Contents

Contact & Imprint

HECTOR School of Engineering and Management, Karlsruhe Institute of Technology (KIT)

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Curriculum may be subject to change.

1 Foreword

Added value of a Master of Sciences 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.

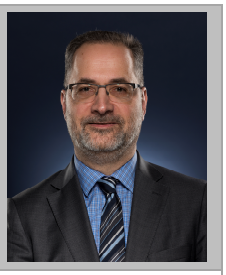
The general aims of the course are essentially already defined by the target group- future executives: developing methodological and personal competencies by communicating fundamental, specialist and interdisciplinary know-how and skills. Graduates of the course will be empowered to make an important 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. Mathias Noe Prof. Dr.-Ing. Hans-Jörg Bauer

Program Directors of Energy Engineering and Management

2 Program Directors

Title/ Name	Prof. Dr.-Ing. Hans-Jörg Bauer	
Phone	+49 (0) 721- 608 43240	
E-Mail	***Hans-Joerg.Bauer@kit.edu***	
Affiliation	Institute of Thermal Turbo Machinery, KIT Kaiserstraße 12, 76131 Karlsruhe	
Current Position	Head of the Institute of Thermal Turbo Machinery, KIT Scientific Speaker KIT Energy Center Director Rolls-Royce University Technology Center in Karlsruhe	
Vita	1989 PhD (Dr.-Ing.) Universität Karlsruhe 1989 – 1994 Family Business, General Manager (1991-1994) 1994 – 1996 Group Leader Combustion Research, ITS, Universität Karlsruhe 1996 – 2004 Rolls-Royce Deutschland GmbH, Combustion Specialist, Group Leader Aerodynamics and Fuel Preparation, Head of Combustor Department, Manager Engineering Quality Since 2004 Full Professor, Institute of Thermal Turbo Machinery, KIT	
Fields of Interest	▪ Heat transfer and cooling of gas turbine components ▪ Gas turbine air & oil systems ▪ Turbo chargers and micro gas turbines ▪ Computational fluid dynamics and advanced instrumentation ▪ Innovation for energy systems ▪ Heat transfer and cooling of gas turbine components	
Memberships & Awards	American Society of Mechanical Engineers Combustion, Fuels & Emissions Committee of the International Gas Turbine Institute Deutsche Gesellschaft für Luft- und Raumfahrt, DGLR	

Title/ Name	Prof. Dr.-Ing. Mathias Noe	
Phone	+49 (0) 721- 608 23500	
E-Mail	***Mathias.Noe@kit.edu***	
Affiliation	Institute for Technical Physics, Karlsruhe Institute of Technology (KIT)	

	Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany
Current Position	Director of Institute for Technical Physics, KIT Professorship in Technical Applications of High Temperature Superconductivity at the Faculty of Electrical Engineering and Information Technology, KIT
Vita	12/1991 Diploma, Technical University Hannover 06/1998 PhD, Technical University Hannover 1997 – 1998 Postdoc, Ecole Polytechnique Federale de Lausanne 1998 – 2001 Researcher at Institute for Technical Physics, Research Center of Karlsruhe 2001 – 2005 Technical Coordinator of the Karlsruhe Tritium Neutrino Experiment at Institute for Technical Physics, Research Center of Karlsruhe 2003 – 2006 Group Leader for Applications of Superconductivity in Power Systems at Institute for Technical Physics, Research Center of Karlsruhe 2006 – today Director of Institute for Technical Physics, KIT; Areas: superconductors and superconducting components, Tritium Laboratory Karlsruhe, cryo technology, vacuum technology 2006 – today Professorship in Technical Applications of High Temperature Superconductivity at the Faculty of Electrical Engineering and Information Technology, KIT
Fields of Interest	▪ Fusion technology (e.g. superconducting magnets, current leads, fuel cycle including tritium processing and vacuum systems) ▪ New and advanced power system components (e.g. cables, generators, transformers, fault current limiters, superconducting energy storage); power system calculations ▪ Cryogenic high voltage engineering ▪ Project management ▪ High field superconducting magnets ▪ Economic evaluations and power system studies ▪ Industrial relations, i.e., joint R&D projects with several companies.
Memberships & Awards	Reviewer DFG, ERC, FP7, Wissenschaftsrat and some journals 2004 – 2010 International Council of Large Electric Systems (CIGRE), Secretary of Working Group “HTS Materials and electrical insulation” 2010 – today International Council of Large Electric Systems (CIGRE), Secretary of Working Group “Emerging test techniques common to HTS power equipment” 2006 – today International Energy Agency (IEA), Implementing Agreement on Assessment of Superconductivity, German Representative 2006 – today Scientific Committee of International Magnet Conference Series 2006 – today Board member of European Society of Applied Superconductivity 2008 – today International Council of Large Electric Systems (CIGRE), Invited expert of Working group, “Fault current limiters” 2009 – today Editorial Board of “IEEE Transactions of Applied Superconductivity” 2009 – 2010 Member of joint CCE-FU-F4E GB Working group on DEMO 2010 – today Member of Technical Advisory Panel of F4E

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	• Modellinglocation decisions in Supply Chain Management • Multiperiodic deisgn 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 Organization

3.1 Program Structure and Curriculum

Excellence in Technology Management: Seven 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

- Electronic Systems Engineering and Management (ESEM)
- Energy Engineering and Management (EEM)
- Financial Engineering (FE)
- Green Mobility Engineering (GME)
- Management of Product Development (MPD)
- Production and Operations Management (POM)
- Service Management and Engineering (SME)

The concurrently taught Executive Master Programs are designed for working professionals. Block lectures scheduled at intervals allow participants to continue with demanding careers while acquiring new skills. The course program officially begins in October of each year and lasts 15 months. After this period the Master Programs will be completed with a Master Thesis. Courses are divided into 10 intensive modules of 10 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 following table (Tab. 3-1) shows the sequence of the modules and the curriculum of the program.

# of Module	Type of Module	Name of Module	Course
1	EM1	Renewables	1. Introduction and Scope of EEM, Energy Systems
			2. Wind and Water Power
			3. Solar and Geothermal Power
2	EM2	Thermal Energy Conversion	1. Technical Combustion/ Heat and Mass Transfer
			2. Thermal Power Plants incl. Coal and Gas Power Plants
			3. Turbo Machinery
			4. Carbon Capture and Storage – Underground Gas Storage
			5. Energy from Biomass

# of Module	Type of Module	Name of Module	Course
3	MM1	International Project Management	1. Project Management
			2. Multi-Project Management in an International Setting
			3. Development Management
			4. Intercultural Management
4	MM2	Finance for Executives	1. Introduction to Finance and Accounting
			2. Financial Accounting
			3. Fundamentals of Finance
5	EM3	Electricity Generation and Energy Storage	1. Power Generators
			2. Batteries and Fuel Cells
			3. Hydrogen Technology
			4. Photovoltaics
			5. Power Electronics
			6. Thermal Energy Storage
6	MM3	Management Accounting, Marketing and Strategy	1. Business Strategy
			2. Management Accounting
			3. Marketing
7	EM4	Smart Networks and Energy Distribution	1. Introduction to Power Systems/ High Voltage Engineering
			2. Components of Power Systems
			3. Transmission and Distribution
			4. Smart Grids and Emerging Technologies
8	EM5	Energy Economics	1. Energy Systems Analysis
			2. Energy Markets
			3. European Network Regulations
			4. Energy Efficiency (Supply and Demand Side)
			5. Integration of Energy Systems and e-Mobility
9	MM4	Corporate Innovation and Intrapreneurship	1. Corporate Entrepreneurship
			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

