts; similarity laws; velocity triangles.
- Conventional Hydro: Operation of hydropower plants; description of Francis Kaplan and Pelton turbines; selection and regulation; transients; design, manufacturing and erection aspects
- Pumped Storage Plants: Objective, design and operation of pump turbine units.
- Physical phenomena in hydropower machines such as cavitation, pressure fluctuations, instabilities, erosion: impact, consequences, prediction, identification, mitigation
- Marine Energy: tidal, ocean current and wave energy devices.

Operation of hydropower plants: monitoring and maintenance aspects.

Literature

- M. Stiebler: Wind energy systems for electric power generation; Springer; 2008
- D. A. Spera, ed.: Wind turbine technology: fundamental concepts of wind turbine engineering; ASME, 2nd ed., 2009
- J. Twidell, G. Gaudiosi, ed.: Offshore wind power; Multi-Science; 2009
- C. Pfleiderer, H. Petermann: Strömungsmaschinen; Springer; 2005
- L. Prandtl: Führer durch die Strömungslehre; Vieweg; 1965

Prerequisites for participation in course

Basics from the bachelor education and practical experience gained during their professional career is desirable, but not obligatory required. Basic knowledge of fluid mechanics and mechanics would be convenient.

Modality of Exam

See 5.1

5.1.3 Solar and Geothermal Power

Course Name

Solar and Geothermal Power

Semester	Module Type	Allocated to the following Module	Lecturers
1	Compulsory (course is assigned to student by examination board)	Renewables	Prof. Dr. Thomas Kohl Prof. Dr.-Ing. Robert Stieglitz
Recurrence	Mode of Teaching	Workload	Credit Points for Course

Each winter semester	Lecture and exercises	Total 72h, hereof 30h contact hours 42h homework and self-studies	2,4

Overall Course Objectives

SOLAR POWER

- Provision of fundamental key parameters thermal solar energy. Transmission of the principal capabilities but also their constraints.
- Supply of the essential physical laws, the relationship of the most important parameters and their scaling laws.
- Transfer of the physical understanding in technical solutions (material choice, component fabrication, compilation of components to a system).

Analysis of different systems option with respect to performance and economics.

GEOTHERMAL POWER

- Understanding the basic concepts behind geothermal energy.

From nm scale processes to a sustainable use of energy.

Learning Targets

Participants

- gain knowledge of the technical fundaments for the utilization of solar thermal energy, its capabilities and limitations. Provisions of physical laws and translation to engineering conditions. Acquisition of capability to conduct back-on the envelope calculations on performance limits of solar thermal systems. Fundamental understanding of interconnection of technical systems to generate heat and electricity and provisions of skills to identify leading parameters in a technical configuration.
- gain knowledge of the technical basics for the use of geothermal energy (physics of energy and energy conversions; statistics on global energy generation and consumption; geothermic as regenerative energy source: current global status and project examples; geothermic as branch of geophysics; classification of the geothermal energy generation; theoretical basics of heat transport in geothermic; technical aspects of the use of geothermal energy).

Course Content

SOLAR POWER

Chapter 1: Potential of solar energy

This first part summarizes the energy content provided by the sun, its spectral behavior temporal and spatial behavior as well as atmospheric aspects leading to absorption, scattering and reflection, leading to direct and diffuse radiation. All parameters decide on the energy yield to be obtained by different technical configurations. Atmospheric conditions, weather statistics may impact the yield further. The aim is to assess the yield to allow for an economic use of solar thermal utilization.

Chapter 2: Principal absorber design, concentration of solar irradiation, materials and technical options for thermal solar energy conversion

The basic components of a solar system are introduced and fundamental efficiency correlations derived. Subsequently the physical constraints and boundary conditions for all of these components are formulated, which are translated in a next step into engineering guidelines. The concentration of solar radiation allows increasing the specific power density on the collector. This in turn imposes not only measures on mirror design and quality but also geometrical set-ups. A central part of a solar thermal unit is the selective solar absorber. The design principles, different technical solutions as well as open issues are illustrated and analyzed. Principal technical solutions are shown and discussed in terms of performance (in time and space), material constraints

(availability, material limitations, ageing-durability). The main focus is to understand the physical limitations given by the collection process.

Chapter 3: Design of power unit components and components

Energy collection and conversion processes are not conceivable without a fundamental understanding of thermal-hydraulics and thermal-dynamics, scoping both active and passive mechanisms of energy transport. The fundamental equations as well as their technical implications on the design of the individual components are illustrated and discussed. In the next step the principal design guidelines for solar power plant are elaborated and put into a context with a system and component design. All elements of a potential plant must be synthesized to conduct a system analysis judging on the performance at nominal conditions.

Chapter 4: Thermal solar power generation and energy storage

The final chapter illustrates options for thermal solar energy generation. Discussed are high and low temperature and concentration systems, their benefits and drawbacks. A crucial aspect therein is the overall availability and the definition of key performance indicators, which considerably depend on the user profile. One further key element is the question of the thermal storage capability, for which several physical solutions are on the market and innovative options are under consideration. They all exhibit different features.

GEOTHERMAL POWER

- Energy content provided by the Earth.
- Introduction on geothermal relevant structure of the Earth.
- Heat transport processes in rocks.
- Basic physics of porous media.
- Application to steady state and transient heat conduction (i.e. temperature field of the Earth, transport in continental and oceanic crust, influence of topography and paleoclimatic temperature signals, radiogenic heat generation, energy conservation).
- Heat advection and Darcy flow regime.
- Introduction into geothermal methods:
  Thermal and petro physical rock properties, Bullard Plot Interpretation, BHT temperature correction, temperature Logging techniques.
- Introduction into Drilling and Logging Technologies: Basics of petro physics and wire line logging; Passive/Active electric measurement; Sonic Log, Nuclear methods; Televiewer methods.
- Introduction and statistics of Geothermal production.
- High temperature systems (Conventional high enthalpy utilization, EGS Systems / Hydraulic Fields in Reservoirs, Associated physical processes in fractured media, Induced Seismicity).
- Low enthalpy utilization (Heat pump, Dimensioning and Installation of Ground Coupled Heat Pump Systems, Current Problems in GCHP Installation).
- Economic Modeling of Heat Extraction from aquifers.

Literature

- U.S. Department of Energy: Report to Congress on Assessment of Potential Impact of Concentrating Solar Power for Electricity Generation; 2007.
- C.E. Kennedy,H. Price, 2005, Progress in development of high-temperature solar-selective coating; Proc. of ISEC2005, 2005 International Solar Energy Conference, Orlando, USA.

Prerequisites for participation in course

Physics, thermodynamics, material sciences, fluid dynamics from the bachelor level, practical technical experience gained during a professional career is helpful, but not obligatory required.
Modality of Exam
See 5.1

5.2 Thermal Energy Conversion

Module Name			
Thermal Energy Conversion			
Semester	Subject	Module Supervisor	Credit Points for Module
1	Engineering	Prof. Dr.-Ing. Hans-Jörg Bauer	6

Module Content

The module “Thermal Energy Conversion” gives an overview on thermal processes for power and heat supply from fossil and biogenic fuels. The whole range of fuel to energy conversion via thermal processes is covered in the module, starting from heat transfer, combustion processes, coal and gas fired power plants, gas and steam turbines, CO2 reduction by capture and storage and finally special aspects of biomass utilization. From a sound knowledge of the technical fundamentals, the module will lead to the understanding of complex energy conversion systems and typical plants. The participants develop and improve their evaluation competence concerning aspects of technology, economy and ecology.

Learning Results (LR)

LR-1: Application of fundamentals of thermodynamics, flow mechanics and heat transfer to the design and dimensioning of thermal power plants.

LR-2: Identification of potentials to optimize the efficiency, effectiveness, and economic environmental compatibility of thermal power plants.

LR-3: Consideration of requirements on power stations, which result from integration in an energy supply system with an enhanced utilization of renewable energy sources.

Workload

Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module).

Controls of Success In EM 2 (5.2)	Modality of Examination	Performance and Duration of Examination	Prerequisites for Exam-participation	Examination Period	Graded
5.2.1 Technical Combustion/ Heat and Mass Transfer	Written examniation	120 minutes	Continuous presence and active participation in the course are strongly recommended	At the end of the module	Yes
5.2.2 Thermal Power Plants incl. Coal and Gas Power Plants					
5.2.3 Turbo Machinery					
5.2.4 Carbon Capture and Storage					
5.2.5 Energy from Biomass					

Grading: The module grade shall be considered proportionally to the credits assigned to the courses.

5.2.1 Technical Combustion/ Heat and Mass Transfer

Course Name			
Technical Combustion/ Heat and Mass Transfer			
Semester	Module Type	Allocated to the following Module	Lecturers
1	Compulsory (course is assigned to student by examination board)	Thermal Energy Conversion	Prof. Dr. rer. nat. habil. Ulrich Maas
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2
Overall Course Objectives			
The lecture aims at delivering the fundamentals and basics of heat transfer and the fundamentals of the physical and chemical processes governing combustion particularly with regard to a deeper understanding of technical combustion systems (e.g. engines, turbines, furnaces).			
Learning Targets			
Participants get an overview of scientific parameters for the description of mass and heat transfer (Including non-steady heat conduction, radiation, convection and phase change etc.) as well as technical combustion processes.			
Course Content			
▪ Fundamental concepts and phenomena of heat transfer. ▪ Heat conduction, heat transfer in presence of convention. ▪ Basic models for heat transfer. ▪ Design of simple heat exchangers, effectivity of heat exchangers. ▪ Fundamental concepts and phenomena of combustion. ▪ Conservation equations for laminar flat flames. ▪ Thermodynamics of combustion processes. ▪ Transport phenomena. ▪ Chemical kinetics. ▪ Laminar flames. ▪ Laminar diffusion flames.			
Literature			

- F. P. Incropera, D. P. DeWitt. Fundamentals of Heat and Mass Transfer, John Wiley & Sons, New York 1996
- VDI Heat Atlas, Springer-Verlag, Berlin Heidelberg New York 2010.
- U. Maas, J. Warnatz, R.W. Dibble : Combustion – Physical and chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, 4th Edition, Springer, Heidelberg 2006

Prerequisites for participation in course

Knowledge of Thermodynamics and Heat Transfer.

Modality of Exam

See 5.2

5.2.2 Thermal Power Plants incl. Coal and Gas Power Plants

Course Name

Thermal Power Plants incl. Coal and Gas Power Plants

Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Thermal Energy Conversion	Prof. Dr.-Ing. Thomas Schulenberg
Recurrence	**Mode of Teaching**	**Workload**	**Credit Points for Course**
Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

The goal of this 2-day lecture is to show realistic examples of major components of power plants to illustrate the theoretical background learned in lecture 6.2.1 of this module. Qualitative explanations will help to understand why each component is designed as such and will indicate technical challenges.

Learning Targets

Participants

- gain insights into the way of functioning of thermal power stations as well as their most important components.
- gain knowledge of steam power plants with stone coal or brown coal combustion (including coal preparation, boiler construction, steam generator, super-heater and re-heater, steam turbine, condenser, feed water pumps and preheater, construction of generators, start-up and load change of the steaming process, flue gas cleaning).
- gain knowledge of gas and steam power plants with natural gas (gas turbines, steam turbines in the gas and steam power plant, waste heat boiler , installation and operation of the power plant).

Course Content
Design of pulverized hard coal and brown coal (lignite) fired power plants, including ▪ Coal mills. ▪ Boiler design. ▪ Evaporator, super heater and re-heater design. ▪ Design of steam turbines, condensers, feedwater pumps and preheaters. ▪ Generator design. ▪ Start up and load changes of the steam cycle. ▪ Design of the flue gas cleaning system with DeNOx system, dust filters and desulphurization system. ▪ Design of combined cycle power plants fired with natural gas, including. ▪ Gas turbine design. ▪ Steam turbine design. ▪ Heat recovery boiler. ▪ Layout of the combined cycle power plant.
Literature
None
Prerequisites for participation in course
No prerequisites required.
Modality of Exam
See 5.2

5.2.3 Turbo Machinery

Course Name			
Turbo Machinery			
Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Thermal Energy Conversion	Prof. Dr.-Ing. Hans-Jörg Bauer,
Recurrence	Mode of Teaching	Workload	Credit Points for Course

Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

Major objective of this course is to give a basic understanding of the basic working principles of the different thermal turbo machines and their major components.

Learning Targets

Participants gain knowledge of the most important components of fluid flow engines and their operating principles: steam and gas turbines system analysis, fluid mechanical basic equations of turbo-machines; axial flow turbines and compressors; the linear cascade, radial equilibrium and three-dimensional stage design; aerodynamic losses; design guidelines for axial flow turbines and compressors; multistage turbo-machines; combustion in gas turbines and gas turbine cooling; radial machines and can apply their knowledge in the business environment.

Course Content

- Thermal turbo machines, introduction and examples.
- Steam & Gas Turbine System Analysis.
- Basic Fluid Mechanics in Turbo Machines.
- Basic Equations, Euler's Turbomachinery Equation.
- Incompressible and compressible flows, boundary layers.
- Similarity Laws.
- Axial Turbines and Compressors and Turbine Stages.
- Planar Turbine Cascades.
- Radial Equilibrium, 3D Turbine Stage Design.
- Aerodynamic Losses in Axial Turbines.
- Axial Compressor Stages.
- Design Principles for Axial Turbines and Compressors.
- Multi Stage Turbomachinery Characteristics.
- Gas Turbine Cooling and Combustion.
- Radial Turbo Machines.

Literature

- H.I.H. Saravanamuttoo, G.F.C. Rogers, H. Cohen, P.V. Straznicky: Gas Turbine Theory; 6th Edition; Prentice Hall; 2008
- A.S. Leyzerovich: Steam Turbines for Modern Fossil-Fuel Power Plants; CRC Press; 2007

Prerequisites for participation in course

Knowledge about Fluid Mechanics, Thermodynamics, Technical Combustion, Thermal Power Plants

Modality of Exam

See 5.2

5.2.4 Carbon Capture and Storage

Course Name			
Carbon Capture and Storage			
Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Thermal Energy Conversion	Prof. Dr. Frank. Schilling
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

The course objectives are to understand the concepts behind underground gas-storage with a special emphasis on carbon capture and storage. The course perspective leads from the nm scale processes to climate change.

Learning Targets

Participants

- gain an overview of the basics of bio-geo-chemical processes in the earth system as well as their interaction on the cycle of energy, water, carbon.
- are taught the basics of the subject CCS and gains following knowledge and competencies:
  - from nm effects through to climate change; critical disputes with the advantages and risks of gas storage (for energy and CCS);
  - methods to evaluate and to reduce risks of gas storage – especially CCS;
  - competencies to scientifically debate the chances and risk of underground gas-storage
  - Exercises and case studies add to the understanding of the topic

Course Content

- Why storing gases underground (Methane, CO2,…).
- Why carbon capture and storage? Global CO_2 cycle, anthropogenic CO_2 emissions and impact to global and regional climate.
- CO_2-capture technologies: Prae-combustion, post-combustion, oxyfuel, chemical looping, further CO_2 reduction technologies.
- Gas transport: Required gas quality, materials, transport options.
- Geological gas storage with a special focus on CO_2:

○ Principles of geological gas storage (caverns, saline aquifers) – the similarities and differences to fluid storage (e.g. oil, waste water) are discussed. ○ Enhanced oil recovery; enhanced gas recovery; coal bed methane; ○ Trapping mechanisms (special focus on long term safety): Structural trapping; chemical trapping; physical trapping; solubility trapping. ○ Exploration & site characterization: Geology, geophysics, geochemical, and geo-mechanical; social aspects. ○ Site Development; drilling; monitoring; erection of injection facility. ○ Monitoring – Prior – during and after Injection: Physical; chemical; biological. ○ Site abandonment. ○ Risk assessment – risk management.
Literature
IPCC, 2005 - Bert Metz, Ogunlade Davidson, Heleen de Coninck, Manuela Loos and Leo Meyer (Eds.) Cambridge University Press, UK. pp 431.
Prerequisites for participation in course
Interest, basic physics and thermodynamics
Modality of Exam
See 5.2

5.2.5 Energy from Biomass

Course Name			
Energy from Biomass			
Semester	Module Type	Allocated to the following Module	Lecturer
1	Compulsory (course is assigned to student by examination board)	Thermal Energy Conversion	Prof. Dr.-Ing. Thomas Kolb Dr. Siegfried Bajohr
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2
Overall Course Objectives			
The course objectives are to provide an overview about the potential of biomass conversion to energy. To understand the processes and technical systems for biomass conversion to energy and chemical energy carriers. To get an insight into the status of commercialization of the different technologies, to understand and be able to evaluate boundary conditions like legal aspects and ecological and economic aspects.			