# of Module	Type of Module	Name of Module	Course
			8. New Product Development and Service Innovation
			9. Measuring Innovation: Innovation Balanced Scorecard
			10. Pitching Business Models
10	MM5	Law and Contracts	1. Decisions, Contracts, Markets and Trade
			2. International Law – The Law of Business Organizations
			3. International Intellectual Property Law

Tab. 3-1 Sequence of the modules and curriculum of the program in EEM

3.2 Academic Calendar Intake 2015

Figure 1: Academic Calendar Intake 2015

3.3 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 5 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 5 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).

3.4 Credit Points

The awarded credit points during the part-time Master of Science Program are distributed as follows (for further information on the ECTS System please see chapter 9.1.):

Module	Hours in class	Credit Points	
		POM, MPD, ESEM, GME, EEM	FE, SME
MM1	75	6	6
MM2	75	6	6
MM3	75	6	6
MM4	75	6	6
MM5	75	6	6
EM1	75	6	8
EM2	75	6	8
EM3	75	6	8
EM4	75	6	8
EM5	75	6	8
Master Thesis	900/600	30	20
Total		90	90

3.5 Lecturers

3.5.1 Management Modules

Name	Institute
Program Director	
Prof. Dr. Stefan Nickel	Institute for Operations Research, KIT
Module Supervisors	
Prof. Dr. Martin E. Ruckes	Institute for Finance, Banking and Insurance, KIT
Prof. Dr. Martin Klarmann	Institute of Economic Information and Marketing, KIT
Prof. Jordi Vinaixa Serra	ESADE
Prof. Dr. Clemens Puppe	Institute of Economic Theory and Statistics, KIT
Lecturers in Alphabetical Order	
Prof. Dr.-Ing. Dr. h.c. Albert Albers	Institute of Product Development, KIT
Dipl.-Inform. Abilio Avila	Institute for Entrepreneurship, Technology Management and Innovation
Miguel Angel Heras	ESADE
Prof. Dr. Elena Bou	ESADE
Dr. Michael A. Buchmann	IMTEAM Intercultural Management Team
Dr. Kerstin Fehre	Institute of Applied Business Studies and Management, KIT
Xavier Ferrás	ESADE
Sven Jacobs	Norton Rose Fulbright LLP
Prof. Dr. Anja Kern	Cooperative State University, DHBW Mosbach
Dr.-Ing. Robert Landwehr	Daimler AG
Prof. Dr. Amy Leaverton	ESADE
Prof. Dr. Hagen Lindstädt	Institute of Applied Business Studies and Management, KIT
Dr. Torsten Lüdecke	Institute for Finance, Banking and Insurance, KIT
Prof. Dr. Martin Schulz	German Graduate School of Management and Law, GGS
Prof. Dr. Enric Segarra Costa	ESADE
Prof. Dr. Orestis Terzidis	Institute for Entrepreneurship, Technology Management and Innovation
Prof. Dr. Luis Vives	ESADE
Prof. Dr. Ivanka Visnjic	ESADE
Prof. Dr. Berthold Wigger	Institute for Economic Policy Research, KIT

3.5.2 Engineering Modules

Name	Institute
Program Directors & Module Supervisors:	
Prof. Dr.-Ing. Hans-Jörg Bauer	Institute of Thermal Turbomachinery, KIT
Prof. Dr.-Ing. Mathias Noe	Institute for Technical Physics, KIT
Lecturers in alphabetical Order:	
Dr. Valentin Bertsch	Institute for Industrial Production, KIT
Prof. Dr. Henning Bockhorn	Engler-Bunte-Institute Division of Combustion Technology, KIT
Prof. Dr. Josep Bordonau	UPC, Universitat Politècnica de Catalunya
Prof. Dr.-Ing. Bruno Burger	Fraunhofer Institute for Solar Energy Systems
Dipl.-Ing. (BA) Oliver Deuschle	EnBW Regional AG
Prof. Dr. Helmut Ehrenberg	Institute for Applied Materials – Energy Storage Systems, KIT
Prof. Dr. Eduard Egusquiza	UPC, Universitat Politècnica de Catalunya
Prof. Dr. rer. pol. Wolf Fichtner	Institute for Industrial Production, KIT
Dr. Thomas Fluhrer	Transnet BW
Prof. Dr. Martin Gabi	Department of Mechanical Engineering, KIT
PD Dr. Patrick Jochem	Institute for Industrial Production, KIT
Dr.-Ing. Thomas Jordan	Institute for Nuclear and Energy Technologies, KIT
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
Prof. Dr. rer. nat. habil. Ulrich Maas	Institute of Technical Thermodynamics, KIT
Dr. Russell McKenna	Institute for Industrial Production, KIT
Prof. Dr. Kay Mitusch	Institute for Economic Policy Research, KIT
Prof. Dr.-Ing. Michael Powalla	Light Technology Institute, KIT
Dr.-Ing. Michael Schäfer	EnBW Regional AG
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
Johan Söderbom	Head of Department Distribution and Sales R&D, Vattenfall AB
Prof. Dr.-Ing. Robert Stieglitz	Institute for Neutron Physics and Reactor Technology, KIT
Prof. Dr. rer. pol. Martin Wietschel	Institute for Industrial Production, KIT Fraunhofer Society

4 Qualification Objectives

4.1 Qualification Objectives at Program Level

All seven 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

4.2 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 ultimately to evaluate the effectiveness of strategies. On the basis of this analysis, recommendations for action can be derived.

5 Description of the Management Modules

5.1 International Project Management

International project management is one of the crucial key qualifications for employees in an internationally acting company. In order to acquire this important competency, the participants receive an introduction to project management that aims at being able to identify and apply goals and quantitative methods of project planning. The participants realize how they can analyze and steer projects. Special emphasis of the module is laid on the pervasion and creation of project-network and Gantt-diagrams, heuristic solution processes and “change management” in the project. Furthermore the calculation approaches in time- and resource-limited projects as well as risk and cost management approaches are in focus. For this purpose methodological competence is conveyed in the areas modeling, planning and disposition of projects. The final focus is on the international diversity of management cultures, their impact on different understandings and practices in project management and on ways to successfully manage international projects.

Module Name: International Project Management

Module Supervisor: Prof. Dr. Stefan Nickel

Type of Module: Management Module 1 (MM1)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Project Management	30	42
Multi-Project Management in an International Setting	15	21
Development Management	15	21
Intercultural Management	15	21

Major Learning Results (LR):

LR-1: Knowledge of the principles and various instruments of project management and project planning and the acquisition of abilities to plan projects and create controlling systems.