Learning Targets
Participants ▪ gain an overview of the various technologies for the use of renewable energy as well as energy efficient technologies for the creation of electric energy (and heat). ▪ gain insights into the planning of systems and get to know their potentials. The emphasis is on the usage of biomass (including biogenic raw materials and their potentials, processes for the generation of energy from biomass, technical systems for the conversion of biomass into fuel).
Course Content
▪ Biogenic resources, potentials. ▪ Processes for energy from biomass: thermo-chemical, chemical, biological. ▪ Technical systems (examples): pyrolysis; gasification; combustion; gas up-grading; biomass to liquid, BTL; fermentation; substitute natural gas, SNG from biomass. ▪ Status of commercialization of different technologies. ▪ Eco-balance. ▪ Legal background EU.
Literature
▪ Handbook biomass gasification– H.A.M. Knoef (Ed.), BTG Biomass Technology Group BV; 2nd edition (2012) ▪ Biomass Gasification – A Synthesis of Technical Barriers and Current Research Issues for Deployment at Large Scale, f^3 Project Report – S. Heyne, T. Liliedahl, M. Marklund, The Swedish Knowledge Centre for Renewable Transportation Fuels – f^3 (2013) ▪ IEA Bioenergy http://www.ieabioenergy.com/ ▪ IEA Task 33: Gasification of Biomass and Waste http://www.ieatask33.org/
Prerequisites for participation in course
No prerequisites required.
Modality of Exam
See 5.2

5.3 Electricity Generation and Energy Storage

Module Name			
Electricity Generation and Energy Storage			
Semester	Subject	Module Supervisor	Credit Points for Module
2	Engineering	Prof. Dr.-Ing. Marc Hiller	6

Module Content

This module focusses on electricity generation on the one side and energy storage on the other. The most commonly used power generator in electrical power stations is a gas turbine. Students will gain an understanding and knowledge of critical issues related to synchronous generator operation. In addition, photovoltaics are among the most discussed forms of the renewable energy generation. They convert solar radiation directly into electrical energy. An understanding of Photovoltaics as an energy source, their working principles and mechanisms is essential to improve the efficiency of the devices. This module gives insights into the public as well as the scientific discussion and highlights boundary conditions with regard to requirements of energy storage.

Batteries and fuel cells are ways to store the power. Participants will become familiar with the concepts of electrochemical energy storage and the design of efficiently working batteries. Hydrogen technology as well as power electronics are key technologies for the use of fuel cells as energy storage and their integration into power networks. The module discusses available, state-of-the-art fuel cell technologies and their efficiencies as well as the involved opportunities and limitations.

Learning Results (LR)

LR-1: Understanding of operational behavior of generators and know-how about current research fields in generator technology.

LR-2: Understanding of the design of photovoltaic plants, batteries, fuel cell systems, hydrogen storage systems, and mechanical storage systems. They are able to evaluate different systems and derive optimum and applicable solutions.

LR-3: Knowledge about electrochemical storage media including the method of operating as well as the characterization of the method. They are able to compare various concepts for secondary batteries, the development and structure of various battery types, their alteration and lifetime.

LR-4: Profound knowledge of technologies of hydrogen generation, storage, transport and usage as well as related security aspects. They are able to assess future developments of the hydrogen economy and its impact on technology.

Workload

Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module).

Controls of Success In EM 3 (5.3)	Modality of Examination	Performance and Duration of Examination	Prerequisites for Exam-participation	Examination Period	Graded
5.3.1 Power Generators	Oral examination	Approx. 20 mniutes per candidate	None	At the end of the course week	Yes

5.3.2 Batteries and Fuel Cells	Oral examination	Approx. 20 minutes per candidate	None	At the end of the course week	Yes
5.3.3 Hydrogen Technology and Thermal Storage	Study Achievement	None	None	-	No
5.3.4 Photovoltaics	Oral examination	Approx. 15 minutes per candidate	None	At the end of the course week	Yes
5.3.5 Power Electronics	Study Achievement	None	None	-	No
Grading: The module grade shall be considered proportionally to the credits assigned to the courses.					

5.3.1 Power Generators

Course Name			
Power Generators			
Semester	Module Type	Allocated to the following Module	Lecturer
2	Compulsory (course is assigned to student by examination board)	Electricity Generation and Energy Storage	Prof. Dr.-Ing. Martin Doppelbauer
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2
Overall Course Objectives			
Understanding and knowledge of critical issues related to synchronous generator operation.			
Learning Targets			
Participants ▪ gain insights into the structure and simulation of the stationary and transient operational behaviour of big power plant generators. ▪ understand structure of high performance generators of the type TLRI. ▪ are able to apply basics of the simulation and modeling of power plant generators. ▪ understand operational behaviour and current research themes in generator technology.			
Course Content			
Theoretical foundation of synchronous generator, modeling and simulation, construction features, steady state and transient operation, case studies.			

Literature
▪ A.E. Fitzgerald, Charles Kingsley, Jr., Stephen D. Umans, Electric Machinery. 6th edition- Mc Graw Hill series in Electrical Engineering. Power and Energy ▪ P.M. Anderson & A.A. Fouad, Power System Control and Stability, 2nd edition, IEEE Press, Power Engineering Series, Wiley-Interscience, 2003. T.A. Lipo, Analysis of Synchronous Machines, Second Edition, June 28, 2012 by CRC Press - 606 Pages
Prerequisites for participation in course
No prerequisites required.
Modality of Exam
See 5.3

5.3.2 Batteries and Fuel Cells

Course Name			
Batteries and Fuel Cells			
Semester	Module Type	Allocated to the following Module	Lecturers
2	Compulsory (course is assigned to student by examination board)	Electricity Generation and Energy Storage	Prof. Dr. Helmut Ehrenberg Dr. Frieder Scheiba
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and exercises	Total 54h, hereof 22,5h contact hours 31,5h homework and self-studies	1,8

Overall Course Objectives
The participant will become familiar with the basic concepts of electrochemical energy storage and the design of efficiently working batteries. Becoming acquainted with the available, state-of-the-art fuel cell technologies and their efficiencies. Understanding and knowledge of the involved opportunities and limitations.
Learning Targets
Participants ▪ gain an overview of the basics characteristics, manner of functioning and stage of development from batteries and fuel cells to energy storage or energy conversion.

- gain knowledge into electrochemical storage media, method of operating and characterization of the method, comparison of various concepts for secondary batteries, development and structure of various battery types, alteration and weariness of batteries.

Course Content

BATTERIES

The basic principles of electrochemistry will be repeated and are applied with respect to electrochemical energy storage. Different concepts for storage systems are compared with a focus on the materials demands. The specific characteristics are discussed and the strengths and weaknesses of the different battery concepts are compared in the light of the specific requirements for mobile and stationary applications, respectively. The following battery systems will be considered: (1) Pb-based acid batteries, (2) NiCd and NiMH alkaline batteries, (3) Lithium-ion batteries.

FUEL CELLS

The principles and the thermodynamics of a fuel cell membrane electrode assembly will be explained. The fuel cell stack is introduced. Different types of low, mid and high temperature fuel cells are presented. Typical losses and definitions of efficiencies are identified, defined respectively. Auxiliary systems and some real world applications are presented.

Literature

BATTERIES

- Lithium Batteries, Science and Technology, C. Julien, A. Mauger, A. Vijh, K. Zaghib, Springer (2016) ISBN 978-3-319-19107-2 / 978-3-319-19108-9 (eBook), DOI 10.1007/978-3-319-19108-9

FUEL-CELLS

- Hydrogen Technology – Mobile and Portable Applications Series: Green Energy and Technology Léon, Aline (Ed.), 2008, XVI, ISBN: 978-3-540-79027-3, Springer
- Hydrogen and Fuel Cells, Fundamentals, Technologies and Applications, Stolten, Detlef (Ed.) 2010, ISBN-13: 978-3-527-32711-9 – Wiley-VCH, Weinheim

Prerequisites for participation in course

Basics of electrochemistry and materials science.Basics of thermodynamics.

Modality of Exam

See 5.3

5.3.3 Hydrogen Technology and Thermal Storage

Course Name

Hydrogen Technology and Thermal Storage

Semester	Module Type	Allocated to the following Module	Lecturers
2	Compulsory (course is assigned to student by	Electricity Generation and Energy Storage	Prof. Dr.-Ing. Thomas Jordan Dr.-Ing. Marc Linder

	examination board)		
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	0,6

Overall Course Objectives

Becoming acquainted with the available, state-of-the-art hydrogen production, storage, transport and utilization technologies. Understanding and knowledge of the concept of a hydrogen economy, the associated technologies and system efficiencies.

Understanding of underlying physical phenomena and hydrogen safety engineering framework and technical sub-systems.

Learning Targets

Participants

- gain knowledge of technologies of hydrogen generation, storage, transport and usage as well as security aspects and future developments through to a hydrogen economy (current and future H2 production techniques, storage and transport techniques; energy consumption of H2 in combustion engines; cells for H2 – creation, fuel cells for cars; charging stations and H2 storage media; safety regulations when handling H2).
- gain additional insights into the framework conditions for security technology when handling H2 and technical subsystems.

Course Content

The cross-cutting issue of hydrogen as an energy carrier and the concept of a hydrogen economy are introduced. The chemical and physical properties of hydrogen are explained. Details of established and high potential future technologies for production, storage, distribution, and energy applications besides fuel cells are given. Systems like hydrogen driven cars, refueling stations, and energy storage applications are characterized with their efficiencies and costs.

Literature

- Hydrogen Technology – Mobile and Portable Applications Series: Green Energy and Technology Léon, Aline (Ed.), 2008, XVI, ISBN: 978-3-540-79027-3, Springer
- Hydrogen and its competitors, Risø Energy Report 3, Risø National Laboratory, Hans Larsen, Robert Feidenhans and Leif Sønderberg Petersen, Risø-R-1469 (EN), ISBN 87-550-3349-0, ISBN 87-550-3350-4 (Internet), ISSN 0106-2840, November 2004

Prerequisites for participation in course

Basics of thermodynamics

Modality of Exam

See 5.3

5.3.4 Photovoltaics

Course Name			
Photovoltaics			
Semester	Module Type	Allocated to the following Module	Lecturers
2	Compulsory (course is assigned to student by examination board)	Electricity Generation and Energy Storage	Prof. Dr.-Ing. Michael Powalla Prof. Dr. Uli Lemmer
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

Which role can PV play in an energy scenario and what are the specifics?

To understand the basic principle of a solar cell and to apply the physical background to real existing solar cell concepts; To understand the technology of different kind of solar module technologies from a production point of view; to have an overview of system components and applications of real existing solar generators.

Learning Targets

Participants

- gain knowledge of photovoltaics as an energy source as well as their basic physical characteristics through to the conception of complete photovoltaic energy systems.

  gain an introduction into the technology of photovoltaic systems: methods for the usage of solar energy; measurement principles for the capture of solar radiation on the earth; solar cells and their structure; efficiency determination; characteristics of solar cells and solar modules; structure of PV-modules; specific system configurations.

Course Content

- The possible role of electrical energy from photovoltaics in national and global energy system scenarios (resources, emissions, PV market and costs).
- Physical fundamentals of energy conversion (solar radiation).
- Semiconductor physics related to solar cells (absorption of light, band structure, transport properties), recombination, optics.
- Energy conversion in semiconductors (p/n junction, theoretical limits, the electrochemical potential).
- Solar cells (characteristics, I/V curve, materials, losses).
- Realization concepts
  - Silicon technology, from quartz to the cell
  - Thin film solar cells
  - Concentrator cells, organic solar cells, dye sensitized solar cells
- Photovoltaics module and production technology.

▪ Photovoltaics energy systems (components, converter, building integration, tracking systems). ▪ Energy performance, system efficiency and outdoor effects.
Literature
▪ P. Würfel, Physics of Solar Cells, (Wiley-VCH, Weinheim, 2009)) ▪ Jef Poortmans, Vladimir Arkhipov, Thin Film Solar Cells, (Wiley, West Sussex England, 2007) ▪ Tom Markvart and Luis Castaner, Solar Cells, Materials, Manufacture and Operation (Elsevier, Oxford, 2005)
Prerequisites for participation in course
Basics of semiconductor physics, optics, thermodynamics
Modality of Exam
See 5.3

5.3.5 Power Electronics

Course Name			
Power Electronics			
Semester	Module Type	Allocated to the following Module	Lecturer
2	Compulsory (course is assigned to student by examination board)	Electricity Generation and Energy Storage	Prof. Dr.-Ing. Marc Hiller
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and exercises	Total 18h, hereof 7,5h contact hours 10,5h homework and self-studies	0,6
Overall Course Objectives			
The course objective is to introduce the fundamental principle of power electronics, which consists in switching voltages with nearly ideal transistors and integrating them to currents by inductors, which then additionally can be integrated by capacitors to other voltages. Frequency converters additionally convert the frequency.			
Learning Targets			
Participants understand and are able to apply: ▪ Switching voltages with transistors. ▪ Pulse width modulation (PWM). ▪ Buck and boost converters.			

- Battery charge regulators: series and shunt regulators, MPP-regulators.
- Single phase and three phase inverters.
- Photovoltaic Inverters for grid connection and off-grid applications.
- Solar module integrated DC/DC converters and micro inverters.
- Utility-scale PV power plants.
- Power electronics for wind turbines.

Course Content

The application of power electronics is growing very fast. Especially in the areas of renewable power generation, power saving and E-Mobility, power electronics is a key technology. Power electronics circuits are used to convert electricity to different voltages or currents. The conversion efficiencies can be up to 99%, depending on the application. The course gives an overview on the principles of power electronics, the basic power electronics circuits and different applications.

Literature

- Fang Lin Luo und Hong Ye: Power Electronics: Advanced Conversion Technologies, January 2010
- Daniel Hart: Power Electronics, January 2010
- Andrzej M. Trzynadlowski: Introduction to Modern Power Electronics, Second Edition, April 2010

Prerequisites for participation in course

Basics in electrical engineering, basics of active and passive components (transistors, inductors, capacitors) are helpful.

Modality of Exam

See 5.3

5.4 Smart Networks and Energy Distribution

Module Name			
Smart Networks and Energy Distribution			
Semester	Subject	Module Supervisor	Credit Points for Module
2	Engineering	Prof. Dr.-Ing. Marc Hiller	6

Module Content

The module gives an overview on major power system components, structure and main operation behavior. It starts with an introduction to power systems and the basic knowledge on high voltage engineering. The second part focuses on the main components and describes mainly the function, the state-of-the art and their behavior. The main transmission and distribution aspects are covered in the third part of the module, including network calculation and control. Due to recent and future changes in power systems, a strong focus is in part four on smart grids and their performance. Additionally building performance with respect to energy balance and energy sources is included.

Learning Results (LR)

LR-1: Students understand the functioning of various insulation materials and major spark-over processes for the dimensioning of high-voltage systems.

LR-2: Students have a basic understanding of the challenges concerning smart grids and assessment of the interaction of major components, e.g. smart metering, smart home, and communication.

LR-3: Students are able to calculate energy balances of buildings and are able to understand such calculations.

Workload

Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module).

Controls of Success In EM 4 (5.4)	Modality of Examination	Performance and Duration of Examination	Prerequisites for Exam-participation	Examination Period	Graded
5.4.1 Introduction to Power Systems/ High Voltage Engineering	Written examination	60 minutes	None	Right after the course	Yes
5.4.2 Components of Power Systems	Oral examination	Approx. 15 minutes per candidate	None	At the end of the course week	Yes
5.4.3 Transmission and Distribution	Written examination	60 minutes	None	At the end of the course week	Yes
5.4.4 Smart Grids and Emerging Technologies	Oral examination	Approx. 15 minutes per candidate	None	At the end of the course week	Yes

Grading: The module grade shall be considered proportionally to the credits assigned to the courses.