LR-2: Analysis of various methods and procedures of multi-project management and project controlling in a global context.

LR-3: Knowledge of the product development process as well as important parameters of product development and development methods in the context of project management.

LR-4: Understanding of cultural issues in project management and application of ways to mitigate cross-cultural risks and leverage cultural differences.

Performance appraisal for this Module:

Within the first Management Module the performance appraisal consits of three written exams and a graded project work. For the course *Intercultural Management* performance appraisal will be based on a case study and class room participation.

Credit Points: 6

5.1.1 Project Management

Lecturer	Prof. Dr. Orestis Terzidis, Prof. Dr. Stefan Nickel, Dipl.-Inform. Abilio Avila
Content	▪ Introduction to project management and to a project case ▪ Project planning cycle and project characteristics ▪ Project innovation through design thinking ▪ Bridging discipline and innovation ▪ Organizational structures ▪ Project objectives, initiation and planning ▪ Activity-on-Node networks ▪ Structural and time analysis ▪ Stochastic time analysis ▪ Project execution ▪ Project monitoring and controlling ▪ Project closing ▪ Teamwork ▪ Stakeholder management ▪ Project communication ▪ Risk management ▪ Cost & budget ▪ Quality management ▪ Traditional project management vs. agile project management ▪ Bridging discipline and agility
Course Objectives	Understand the general approach in project management and know-how to plan, initiate and execute projects.
Learning Targets/ Skills	The Participant ▪ gains competencies of the principles and instruments of project management ▪ gains skills to plan, initiate and execute projects ▪ learns how to manage competing objectives and stakeholders.

Pre-Requisites	none
Teaching Method	The course consists of introductory lectures, accompanying exercises, cases and discussions. The overall teaching approach is based on action learning / experiential learning.
Performance Appraisal	

	Written	Oral
Participation during course	-	-
Case Study	-	25%
Project Work	-	25%
Exam	50%	-

Course Material	Slides, templates, checklists
Literature	• A Guide to the Project Management Body of Knowledge (PMBOK® Guide)—Fifth Edition, Project Management Institute • The Fast Forward MBA in Project Management, Eric Verzuh • Agile Product Management with Scrum: Creating Products That Customers Love, Addison-Wesley, Roman Pichle • Scrum Guide 2013, Ken Schwaber, Jeff Sutherland • Designing for Growth: A Design Thinking Tool Kit for Managers (Columbia Business School Publishing), Jeanne Liedtka, Tim Ogilvie • Operations Research, Stefan Nickel, Oliver Stein, Karl-Heinz Waldmann, 2014, Springer-Lehrbuch
Contact Lecturer	Prof. Dr. Orestis Terzidis, E-Mail: ***Orestis.Terzidis@kit.edu*** Prof. Dr. Stefan Nickel, E-Mail: ***Stefan.Nickel@kit.edu*** Abilio Avila, E-Mail: ***Abilio.Avila@kit.edu***

5.1.2 Multi-Project Management in an International Setting

Lecturer	Dr.-Ing. Robert Landwehr
Content	▪ Identification of the main characteristics and problems of international single and multi-project management ▪ Introduction of methods and tools for multi-project management ▪ Discussion of the organization and financing as well as the cultural aspects of international single and multi-project management ▪ Analysis of real world business cases
Course Objectives	Because of the growing importance of project work and the increasing internationalization of projects, this course focuses on complex multi-project management approaches in global environment. The content the course “project management and scheduling” are extended by introducing methods and tools for managing single and multiple projects. Another point of focus is the organization and the financing of international projects. In addition the cultural aspects of international collaboration are also discussed. The content of the course is complemented by industrial examples to provide a practical reference. The concerted aim is to impart the basic knowledge of project, development and innovation management.

Learning Targets/ Skills	The Participant ▪ gains knowledge of various methods and procedures of project management and project controlling in a global context. ▪ is able to analyze problem areas of project management in international and intercultural coherences and to specifically contribute to the improvement of project management in an intercultural environment. ▪ is able to structure a project portfolio in critical and confusing situations and to make proposals to the top-management about the evaluation and selection or prioritization of projects. ▪ is capable to systematically establish and apply a multi-project management system including related tools and processes (including project portfolio analysis, program management, risk evaluation, interdependency analysis etc.) with the aid of the mediated knowledge in a business (respectively at a location).
Pre-Requisites	Professional basic knowledge in project management, such as project planning, risk assessment for projects and project controlling.
Teaching Method	The course consists of lectures, and industrial presentations as well as accompanying exercises and collective discussions.
Performance Appraisal	

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work	-	-
Exam	100%	-

Course Material	Lecture notes and presentations in digital form.
Literature	▪ B.P. Lientz, K.P. Rea: International Project Management, 2002 ▪ Owen J. Murphy: International Project Management; South-Western Pub 2005; ISBN: 0324203020
Contact Lecturer	Dr.-Ing. Robert Landwehr, E-Mail: ***Mail@Robert-Landwehr.de***

5.1.3 Development Management

Lecturer	Prof. Dr.-Ing. Albert Albers
Content	Development management is an essential function in many industries and strongly related to project management. Well founded knowledge within this field is extremely advantageous. By taking part in this course, participants learn to define and characterize development of projects. The significance of the processes, that make a product and a company successful are also taught. Thus participants gain insight into the influences on targets, methods to control development processes, cost and time management, human resource management, quality management and information management. In addition, fundamental methods, such as the adaptation of phase models, the strategic planning of human resources and the integration of a development department into a company, will be taught. Real examples are presented in order to convey company structures, project management and the influence of company-specific factors,

	three key issues within development management.
Course Objectives	Great ideas do not suffice to turn R&D investments into profitable products. This course offers a groundbreaking innovative approach towards developing products that consumers will buy and therefore help to support a company's long-term success based on an effective project management.
Learning Targets/ Skills	The Participant ▪ gains competencies of the product development process and the existing dependencies on markets and businesses as well as important parameters of product development and development methods. ▪ is capable of analyzing the development process in terms of project management on the basis of a systematic development approach (including profile definition, idea generation, conceptual and integrated development). ▪ learns, based on practically oriented case studies, how to apply creativity techniques, like development rules and principles for quality management, to be able to find ideal solution processes in the project planning of a development process.
Pre-Requisites	No specific prerequisites are required.
Teaching Method	The course structure consists of lectures, and industrial presentations as well as accompanying exercises and group discussions.
Performance Appraisal	

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work	-	-
Exam	100%	-

Course Material	Lecture notes and presentations in printed form.
Literature	A comprehensive reader will be supplied.
Contact Lecturer	Prof. Dr.-Ing. h.c. Albert Albers, E-Mail: ***Albert.Albers@kit.edu***