5.4.1 Introduction to Power Systems/ High Voltage Engineering

Course Name			
Introduction to Power Systems/ High Voltage Engineering			
Semester	Module Type	Allocated to the following Module	Lecturer
2	Compulsory (course is assigned to student by examination board)	Smart Networks and Energy Distribution	Dr. Hanno Stagge
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

The main goal of this lecture is to teach the basics for understanding the following lectures on power system components and transmission and distribution. These lectures require a minimum understanding on structure of power systems, definitions and knowledge on electrical insulation.

Learning Targets

Participants

- gain knowledge of the structural principles and calculation methods for the calculation of electric networks.
- gain competencies to evaluate the high voltage insulation for various applications.

Course Content

Introduction to Power Systems

- Basics of power systems for engineers and scientists.
- General structure of power systems.
- Definition of complex power.
- 1-phase and 3-phase systems.
- Symmetrical and unsymmetrical systems.
- Phasor diagrams for load flow, short circuit and no load.

High Voltage Engineering

- Electrical insulation systems (solid, liquid, gaseous).
- Breakdown in homogenous and inhomogeneous conditions.

Insulation coordination.

Literature

- Y. Hase, Handbook of Power System Engineering, April 2007, Wiley

▪ E. Kuffel, W. S. Zaengl, J. Kuffel, High Voltage Engineering: Fundamentals, Ausgabe 2, illustriert, Verlag Newnes, 2000
Prerequisites for participation in course
Basics of electric circuits (Kirchhoff's law, Ohms law, AC current, complex numbers, etc.) are helpful.
Modality of Exam
See 5.4

5.4.2 Components of Power Systems

Course Name			
Components of Power Systems			
Semester	Module Type	Allocated to the following Module	Lecturer
2	Compulsory (course is assigned to student by examination board)	Smart Networks and Energy Distribution	Thomas Hammer
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives
This lecture gives a detailed technical overview on all components of power grids on a high level. The relevant specifications and quality aspects of network components should be present. The working principles of the components as well as their interconnections are explained.
Learning Targets
After the lecture the participant should have reached the learning targets on the following topics: ▪ Function, stresses and design aspects on the main components in power grids. ▪ Materials and material properties used in high voltage equipment. ▪ Amount of value of the different components. ▪ Substation technology and operation principles. ▪ Transmission line technologies. ▪ Main aspects of substation construction including measures for personnel safety.
Course Content
The setup and working principles of all important and expensive components in transmission and distribution grids is given. The lecture is focused on substation technology, power transformers, instrument transformers, circuit breakers, insulators, insulation

coordination and surge arrestors. In a second part the main aspects of overhead transmission lines and cable connections including all adjacent components are explained in detail. Finally different designs and substation technologies, for example AC air insulated, SF6-insulated, HVDC, are described with its advantages, disadvantages and application ranges.
Literature
A comprehensive reader will be supplied prior to the beginning of lecture.
Prerequisites for participation in course
Basic knowledge in electrical engineering or similar, basics in high voltage engineering and power system engineering with basic knowledge in the following topics. ▪ Static electric and magnetic fields, basic equations and dimensions. ▪ Network analysis. ▪ Physical background of electrical discharges in air
Modality of Exam
See 5.4

5.4.3 Transmission and Distribution

Course Name			
Transmission and Distribution			
Semester	Module Type	Allocated to the following Module	Lecturer
2	Compulsory (course is assigned to student by examination board)	Smart Networks and Energy Distribution	Dr. Christoph Dörnemann
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2
Overall Course Objectives			
Functionality and main characteristics of the transport and distribution networks are understood.			
Learning Targets			
Participants ▪ get an introduction to the regulation and the running of electric networks. ▪ understand and can apply the structural principles of networks and respective calculation methods and safety principles.			
Course Content			

Introduction to the role and functions of electric power networks. In addition to basic technical understanding of networks, the lecture addresses issues such as network topologies, network calculation methods, components and concepts of network technology, effects of neutral point treatment, principles of power system protection, and typical units of a network operator.
Literature
Elektroenergiesysteme, Adolf J. Schwab; Springer Verlag
Prerequisites for participation in course
No prerequisites required.
Modality of Exam
See 5.4

5.4.4 Smart Grids and Emerging Technologies

Course Name			
Smart Grids and Emerging Technologies			
Semester	Module Type	Allocated to the following Module	Lecturer
2	Compulsory (course is assigned to student by examination board)	Smart Networks and Energy Distribution	Prof. Dr. Hartmut Schmeck
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each summer semester	Lecture and exercises	Total 72h, hereof 30h contact hours 42h homework and self-studies	2,4

Overall Course Objectives
The course gives an overview of challenges and chances in the ongoing transformation of the energy grid due to the energy transition from fossil fuels to renewable energy sources. The main aspects are the challenges for adequate support from information and communication technologies and the impact of smart meter infrastructures, based on experience in Germany and Scandinavia. Example scenarios are taken from energy management in smart building environments, electric vehicle infrastructures and control of energy distribution systems. Another topic is the modelling and design of energy relevant aspects in buildings using standard tools like EnergyPlus.
Learning Targets
Participants ▪ gain knowledge for the further development of electric networks through to intelligent grids for the accomplishment of future challenges in efficient use of electricity. ▪ get application knowledge into network communication and information as well as Smart Homes.

Course Content
SMART GRIDS The course will give an overview of current and anticipated future approaches to the distribution and management of electrical energy and on the particular aspects of integrating the batteries of an increasing number of electrical vehicles into the power system. The following topics will be covered (tentative plan) ▪ Structure of the power distribution network (from power generation to power consumption). ▪ Management tasks in electrical energy networks. ▪ Balancing zones, balancing groups, and the tasks of balancing group managers (power schedule planning, the roles of primary, secondary and tertiary balancing power). ▪ Power mix and the special aspects of power generation from renewable sources (including 20-20-20 targets of the European SET plan). ▪ Storage facilities for the energy system. ▪ Market structures in the power system (EEX, day-ahead and intra-day trading). ▪ Information and communication technology in the power system (intelligent metering, communication protocols, selecting appropriate information, privacy issues). ▪ Demand side management (central and decentralized approaches, increasing the flexibility of power consumption and power supply). ▪ Intelligent power management for electrical vehicles (charging, discharging, private and public power charging stations, concepts for roaming, power-aware routing services etc.). EMERGING TECHNOLOGIES ▪ Basics of superconductivity and superconducting phenomena. ▪ Characteristics of most relevant high temperature superconductors. ▪ Energy transmission with superconducting cables. ▪ Superconducting motors, generators and transformers. ▪ Fault current limiters. ▪ Magnetic energy storage.
Literature
▪ B. Seeber, Handbook of Applied Superconductivity, ISBN 0 7503 0377 8 Vol. 2 Applications, 1998, IOP Publishing ▪ Peter J. Lee, Engineering Superconductivity, ISBN: 0-471-41116-7, Wiley Interscience, 2001 ▪ Swarn S. Kalsi, Applications of High Temperature Superconductors to Electric Power Equipment, ISBN: 978-0-470-16768-7, 332 pages, March 2011, Wiley-IEEE Press
Prerequisites for participation in course
Some knowledge of electrical power systems and of some fundamentals of information and communication technology. Participation in course Components of Power System and Transmission and Distribution is desirable, but not a prerequisite
Modality of Exam
See 5.4

5.5 Energy Economics

Module Name			
Energy Economics			
Semester	Subject	Module Supervisor	Credit Points for Module
3	Engineering	Prof. Dr.-Ing. Hans-Jörg Bauer	6

Module Content
Within this module different peculiarities of the energy market (energy efficiency on the supply and demand side, electric mobility, market opening, regulation, etc.) are analyzed from a techno-economic point of view. In order to be able to identify optimal strategies within this complex sector an introduction into energy systems analysis will be given at the beginning of the module. Energy Systems Analysis considers the totality and the interactions of energy systems, among other things, with the commodities industry, the building trade, industry and transport. Integration of Energy Systems and e-mobility concludes this module.
Learning Results (LR)
LR-1: Understanding of the interaction of national and European energy markets and their legal framework conditions. LR-2: Identification and implementation of energy efficiency potentials. LR-3: Understanding and integrated optimization of technical, economic, and ecological aspects of energy systems and their components. LR-4: Understanding of system-overlapping relationships, with the interface between energy and mobility being used as an example.
Workload
Total 180h, hereof 75h contact hours, 105h homework and self-studies (hereof 65 during module, 40 in preparation of module).