5.1.4 Intercultural Management

Lecturer	Dr. Michael Buchmann
Content	Why and what is 'Intercultural Management'? ▪ 'Culture' in the sense of 'business culture', 'corporate' or 'leadership culture' and 'national management culture'; it's strong impact on business and management performance ▪ Triangle and interaction of 'culture', 'context' and 'individual' ▪ Cultural competence as a key factor for international success Systems and indicators to measure and describe different management cultures ▪ Survey of individual values of participants, comparisons with cultural values ▪ Dimensions of culture (Hofstede, Hall)

<table>
<tr><td></td><td>

Hofstede's 5 dimensions of culture; references to Hall, Trompenaars, Globe
'Culture standards', factors of variations, changes over time
Illustrations and examples from and reference to countries of participants

Applications

Specific implications for international project management

Communication, risk and conflict management
Hierarchy and stake holder management, leadership
Team composition, development and cooperation
Planning, structuring and time management

with further attention to virtual teams
Leveraging intercultural polarities –process and tools for international project management
Leveraging intercultural polarities –process and tools for international project management
Case study

</td></tr>
<tr><td>Course Objectives</td><td>Cultural differences are mainly based on historical reasons and depend on the social perspective and judgment. The objective of this course is to understand this approach and accept the consequences for the individual behavior. Culture appropriate behavior greatly increases success in international management and cooperations. Participants acquire a clear and manageable system to tell and successfully interact with cultural differences in project management.</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant

is able to systematically analyze cultural differences
acquires a comprehension of intercultural differences and the effects on global project management teams in order to adjust the own behavior.

</td></tr>
<tr><td>Pre-Requisites</td><td>Open mindedness.</td></tr>
<tr><td>Teaching Method</td><td>Power point presentations and lectures with frequent examples, discussions with and contributions by participants, individual survey, exercises and short cases</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>60%</td></tr>
<tr><td>Case Study</td><td>-</td><td>40%</td></tr>
<tr><td>Project Work</td><td>-</td><td>-</td></tr>
<tr><td>Exam</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>Lecture notes and presentations in printed form</td></tr>
<tr><td>Literature</td><td>

Geert Hofstede: Cultural Dimensions for Project Management, in J. O. Riis, J. Lauridsen, M. Fangel, S. Hildebrandt and F. Runge (eds): Project Management – Tools and Visions, Proceedings of the 7th Internet World Congress 1982, Volume G-K, Copenhagen, The Danish Technical Press, 1982, 683-700, Also in International Journal of Project Management, Vol. 1, no. 1, 1983, 4-48
Nancy J. Adler with Allison Gundersen: International Dimensions of Organizational Behavior, Thomson Higher Education, Mason OH USA, 5th ed. (international student edition) 2007.
Geert Hofstede, Gert Jan Hofstede, Michael Minkov: Cultures and Organizations:

</td></tr>
</table>

	Software of the Mind – Intercultural Cooperation and its Importance for Survival, revised and expanded 3. ed., Mc Graw Hill 2010.
Contact Lecturer	Dr. Michael Buchmann, E-Mail: ***Buchmann@executivesynergy.net***

5.2 Finance for Executives

The module "Finance for Executives" focuses on analyzing, interpreting and reporting business activities in companies. The module's focus is on financial accounting and on corporate finance. In the financial accounting segment, participants gain an understanding of how financial accounting is used by prospective consumers of corporate financial information, such as managers, stockholders, financial analysts, and creditors. The course enables students to understand how economic events are recorded in the three main financial statements: income statement, balance sheet, and statement of cash flows. Participants will develop the skills needed to analyze corporate financial statements.

In the corporate finance segment, participants gain a profound economic and methodical knowledge of modern financial management. Participants develop an understanding of how capital is allocated within companies and are able to assess the profitability of investment projects and acquisitions. In addition, participants gain a thorough understanding how financial markets work and how companies are able to obtain capital from financial markets to support their business strategy.

Module Name: Finance for Executives

Module Supervisor: Prof. Dr. Martin E. Ruckes

Type of Module: Management Module 2 (MM2)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Introduction to Finance and Accounting	7,5	10,5
Financial Accounting	33,75	47,25
Fundamentals of Finance	33,75	47,25

Major Learning Results (LR):

LR-1: Evaluation of investment projects from a financial point of view and the development of an understanding of the main principles of business finance and the efficient acquisition of capital resources.

LR-2: Development of an understanding of how financial statements are generated and how users of financial information analyze financial statements.

LR-3: Application of concepts to real world problems by combination of concepts of financial accounting, financial management and business strategy.

Performance Appraisal for this Module:

Within the second Management Module the performance appraisal consists of two written exams and a case study with a presentation.

Credit Points: 6

5.2.1 Introduction to Finance and Accounting

Lecturer	Prof. Dr. Martin E. Ruckes Dr. Torsten Lüdecke
Content	The introductory lecture reviews some of the most challenging issues and questions raised by modern corporate finance and focuses on how this discipline views and uses financial statements. The balance sheet and the income statement are presented as the two most important financial statements. Both statements are analyzed with respect to the question how management decisions shape financial statements.
Course Objectives	The course shows how finance and accounting work together and build upon each other. To that end, key principles and concepts along with many important terms from both domains are introduced and defined.
Learning Targets/ Skills	The Participant gets a broad understanding of ▪ what executives want to accomplish in corporate finance ▪ guiding principles of finance and accounting, ▪ the content, structure, and use of major financial statements.
Pre-Requisites	None
Teaching Method	Lecture as well as accompanying exercises, homework, discussion sections and cases.
Performance Appraisal	

	Written	Oral
Participation during course	-	100%
Reflection document	-	-
Project Work	-	-
Exam	-	-

Course Material	Lecture notes, homework, exercises and case studies.
Literature	Hawawini, G. and Viallet, C. (2011): Finance for Executives, 4th ed., South-Western Publishing. Penman, S.H. (2013): Financial Statement Analysis and Security Valuation, 5th ed., McGraw Hill.
Contact Lecturer	Prof. Dr. Martin Ruckes, E-Mail: ***Martin.Ruckes@kit.edu*** Dr. Torsten Lüdecke, E-Mail: ***Torsten.Luedecke@kit.edu***

5.2.2 Financial Accounting

Lecturer	Dr. Torsten Lüdecke
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.
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/ Skills	The Participant is able to ▪ understand the balance sheet, income statement and statement of cash flow ▪ track corporate decision-making into financial statements, ▪ apply financial statement analysis.
Pre-Requisites	None
Teaching Method	The course structure consists of lectures as well as accompanying exercises, cases, homework and discussion sections.
Performance Appraisal	

	Written	Oral
Participation during course	-	-
Case Study	-	20%
Project Work	-	-
Exam	80%	-

Course Material	Lecture notes, homework, case studies and exercises. Printed material.
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.
Contact Lecturer	Dr. Torsten Lüdecke, Email: ***Torsten.Luedecke@kit.edu***

5.2.3 Fundamentals of Finance

Lecturer	Prof. Dr. Martin E. Ruckes
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 problems of optimal capital structure and the dividend decision are addressed.
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, ▪ firm valuation.

Learning Targets/ Skills	The Participant ▪ is placed in a position to judge corporate investment projects from a financial point of view, ▪ gains a thorough comprehension of the main principles of business finance, ▪ is able to assess the value of business enterprises
Pre-Requisites	None
Teaching Method	The course structure consists of lectures as well as accompanying exercises, cases, homework, discussion sections and cases.
Performance Appraisal	

	Written	Oral
Participation during course	-	-
Case Study	-	20%
Project Work	-	-
Exam	80%	-

Course Material	Lecture notes, homework, exercises and case studies.
Literature	Hawawini, G. and Viallet, C. (2015): Finance for Executives, 5th ed., South-Western Publishing
Contact Lecturer	Prof. Dr. Martin E. Ruckes, E-Mail: ***Martin.Ruckes@kit.edu***

5.3 Management Accounting, Marketing and Strategy

This module addresses three key core functions of any business: Management Accounting, Marketing and Strategy. Participants will be introduced to fundamental concepts in each of these three domains. After the module they will be able to apply methods and tools to face challenges in this context.

In the Management Accounting part of this module, participants will understand the key principles behind cost accounting, planning, and control. In the Marketing element, participants will be introduced to the marketing concept and the marketing mix. The implementation of the marketing concept will then be illustrated along the challenge of selling hybrid offerings made up of products and services ("solution selling"). Doing so, the module also introduces a number of important sales concepts. Finally, the Strategy element of the course will introduce participants to a strategic perspective on business portfolios, by using analysis and evaluation tools to, at the end, formulate strategies at a company level.

Module Name: Management Accounting, Marketing and Strategy

Module Supervisor: Prof. Dr. Martin Klarmann

Type of Module: Management Module 3 (MM3)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Business Strategy	15	21
Management Accounting	37,5	52,5
Marketing	22,5	31,5

Major Learning Results (LR):

LR-1: Description of central concepts of strategic management alongside the ideal-typical strategy process and the implementation of internal and external analyses.

LR-2: Evaluation of accounting systems, instruments of cost management and identification of interfaces with financial accounting, financial management and business strategy.

LR-3: Understanding of the marketing concepts. Ability to apply key methods to the analysis and handling of marketing and sales problems, especially in the context of selling solutions.

Performance appraisal for this Module:

Within the third Management Module the performance appraisal for *Management Accounting* and *Business Strategy* consists of a written exam and assignment during class. For the course *Marketing* the performance appraisal will be based on case study presentations and a simulation game.

Credit Points: 6

5.3.1 Business Strategy

Lecturer	Prof. Dr. Hagen Lindstädt Dr. Kerstin Fehre
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.
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/ Skills	The Participant ▪ is able to describe central concepts of strategic management alongside the ideal-typical strategy process ▪ is able to undertake internal and external strategic analyses (e.g. SWOT Analysis) with the goal of strategy formulation ▪ understands the classical concepts and sources of competitive advantages as well as their meaning for the formulation of competitive and business strategies ▪ is able to formulate strategies at a company level and at a business unit level ▪ understands the central principles of strategy evaluation and strategy implementation as well as the classical concepts of change management.
Pre-Requisites	No specific prerequisites are required; however prior knowledge of accounting and financial management as well as principles of business administration is advantageous.
Teaching Method	The course structure consists of lectures and accompanying exercises, cases, and discussion sections. PowerPoint slides will be presented. Selected media will be used as necessary.
Performance Appraisal	

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work	-	-

	Exam	100 %	-
Course Material	A comprehensive reader will be provided.		
Literature	▪ Robert M. Grant: Contemporary Strategy Analysis, Blackwell, 7th ed. 2010		
Contact Lecturer	Prof. Dr. Hagen Lindstädt, E-Mail: ***Hagen.Lindstaedt@kit.edu*** Dr. Kerstin Fehre, E-Mail: ***Kerstin.Fehre@kit.edu***		

5.3.2 Management Accounting

Lecturer	Prof. Dr. Anja Kern		
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		
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/ Skills	The Participant gains an understanding of key concepts and techniques of management accounting, is able to use relevant costs for decision making, and is in the position to purposeful apply instruments for planning and control.		
Pre-Requisites	We build on some understanding from Management Module 1, in particular: ▪ Principles of financial accounting ▪ Discounting of future cash flows		
Teaching Method	The meetings will be partly lecture style and there will also be ample time for students to work on assignments and for plenary discussion of those assignments and related topics. These discussions should additionally stimulate students to exchange professional ideas and experience.		
Performance Appraisal		Written	Oral
	Participation during course	30%	10%
	Case Study	-	-
	Project Work	-	-
	Exam	60%	-
Course Material	Lecture slides and textbook (see below)		
Literature	Cost Management" by M. Wouters, F. Selto, R. Hilton, and M. Maher, 2012, McGraw-Hill Higher Education, ISBN-13 9780077132392		
Contact Lecturer	Prof. Dr. Anja Kern, E-Mail: ***dranjakern@gmail.com***		

5.3.3 Marketing

Lecturer	Prof. Dr. Martin Klarmann
Content	▪ Introduction to Marketing ▪ Essentials in Marketing Strategy ▪ Product Management ▪ Pricing ▪ Sales Management
Course Objectives	It is the overarching objective of this class to introduce participants to the marketing concept (i.e., seeing the firm from the customer's perspective). To do so, essential marketing decisions in the context of product management, pricing, and sales management are discussed and participants are introduced to key tools to approach these issues. Selling "solutions" is the key context in which most of these methods are introduced.
Learning Targets/ Skills	The Participant ▪ Understands the idea of market segmentation and iscapable of choosing appropriate segmentation criteria for his or her own firm. ▪ Understands marketing's product concept and is able to apply conjoint analysis to distinguish important from less important parts of the offering. ▪ Knows what a "solution" is and can avoid key mistakes in the implementation of solution selling. ▪ Can estimate a price demand function and apply the three key approaches to determining prices for an offering. ▪ Can make educated choices with regard to the channel structure of his or her firm. ▪ Can design and implement different approaches to measuring customer feedback. ▪ Knows the basic personal selling process and the challenges that go with it.
Pre-Requisites	None
Teaching Method	Lecture, case study, and a simulation game.
Performance Appraisal	

	Written	Oral
Participation during course	-	
Case Study	-	80%
Simulation Game	-	20%
Exam	-	-

Course Material	All slides presented in class will be provided to students. Case study reading material will be distributed upfront the module.
Literature	▪ Christian Homburg, Sabine Kuester, and Harley Krohmer (2009), Marketing Management: A Contemporary Perspective, New York (McGraw-Hill) ▪ Christian Homburg, Heiko Schäfer, and Janna Schneider (2012), Sales Excellence: Systematic Sales Management (Management for Professionals), Berlin (Springer)
Contact Lecturer	Prof. Dr. Martin Klarmann, E-Mail: ***Martin.Klarmann@kit.edu***

5.4 Corporate Innovation and Intrapreneurship

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.