Controls of Success In EM 5 (5.5)	Modality of Examination	Performance and Duration of Examination	Prerequisites for Exam-participation	Examination Period	Graded
5.5.1 Energy Markets	Oral examination	Approx. 15 minutes per candidate inutes	None	At the end of the course week	Yes
5.5.2 European Network Regulations	Oral examination	Approx. 20 minutes per candidate	None	At the end of the course week	Yes
5.5.3 Energy Systems Analysis					
5.5.4 Energy Efficiency (Supply and Demand Side)	Written examination	60 minutes	None	At the end of the course week	Yes
5.5.5 Integration of Energy Systems and E-Mobility	Study Achievement	None	None	-	No
Grading: The module grade shall be considered proportionally to the credits assigned to the courses.					

5.5.1 Energy Markets

Course Name			
Energy Markets			
Semester	Module Type	Allocated to the following Module	Lecturers
3	Compulsory (course is assigned to student by examination board)	Energy Economics	Prof. Dr. Dogan Keles Dr. Massimo Genoese
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

Participants will get acquainted with modern energy markets. There will be an introduction into pricing and investments in the different submarkets of the electricity market. Participants will understand the various determinants for short and long-term decisions in the power industry.

Learning Targets

Participants

- gain knowledge of the development of the liberalization in the energy market.
- get to know wholesale markets for electricity.
- understand the markets for emission allowances.
- gain insights into various products such as Forwards and Futures, Re-serve energy markets and markets for transmission rights.
- understand the principles of risk management in energy markets.

Course Content

- Liberalization of energy markets.
- The power market and the corresponding submarkets (Wholesale spot market, Intraday market, Forwards and futures markets, Emission rights market, Markets for ancillary services).
- Pricing and investments in liberalized power markets.
- Risk management.
- Market power.

Literature

Steven Stoft (2002): Power System Economics, John Wiley & Sons New York

Prerequisites for participation in course

No prerequisites.
Modality of Exam
See 5.5

5.5.2 European Network Regulations

Course Name			
European Network Regulations			
Semester	Module Type	Allocated to the following Module	Lecturers
3	Compulsory (course is assigned to student by examination board)	Energy Economics	Prof. Dr. Kay Mitusch Thomas Fluhrer
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

The course objective is to provide general insights into the regulation of energy networks and the corresponding economic principles. Therefore, the necessity of regulation and the objectives and principles, as well as limits of regulation will be described. A major focus of the analysis will be on the performance incentives of the regulated firms concerning cost efficiency, quality, investments and incentives to employ renewable resources resp. deploy network capacities to cope with renewable resources. Furthermore, students will be provided with a critical reflection of the different practices of energy network regulation in Europe

Learning Targets

Participants

- get an overview of economic regulation and natural monopoles.
- learn the particular issues of electricity network regulation.
- learn the concept of efficient spatial pricing and the practical approaches to congestion pricing in electricity networks.

Course Content

Chapters.

- Monopoly theory and its implications for regulation.
- Competition law and regulation (general vs. specific competition policy).
- Types of regulation: Principles of access regulation and pricing; Unbundling approaches in the EU and Germany; cost based regulation; incentive regulation.

- Regulatory practice in Germany and the EU: History; current incentive regulation (regulation formulas); analytical cost modeling used by regulators; benchmarking approaches, yardstick regulation.
- Investment incentives and programs, particularly with respect to the challenges of renewable resources use.
- Management of bottlenecks in the European transmission network.
- Nodal pricing.

The course starts with the economic concept of efficient allocation and an exposition of the basic monopoly problem. Next, the general problems and concepts underlying economic regulation will be explained. These will then be applied to the energy sector, with detailed references to the German energy market and the German regulatory practice.

On the second day the main current challenges of regulation will be outlined, which concern the quality of services, the quality of the infrastructure, and investment incentives. These problems are intertwined with the additional policy demands concerning a swift transition to "green" energy production (i.e. by wind, sun and biogases), in some countries aggravated by the simultaneous demand for an end of nuclear energy production. However, this course only deals with the implied changes on the electricity networks, and the additional problems for network regulation coming from this. After taking stock of these various challenges, the responses of different countries' policies and regulations will be outlined and discussed.

Energy networks are spatial networks. From the point of view of allocation theory, there should be differential prices for electricity in different locations. The corresponding nodal price model will be explained. In reality, European countries face network bottlenecks and congestion particularly at the boundaries between states, but sometimes also between different regions of the same state. Different forms of congestion management, some of them related to the nodal price model, will be discussed from a practical point of view.

Literature
None
Prerequisites for participation in course
Basics in micro economics.
Modality of Exam
See 5.5

5.5.3 Energy Systems Analysis

Course Name			
Energy Systems Analysis			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Energy Economics	Dr. Armin Ardone
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Dozent	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

The course will address the following questions

- What is energy systems analysis?
- How can energy systems be modelled/ optimized?
- Which modelling techniques are applicable in which field of energy systems analysis?
- What can be achieved with energy systems modelling and where are its limits?
- How can energy systems models support the understanding of interdependencies in energy economics?

Learning Targets

Participants

- acquire knowledge of interdependencies in energy economy.
- get to know various simulation methods and fundamentals (applied game theory, optimizing models, Multi-Agent-Modules) that are based on these.
- understand and can apply the possibilities and limits of energy system analysis.

Course Content

- Overview and classification of energy systems modelling approaches.
- Usage of scenario techniques for energy systems analysis.
- Unit commitment of power plants.
- Scenario-based decision making in the energy sector.
- Visualisation techniques for decision support in the energy sector.

Literature

Will be provided during the lecture.

Prerequisites for participation in course

Basics in energy economics.

Modality of Exam

See 5.5

5.5.4 Energy Efficiency (Supply and Demand Side)

Course Name			
Energy Efficiency (Supply and Demand Side)			
Semester	Module Type	Allocated to the following Module	Lecturer
3	Compulsory (course is assigned to student by examination board)	Energy Economics	Prof. Dr.-Ing. Hans-Jörg Bauer Dr. Patrick Plötz
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Lecture and exercises	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2

Overall Course Objectives

The course objective is to identify and assess the potential of reducing fuel consumption and the related environmental impact by an efficiency increase of the energy system. Both the supply side as well as the utilization of energy are addressed.

Learning Targets

Participants

- view the topic of energy supply from a different perspective than in other modules.
- gain knowledge building on the technical basics of business or economic aspects of energy supply.
- engage in the historic development of energy efficiency, measured for the increase of the effect on various supply units, flexibility of the supply side for the integration of renewable energies, energy efficiency in various demand sectors, modeling of energy efficiency measures. Obstacles for energy efficiency and solution possibilities and energy efficiency in general.

Course Content

SUPPLY SIDE

- Historical development of power plant efficiency.
- Measures to increase power plant efficiency: Gas turbines; Steam power plants; Combined cycle.
- CCS efficiency penalty.
- Environmental impact.
- Integration of renewables: power plant flexibility and part load efficiency.

DEMAND SIDE

- Challenges and role of energy efficiency.
- Policy framework.
- Modelling of energy demand and energy efficiency potentials.
- Efficiency measures in demand sectors.
- Demand side management.