Module Name: Corporate Innovation and Intrapreneurship

Module Supervisor: Prof. Jordi Vinaixa Serra

Type of Module: Management Module 4 (MM4)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Corporate Entrepreneurship	7,5	10,5
Entrepreneurial Leadership	7,5	10,5
Strategic Innovation Management	7,5	10,5
Opportunity Development – Design Thinking	7,5	10,5
Exploring the Opportunity: Technology and Markets	7,5	10,5
Pitching Business Ideas	7,5	10,5
Creating Value through Business Models	7,5	10,5
New Product Development and Service Innovation	7,5	10,5
Measuring Innovation: Innovation Balanced Scorecard	7,5	10,5
Pitching Business Models	7,5	10,5

Major 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.

Performance appraisal for this Module:

There will be an overall examination for this module. It will consist of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.

Credit Points: 6

5.4.1 Corporate Entrepreneurship

Lecturer	Prof. Jordi Vinaixa Serra
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
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/ Skills	The Participant ▪ gains competencies of various innovation modules (linear modules, open innovation, etc.). ▪ learns the application on the basis of fit methods and processes (Portfolio Strategy, Emphatic Design, QFD, Prototypes, etc.).
Pre-Requisites	Some experience and knowledge in marketing and finance are desirable.
Teaching Method	The learning experience is based on a range of teaching methods that seek to foster understanding of the entrepreneurial process and the development of entrepreneurial skills

<table>
<tr><td></td><td>among the participants, such as case discussions, theoretical presentations, self-directed learning based on recommended readings, role play, teamwork.</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>50%</td><td>50%</td></tr>
<tr><td>Exam</td><td>-</td><td>-</td></tr>
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</td></tr>
<tr><td>Course Material</td><td>The course structure consists of lectures and accompanying exercises, cases, homework, and discussion sections. PowerPoint transparencies will be presented. Selected media will be used as necessary.</td></tr>
<tr><td>Literature</td><td>▪ 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).</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Jordi Vinaixa Serra; E-Mail: Jordi.Vinaixa@esade.edu</td></tr>
</table>

5.4.2 Entrepreneurial Leadership

Lecturer	Amy Leaverton
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.
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
Pre-Requisites	No specific pre-requisites are required
Teaching Method	In this session participants will be lead through a series of lively discussions and group activities centered on the importance of self-awareness in entrepreneurial leadership. Personal value systems, learning styles, communication styles, and influencing styles will be explored and insight will be provided as to how knowledge of one's unique package of styles can be transformed into a skill set of leadership tools for igniting and sustaining high performing entrepreneurial teams. To stimulate learning and discussion, the instructor will guide participants through a step-by-step interpretation of the Kolb Learning Style Inventory as well as a variety of in-class activities in a highly participative, positive, creative, and energetic class environment.
Performance Appraisal	There will be an overall examination for this module. It will consist of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work		50%
Exam	-	50%

Course Material	Assigned Article Readings: ▪ 'What Makes a Good Leader?', Daniel Goleman ▪ 'The Art of Changing the Brain', James E. Zull ▪ 'What Great Managers', Marcus Buckingham ▪ 'Level 5 Leadership', Jim Collins
Literature	▪ The Fifth Discipline, Peter Senge ▪ The Leadership Mystique, Manfred Kets de Vries
Contact Lecturer	Amy Leaverton, E-mail: ***Amy.Leaverton@esade.edu***

5.4.3 Strategic Innovation Management

Lecturer	Elena Bou
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
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/ Skills	The Participant ▪ gains competencies of the various approaches of innovation management as a whole. ▪ gets to know new modules of knowledge creation, open Innovation and shared networks. ▪ gains the competency to build innovation networks and leadership systems.
Pre-Requisites	Some experience and knowledge in marketing and finance are desirable.
Teaching Method	The course will be taught in 8 lectures, including group work and discussion. In each session, there will be different activities to foster the participation of the students. These activities are designed to deepen the student's knowledge of topics raised in the lectures and contextualize the concepts in different business situations. Some of these activities include: analysis of real case studies, discussions of selected readings, exercises, videos and guest speakers presentations.
Performance Appraisal	There will be an overall examination for this Module. It will consist of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work	50%	50%
Exam	-	-

Course Material	The course structure consists of lectures and accompanying exercises, cases, homework, and discussion sections. PowerPoint transparencies will be presented. Selected media will be used as necessary.
Contact Lecturer	Elena Bou, E-Mail: ***Elena.Bou@esade.edu***

5.4.4 Opportunity Development – Design Thinking

Lecturer	Enric Segarra Costa
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.
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

<table>
<tr><td></td><td>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.</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The participants synthesize on the basis of the acquired competencies innovation management on the basis of case studies.</td></tr>
<tr><td>Pre-Requisites</td><td>No specific pre-requisites are required.</td></tr>
<tr><td>Teaching Method</td><td>The methodology used is known as experiential learning, a mix between Analytical Thinking and Creative Thinking, which will be applied by forming multidisciplinary teams with the objective of identifying new opportunities from insights and generate novel solutions.</td></tr>
<tr><td>Performance Appraisal</td><td>There will be an overall examination for this module. It will consist of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>50%</td></tr>
<tr><td>Exam</td><td>-</td><td>50%</td></tr>
</table></td></tr>
<tr><td>Course Material</td><td>▪ Need for Leaders who think outside the box by Roger Neill. Financial Times, January 17th 2011.
▪ Planning on the left side and managing on the right by Henry Mintzberg. Harvard Business Review 2000.
▪ Where do Ideas Come from? By Enric Segarra. Harvard-Deusto Business Review. February 2010.</td></tr>
<tr><td>Literature</td><td>▪ 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.</td></tr>
<tr><td>Contact Lecturer</td><td>Enric Segarra Costa, E-Mail: Enric.Segarra@esade.edu</td></tr>
</table>

5.4.5 Exploring the Opportunity: Technology and Markets

<table>
<tr><td>Lecturer</td><td>Xavier Ferrás.</td></tr>
<tr><td>Content</td><td>

Features of the new competitive environment
Expansion of the innovation phenomena (from technology-push and market pull 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

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<tr><td>Course Objectives</td><td>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</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant 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.

</td></tr>
<tr><td>Pre-Requisites</td><td>Some experience and knowledge in marketing and finance are desirable.</td></tr>
<tr><td>Teaching Method</td><td>The dynamics of the course will alternate theoretical presentations with practical business cases.</td></tr>
<tr><td>Performance Appraisal</td><td>There will be an overall examination for this Module. It will consist out of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>50%</td><td>50%</td></tr>
<tr><td>Exam</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>The course structure consists of lectures and accompanying exercises, cases, homework, and discussion sections. PowerPoint transparencies will be presented. Selected media will be used as necessary.</td></tr>
<tr><td>Literature</td><td>

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.

</td></tr>
</table>

Contact Lecturer	Xavier Ferras, E-Mail: ***Xavier.Ferras@esade.edu***

5.4.6 Pitching Business Ideas

Lecturer	Prof. Jordi Vinaixa Serra
Content	Presentation of Business Models developed for the Business Ideas, worked out during the module.
Course Objectives	To improve participant's presentation skills so they can obtain the resources required for the implementation of their project.
Learning Targets/ Skills	Participants will have to present their ideas in a convincing way in order to obtain the resources required for the implementation of their project.
Pre-Requisites	Some experience and knowledge in marketing and finance are desirable.
Teaching Method	Presentations and teacher's feedback.
Performance Appraisal	There will be an overall examination for this Module. It will consist of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work	50%	50%
Exam	80 %	-

Course Material	The course structure consists of preparation of presentations, discussion and feedback in group. PowerPoint transparencies will be presented. Selected media will be used as necessary.
Literature	K.D. Elsbach (2003), *How to Pitch a Brilliant Idea*, Harvard Business Review, 117-123**.**
Contact Lecturer	Prof. Jordi Vinaixa Serra, E-Mail: ***Jordi.Vinaixa@esade.edu***

5.4.7 Creating Value through Business Models

Lecturer	Luis Vives
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.
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.
Pre-Requisites	Some experience and knowledge in marketing and finance are desirable.

Teaching Method	Through cases, examples, and readings, we will examine how entrepreneurs establish and manage business models that realize business opportunities. Bring to class your passion and inquisitiveness, as well as the wealth of your own experiences and insights, stories you have heard, seen, or read about, that feature distinctive business models and how they came into being and were sustained on their own.
Performance Appraisal	There will be an overall examination for this Module. It will consist of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work	50%	50%
Exam	80 %	-

Course Material	The course structure consists of lectures and accompanying exercises, cases, homework, and discussion sections. PowerPoint transparencies will be presented. Selected media will be used as necessary.
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.
Contact Lecturer	Luis Vives, E-Mail: ***Luis.Vives@esade.edu***

5.4.8 New Product Development and Service Innovation

Lecturer	Ivanka Visnjic
Content	We will be discussing most recent innovation practices in the world that is increasingly turning towards services. Where does innovation potential comes 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
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).
Pre-Requisites	Some experience and knowledge in marketing and finance are desirable.
Teaching Method	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.
Performance Appraisal	There will be an overall examination for this Module. It will consist of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work	50%	50%
Exam	-	-

Course Material	The course structure consists of lectures and accompanying exercises, cases, homework, and discussion sections. PowerPoint transparencies will be presented. Selected media will be used as necessary.
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
Contact Lecturer	Ivanka Visnjic, E-Mail: ***Ivanka.Visnjic@esade.edu***

5.4.9 Measuring Innovation: Innovation Balanced Scorecard

Lecturer	Miguel Angel Heras
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

<table>
<tr><td>Course Objectives</td><td>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.</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant is able to:

▪ 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.</td></tr>
<tr><td>Pre-Requisites</td><td>Some experience and knowledge in marketing and finance are desirable.</td></tr>
<tr><td>Teaching Method</td><td>The methodology is highly participatory and action-oriented. It is a combination of presentations and class discussions – in constant interaction with participants – and the analysis and discussion of cases that allow a gradual implementation of the concepts introduced. The professor will act in two ways: developing theoretical concepts and facilitating discussions.</td></tr>
<tr><td>Performance Appraisal</td><td>There will be an overall examination for this Module. It will consist of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.

<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>50%</td></tr>
<tr><td>Exam</td><td>-</td><td>50%</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>The course structure consists of lectures and accompanying exercises, cases, homework, and discussion sections. PowerPoint transparencies will be presented. Selected media will be used as necessary.</td></tr>
<tr><td>Literature</td><td>▪ 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.</td></tr>
<tr><td>Contact Lecturer</td><td>Miguel Angel Heras, E-Mail: Miguelangel.Heras@esade.edu</td></tr>
</table>

5.4.10 Pitching Business Models

Lecturer	Prof. Jordi Vinaixa Serra
Content	Presentation of Business Models developed for the Business Ideas, worked out during the module.
Course Objectives	To improve participant's presentation skills so they can obtain the resources required for the implementation of their project.
Learning Targets/ Skills	Participants will have to present their ideas in a convincing way in order to obtain the resources required for the implementation of their project.
Pre-Requisites	Some experience and knowledge in marketing and finance are desirable.
Teaching Method	Presentations and teacher's feedback.
Performance Appraisal	There will be an overall examination hold for this Module. It will consist out of a presentation of a business idea in week 1, a presentation of a business model in week 2 and a final paper to be written.

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work	50%	50%
Exam	-	-

Course Material	The course structure consists of preparation of presentations, discussion and feedback in group. PowerPoint transparencies will be presented. Selected media will be used as necessary.
Literature	K.D. Elsbach (2003), *How to Pitch a Brilliant Idea*, Harvard Business Review, 117-123.
Contact Lecturer	Prof. Jordi Vinaixa Serra, E-Mail: ***Jordi.Vinaixa@esade.edu***

5.5 Law and Contracts

This module consists of an economic and a juristic part. In the economic part the subject areas decision theory, expected use, risk and ambiguity, negotiation- and basis-incentive-theory create the starting basis. The main goal of this part of the module is to deepen the knowledge of the participants in problems and concepts of the macroeconomic and microeconomic theory. The participants cut through the concepts and quantitative methods of the macroeconomic and microeconomic theory and are enabled to independently give an opinion on macro- and microeconomic problems. Furthermore, current problems of the world economy are discussed, for example stagnation and economic growth, unemployment and international labor division and harmonization of the international currency system. In this way the participants are enabled to recognize relevant economic coherences and to create connections to their practical experiences.

The juristic module part is divided in lectures about business law and lectures about international patent, trademark and copyright law. The participants gain deepened knowledge of complex under company law constructions. In the process the participants get to know various corporate structures and understand the implications of forms of company for the risk management and for the guidelines in financial reporting. Moreover, the participants are conveyed the knowledge on which juristic basis the terminology of “intellectual property” is based and which consequences this has on business decisions.

Module Name: Law and Contracts

Module Supervisor: Prof. Dr. Clemens Puppe

Type of Module: Management Module 5 (MM5)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Decisions, Contracts, Markets and Trade	37,5	52,5
International Law - The Law of Business Organizations	22,5	31,5
International Intellectual Property Law	15	21

Major Learning Results (LR):

LR-1: Dealing with advanced concepts of the microeconomic theory and basic concepts of the macroeconomic theory.

LR-2: Fundamental knowledge of the German and international business law.

LR-3: Detailed knowledge of the judicature of “intellectual property“.

Performance appraisal for this Module:

Within the fifth Management Module the performance appraisal will be based on written exams with varying components of class room participation like case study and project work.