Literature
▪ S. C. Bhattacharyya; Energy Economics – Concept, Issues, Markets and Governance; Springer, 2011 ▪ H.I.H. Saravanamuttoo, G.F.C. Rogers, H. Cohen, P.V. Straznicky: Gas Turbine Theory; 6th Edition; Prentice Hall; 2008 ▪ A.S. Leyzerovich: Steam Turbines for Modern Fossil-Fuel Power Plants; CRC Press; 2007
Prerequisites for participation in course
Basic knowledge in Fluid Mechanics, Thermodynamics, Technical Combustion, Thermal Power Plants, Thermal Turbomachinery are strongly recommended.
Modality of Exam
See 5.5

5.5.5 Integration of Energy Systems and E-Mobility

Course Name			
Integration of Energy Systems and E-Mobility			
Semester	Module Type	Allocated to the following Module	Lecturers
3	Compulsory (course is assigned to student by examination board)	Energy Economics	PD Dr. Patrick Jochem Dr. Armin Ardone
Recurrence	Mode of Teaching	Workload	Credit Points for Course
Each winter semester	Dozent	Total 36h, hereof 15h contact hours 21h homework and self-studies	1,2
Overall Course Objectives			
The objective of this lecture is to give students an overview of current research topics in the context of energy efficiency and electric mobility as well as the necessary basic methodologies in this context.			
Learning Targets			
Participants ▪ understand the concept of energy efficiency as applied to specific systems ▪ obtain an overview of the current trends in energy efficiency ▪ are able to determine and evaluate alternative methods of energy efficiency improvement ▪ overview technical and economical stylized facts on electric mobility ▪ judge economical, ecological and social impacts through electric mobility			
Course Content			

This lecture series combines two of the most central topics in the field of energy economics at present, namely energy efficiency and electric mobility. The objective of the lecture is to provide an introduction and overview to these two subject areas, including theoretical as well as practical aspects, such as the technologies, political framework conditions and broader implications of these for national and international energy systems.

The energy efficiency part of the lecture introduces the concept of energy efficiency, the means of affecting it and the relevant framework conditions. Further insights into energy and energy efficiency in economic theory, as well as economy-wide measurements of energy efficiency, and associated difficulties, are given with recourse to several practical examples. Means for energy efficiency on a systems level and decentralized technologies for households are then examined.

The electric mobility part of the lecture examines all relevant issues associated with an increased penetration of electric vehicles including their technology, their impact on the electricity system (power plants and grid), their environmental impact as well as their optimal integration in the future private electricity demand (i.e. smart grids and V2G). Besides technical aspects, the user acceptance and behavioral aspects are also discussed.

Literature

- OECD/IEA, 2008, “Worldwide Trends in Energy Use and Energy Efficiency: Key Insights from IEA Indicator Analysis”, IEA, Paris, France.
- OECD/IEA, 2007, “Mind the Gap – Quantifying Principal-Agent Problems in Energy Efficiency”, IEA, Paris, France.
- Martin Pehnt, Ed., 2010, „Energieeffizienz : ein Lehr- und Handbuch“, Berlin ; Heidelberg : Springer (in German), ISBN: 978-3-642-14250-5

Prerequisites for participation in course

Basic knowledge of Energy and Environment, Energy Economics, Thermodynamics, Sustainable Development, Microeconomics is desirable.

Modality of Exam

See 5.5

6 Master Thesis Energy Engineering and Management

The Master Thesis can be performed either as a research project in one of the institutes at the KIT or in cooperation with the participant's company. In the latter case, it should be performed under the supervision of an advising faculty member from the HECTOR School.

The following table (Tab. 6-1) summarizes the Master Thesis scope and process:

Content	The scope of the Master Thesis should contain the following criteria: ▪ description of the problem ▪ review of the relevant literature (state of the art) ▪ definition, selection and description of suitable approaches ▪ execution of the necessary work schedule (experiments, statistical analyses) ▪ derivation of a conclusion ▪ discussion of validity, scope and verification
Learning Targets/ Skills	Participants demonstrate the skills to independently solve a scientific problem adapting methods and models acquired during participation in the modules 1-10.
Pre-Requisites	Successful completion of 80% of the modules and exams.
Workload	The Master Thesis is to be completed within a period of 9 months. Start of the Master Thesis is the 1st day of the following month after the 8th HECTOR School module.
Master Thesis Operations	1. Orientation Phase: Until module 6 the participants are asked to search for a project within their professional environment. Along with this, they are also asked to search for a first supervisor within the lecturers of the HECTOR School. 2. Registration Phase: The participants are asked to hand in the official Master Thesis application form with an outline of the Master Thesis topic and signed by the chosen first supervisor to the student office of the HECTOR School until the end of module 8. The participant then receives the approval by the study regulations committee. 3. Project Phase: The project phase starts with the 1st of the following month after the 8th HECTOR School module. During the project phase, the participants are asked to follow a milestone plan, which is agreed on with their supervisor. The participants regularly report about their progress to the HECTOR School. Before the final submission, the students will hold official colloquia, where they are asked to present the contents of their Master Thesis in a 20 minutes colloquium using modern media. The colloquia dates are usually set around 4 weeks before the official submission date. 4. Submission Phase: The participant is asked to hand in two paper copies and a digital version on CD or data stick to the student office by the announced completion date. Templates and style formats will be communicated by the HECTOR School.

Tab. 6-1 Master Thesis scope and process

Further information on the Master Thesis regulations can be found in the General Study and Examination Regulations, § 14 (see also Chap. 8.4).

7 Karlsruhe Institute of Technology (KIT)

On October 01, 2009, the Karlsruhe Institute of Technology (KIT) was founded by a merger of Forschungszentrum Karlsruhe and Universität Karlsruhe. The basis was the KIT Merger Act that was adopted unanimously by the Baden-Württemberg state parliament in July 2009. KIT bundles the missions of both precursory institutions: A university of the state of Baden-Wuerttemberg with teaching and research tasks and a large-scale research institution of the Helmholtz Association conducting program-oriented provident research on behalf of the Federal Republic of Germany. Within these missions, KIT is operating along the three strategic fields of action of research, teaching, and innovation.

With roundabout 9450 employees and an annual budget of about EUR 850 million, one of the largest research and teaching institutions nationwide is established in Karlsruhe. It has the potential to assume a top position worldwide in selected fields of research. The objective: KIT will become an institution of top research and excellent scientific education as well as a prominent location of academic life, life-long learning, comprehensive advanced training, unrestricted exchange of know-how, and sustainable innovation culture.

7.1 Department of Mechanical Engineering

Production Technology: Taking an integrated approach

The holistic treatment of products and production in an international environment is central to industrial engineering research projects at Karlsruhe; included in this is not only manufacturing itself, but also operation, maintenance and recycling. The opening of national borders for industries results in the necessity to reduce development times and in turn increase the application of technical models and computational simulations.

Research at Karlsruhe in production focuses on taking an integrated approach to the product and the production within an international context. It is not restricted to the process of production alone, but also includes aspects such as plant operation, maintenance and recycling. Another aspect is the increasing pressure to intensify automation. Research and teaching at the Department's production-technology oriented institutes cover almost every phase of the product life cycle. Research includes issues such as product planning, design, production planning, manufacturing and assembly, quality management, material flow technology and logistics as well as industrial management and ergonomics.

Product Development and Design: The creative element

Product Development and Design have the goal of examining and developing a theoretical basis for methodical development processes including the respective computing systems (CAD/CAM). Taking traditional design methods as a starting point, researchers use an integrated approach to accompany and systematically manage the entire product development and production process. Complex product development and production tasks are solved in close cooperation with industry. In doing so the focus is on the entire development chain – from environmentally compatible and strategic product planning

brainstorming all the way to creating complete three dimensional CAD designs is focused on. Simulations and prototype construction are also part of the process. Other research areas include:

- Energy and environment – developing sustainable technology
- Material Technology – enabling innovative engineering
- Microsystem technology- large impact from small devices
- Mechatronics – a symbiosis of two technological worlds
- Vehicle and powertrain technology – the motors of a mobile society
- Theoretical basics – the foundations of engineering

7.2 Department of Economics and Business Engineering

Research and teaching in the Department of Economics and Business Engineering at Karlsruhe is distinguished by interdisciplinary networked tasks and a focus on current developments. The faculty is the largest training center for graduate industrial engineers in Germany.

The interdisciplinary course in industrial engineering with business studies has characteristics that are typical for Karlsruhe Institute of Technology (KIT): it is geared towards quantitative problems and is therefore strongly method-orientated; it also includes applied computer science. Working in an interdisciplinary network, perhaps taking both economic and technical aspects into account at the same time, is essential for the design, manufacture and marketing of products.

Interdisciplinary research

Despite the large number of resources devoted to teaching at the institutes, research is still very much a priority. The interdisciplinary Research Training Group “Market Engineering” recently founded bridges the gap between education and research. The program is devoted to designing institutions, services, systems and social models for electronic markets while taking into account all of the economic, technology-based and legal aspects.

The main fields of research include:

- Finance and capital market research
- Marketing and market research
- Mapping work processes using computer science
- Information management
- Production and materials flow management
- Ergonomics
- Sustainable construction

- Traffic prediction and transport network planning
- System dynamics and innovation
- Optimization, resource management and risk management
- Actuarial science and applied risk science
- Welfare economics
- Experimental economic research

7.3 Department of Computer Science

Without the use of computers hardly anything in our society would function. Whether in transportation, production, administration, health care or leisure, computers unobtrusively complete increasingly important tasks. As a result, information technology has become an extremely significant sector. The Universität Karlsruhe (TH) was the first German university to offer a full Diploma degree in computer science in 1972. Ever since then, the Department of Computer Science is considered a leader in the field and internationally ranked number one in all the major rankings and evaluations.

Research and education in computer science at the Karlsruhe Institute of Technology (KIT) is characterized by its breadth coupled with a strong focus on theoretical and practical aspects of computer science. The value that the faculty places on multi-disciplinary education is shown by the offer of business informatics degree program. Other fields of research include:

- The applications of computer science: computer-aided surgery
- Semi-humanoid robot systems
- Computers for everyday use

7.4 Department of Electrical Engineering and Information Technology

Its 15 institutes – including two interdepartmental research centers – and approximately 1500 students put the department in the very heart of engineering at the Karlsruhe Institute of Technology (KIT). By focusing on automation, energy, information and communication technology and electronic components and circuits, the faculty puts students in touch with all of the cutting-edge areas of electrical engineering and information technology.

The demand for components and systems for the fast transfer, storage, visualization and processing of information is steadily increasing. Hybrid and quantum components and molecular electronics result in completely new possibilities for future information processing and storage.

Microelectronic and nanoelectronic components also enable the so-called System on Chip (SoC): the integration of complete microelectronic systems onto a single silicon chip has become feasible through

the rapid development of CMOS VLSI technology. This demands cost-effective technology, application specific hardware/software architectures and highly efficient design methods. Other research areas include:

- Mechatronics – new functions through interdisciplinary research
- Energy at the cross roads of ecology and economics
- Fuel cells: a technology for the future
- Wireless communication: effective planning of transmitter networks
- Systems engineering: personal health monitoring
- Aviation and aeronautics
- Microelectronics, nanoelectronics and optoelectronics

7.5 Department of Chemical Engineering

The Department of Chemical Engineering and Process Engineering at the KIT with 12 chairs at 6 institutes and about 1000 students is one of the world's largest in their field of study. Chemical Engineers have been educated successfully in Karlsruhe since 1928. The traditional courses chemical engineering and process engineering were complemented by the bioengineering program in 2001. All three courses have steadily increasing intake and graduate numbers.

Chemical engineering, process engineering and biological engineering are interdisciplinary engineering sciences connecting the fields of engineering, technical physics, mathematics, and chemistry. The focus of research and teaching at the faculty is in the three general themes material process technology, biotechnology and food technology, energy and environmental technology.

7.6 Department of Civil Engineering, Geo and Environmental Sciences

At the beginning of the foundation of the University of Karlsruhe stood the engineer Johann Gottfried Tulla. In 1807 he founded an Engineering School in order to educate employees for the administration of Highway Building and Hydraulic Engineering, which was organized by him. An architect joined this project: Friedrich Weinbrenner, his Building School arose from the Architectural Drawing School, which existed since 1787. The union of Tulla's Engineering School and Weinbrenner's Building School with the Academy of Machine Construction of Freiburg and a School of Forestry gave rise to the foundation of a Polytechnic School in 1807. It achieved academic quality and was called "technical academy". Tulla, the principal of the highway building and hydraulic administration of Baden County had already intensely prepared the project. In Paris short after Napoleon's coup d'état he had got to know the Polytechnic University of Ecole – the University, which at first gave its students a basic scientific education, before it specialized the prospective engineers in their future profession.

Today both the traditional acquiring of basic scientific knowledge and accomplishing of applied scientific work are regarded as equally important at the University Fridericiana, how the university is called since 1902. And Tulla's special field of activity – the regulation of the Rhein is still researched today. Since 2002 Geo- and Environmental Sciences and the Civil Engineering work together within this department. Thus the dovetail connection and interaction of building structures and their environment and the study of intervention/interference in the city and cultivated landscape are accommodated during the education and research.

8 Appendix

8.1 European Credit Transfer and Accumulation System

8.1.1 What is the ECTS (European Credit Transfer System)?

The European System for calculating, assessing and accumulating student performance is a system specifically designed for students. It is based on the workload that the student must complete in order to achieve the objectives of the program of study. These objectives are primarily defined in the form of learning outcomes and the competencies that are to be acquired in the course of study.

8.1.2 What are the primary aspects of ECTS?

The ECTS is based on the general understanding that the workload for a full-time student during an academic year corresponds to a total of 60 ECTS-credits. That means that the workload for a full-time student studying in Europe comprises 1500-1800 working hours per year in most cases. For our part-time program the workload consists of 90 ECTS for the whole program which is effectuated in approximately 1,5-2 academic years.

- The workload in ECTS consists of the time that a student requires to complete a variety of learning activities, such as attending lectures and seminars (contact hours), self-study, project work, exam preparation, etc.
- Credits are assigned to all components of a program of study (e.g. modules, courses, laboratories, final project, etc.) and indicate the workload of each component in relation to the total workload that would be required in one full year of study in the appropriate program of study.
- The learning results are a set of competencies, which indicate what the students should know, understand, and be able to do at the end of a short or long learning process. Credits in ECTS are awarded to students only after the course has been completed and a corresponding evaluation of the desired learning results has been made.
- The assessment of student performance is documented via the commonly-used grading system for each local/national region. It is good practice, especially in the case of credit transfers, to include an ECTS grade. The ECTS grading scale ranks students based on a statistical distribution. Thus, statistical data on student performance is a necessary prerequisite for applying the ECTS grading scheme. Successful students can obtain the following grades: A for the best 10%, B for the next 25%, C for the next 30%, D for the next 25%, E for the next 10%. Unsuccessful course performance receives a grade F. The transcript of records need not specify the number of failed attempts.

8.2 Quality Management

The HECTOR School of Engineering and Management guarantees for the quality and continual improvement of the curriculum. A number of tools are used in order to ensure the high academic and pedagogic standards defined by their members.

8.2.1 Course evaluation

After each module a written questionnaire is distributed to the participants on which they can evaluate the quality of the lectures. The main topics are:

- lecture content
- practical applicability
- interference/overlap with other lectures
- relationship/link to preceding lectures
- speed of material presentation
- extension of the lecture material
- usefulness/relevance of lecture notes
- audibility of lecturer
- blackboard, transparency structure
- preparation of lecturer
- presentation style and motivation
- willingness to answer questions

After each module the returned questionnaires are analyzed and published on the SharePoint of the HECTOR School and are discussed with lecturers and students.

8.3 Admissions Regulations

The official “Satzung für den Zugang zu dem weiterbildenden Masterstudiengang Energy Engineering and Management am Karlsruher Institut für Technologie” can be found here: http://www.sle.kit.edu/amtlicheBekanntmachungen2013.php

A translated version of the “Admission Regulations” can be found on the HECTOR School SharePoint.

8.4 General Study and Examination Regulations

The official “Studien- und Prüfungsordnung des Karlsruher Instituts für Technologie (KIT) für den weiterbildenden Masterstudiengang Energy Engineering and Management” can be found here: https://www.sle.kit.edu/downloads/AmtlicheBekanntmachungen/2017_AB_056.pdf

A translated version of the “General Study and Examination Regulations” can be found on the HECTOR School SharePoint.

8.5 Fees Regulations

The official “Satzung des Karlsruher Instituts für Technologie (KIT) über die Studiengebühren für die weiterbildenden Masterstudiengänge Electronic Systems Engineering & Management, Energy Engineering & Management, Financial Engineering, Green Mobility Engineering, Management of Product Development, Production and Operations Management, Service Management & Engineering” can be found here: http://www.sle.kit.edu/amtlicheBekanntmachungen2013.php

A translated version of the “Fees Regulations” can be found on the HECTOR School SharePoint.