Credit Points: 6

5.5.1 Decisions, Contracts, Markets and Trade

Lecturer	Prof. Dr. Clemens Puppe Prof. Dr. Berthold Wigger
Content	The course treats the fundamental principles of economics both from a microeconomic and a macroeconomic perspective. In the microeconomic part, the focus is on the impact of individual decisions on market equilibrium and the optimal design of contracts. The basic modeling tools including expected utility theory, the derivation of individual demand with quasi-linear preferences, and the fundamental concepts of game theory and bargaining theory are introduced. The macroeconomic part covers the topics of trade cycles and economic growth, money and inflation, aggregate income and unemployment. Current issues such as the open economy and problems of European integration will also be discussed.
Course Objectives	The participant will be trained in basic economic thinking both from a micro- and a macroeconomic perspective and in basic econometrics. The purpose of the course is to provide the necessary background for all other courses related to economics.
Learning Targets/ Skills	The Participant ▪ knows how to deal with advanced concepts of the microeconomic theory – for example the general theory of equilibrium or the pricing theory – and are able to apply these to real problems, e. g. the allocation of factor and goods markets. ▪ knows the basic concepts of the macroeconomic theory, especially the dynamic theory of equilibrium, and are able to apply these to the latest political issues, for example questions of optimal taxation, arrangement of pension insurance systems as well as politico-economic and monetary policy arrangements to stabilize business cycles and economic growth. ▪ understands and can apply the substantial techniques to analyze inter temporal macroeconomic models with uncertainty. ▪ understands the dynamic theories of equilibrium that are necessary for the description of prices and allocations of goods and financial markets as well as their temporal development.
Pre-Requisites	Basic knowledge of linear algebra and analysis.
Teaching Method	The material presented in the course will be supplemented by problem sets and exercises. Part of the course will consist of case studies. Homework and discussion sections complete the lectures.
Performance Appraisal	

	Written	Oral
Participation during course	-	20%
Case Study	-	10%
Project Work	-	-

	Exam	70 %	-
Course Material	The course material will be presented using all types of electronic and other multi-media devices. Lecture notes will be available in printed form.		
Literature	▪ Varian (2010): Intermediate Microeconomics: A Modern Approach, 8th Edition, Norton. ▪ Mankiw (1999): Macroeconomics, Worth Publishers ▪ Burda/Wyplosz (2001): Macroeconomics – A European Text, Oxford University Press		
Contact Lecturer	Prof. Dr. Clemens Puppe, E-Mail: ***Clemens.Puppe@kit.edu*** Prof. Dr. Berthold U. Wigger, E-Mail: ***Berthold.Wigger@kit.edu***		

5.5.2 International Law – The Law of Business Organizations

Lecturer	Prof. Dr. Martin Schulz		
Content	This course provides insight into important business law issues 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. Special emphasis will be placed on recent developments in the EU including the new multinational corporate form of the European Company (SE). We will analyze some prominent forms of business organizations with a special focus on limited liability companies and stock corporations. Key practical issues such as the incorporation of business forms, important questions relating to composing corporate contracts, corporate governance and compliance issues as well as the liability of shareholders and managers will also be discussed and analyzed.		
Course Objectives	The Participant ▪ understands how business law functions (also in cross border cases). ▪ gains insight into important forms of business organizations. ▪ learns central issues of business law including their international dimension. ▪ recognizes the interdependence of business law within a globalized economy.		
Learning Targets/ Skills	The Participant becomes familiar with important forms of business organizations and learns how to deal with business law issues including international aspects and cross border elements. The Participant learns how to structure and communicate legal issues in international business law cases.		
Pre-Requisites	A basic knowledge of German as well as basic knowledge of legal concepts (such as contracts) is helpful.		
Teaching Method	The course structure consists of lectures including case studies and home reading.		
Performance Appraisal		Written	Oral
	Participation during course	-	-
	Case Study	-	-
	Project Work	-	50%
	Exam	50%	-

Course Material	PowerPoint Presentations, case studies based on actual law cases and a reader (to be prepared and distributed in advance).
Literature	▪ Kraakman, Reinier / Davies, Paul / Hansmann, Henry / Hertig, Gerard / Hopt, Klaus / Kanda, Hideki / Rock, Edward, The Anatomy of Corporate Law, A Comparative and Functional Approach, 2nd edition Oxford 2009. ▪ Schulz, Martin/ Wasmeier, Oliver. The Law of Business Organizations – A Concise Overview of German Corporate Law, Heidelberg 2012. ▪ Du Plessis, Jean J. / Großfeld, Bernhard / Luttermann, Claus / Saenger, Ingo / Sandrock, Otto, German Corporate Governance in International and European Context, Berlin 2007.
Contact Lecturer	Dr. Martin Schulz, E-Mail: ***Martin.Schulz@ggs.de***

5.5.3 International Intellectual Property Law

Lecturer	Sven Jacobs
Content	In international business relations, intellectual property plays an ever increasing role. In innovative industries and in the information society, patents, trademarks and copyrights often constitute the most valuable asset of a firm. Knowledge of how the international IP system works, how IP can be protected beyond national boundaries, is therefore an important part of managing problems of law and contracts. The course gives an overview of the fundamental principles of international Intellectual Property (IP) law as part of the global system of international trade law. The mechanisms of international protection by registration rights (patents, trademarks) and non-registration rights (copyright) are explained. The course focuses both on the legal rules and mechanisms in place and on the underlying philosophies of unification and harmonization of conflicting IP policy options and aims. The course also highlights institutional aspects of the WTO/TRIPS-system and of European harmonization in the area of IP.
Course Objectives	The course aims at a general understanding of the mechanisms of international IP law, in particular, how the international system is built on the basis of the notion of territoriality and national law. The course interrelates with the other legal lecture (International Law –The Law of Business Organizations, taught by Schulz).
Learning Targets/ Skills	The Participant ▪ holds detailed knowledge of the main rights of intellectual property, ▪ analyses and evaluates more complex issues and adds them to a legal solution, ▪ transforms the legal fundamentals in contracts about the usage of intellectual property and solves more complex violation cases, ▪ knows and understands the basics of legal application procedures and has a wide overview of the legal matters caused by the internet.
Pre-Requisites	The Participant should have some basic knowledge and work experience in intellectual property (IP) law. Specialized knowledge in at least one of the major IP rights (patents; trademark; copyright) is advisable, but not a prerequisite.
Teaching Method	The course consists of lectures, as well as accompanying exercises and discussion sections.

<table>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>20%</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>-</td></tr>
<tr><td>Exam</td><td>80%</td><td>-</td></tr>
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</td></tr>
<tr><td>Course Material</td><td>▪ Course book (see literature); handouts
▪ Legal sources (online)
▪ PowerPoint presentations
▪ Optional: discussion forum</td></tr>
<tr><td>Literature</td><td>▪ Goldstein, International Intellectual Property Law, Foundation Press, New York, 2001 (or later edition, if available at the time of the course)
▪ WIPO Intellectual Property Handbook – Policy, Law and Use, 2nd edition, Geneva, 2004. Wipo Publication No. 489(E).</td></tr>
<tr><td>Contact Lecturer</td><td>Sven Jacobs, E-Mail: Sven.Jacobs@nortonrosefulbright.com</td></tr>
</table>

6 Description of the Engineering Modules

6.1 Renewables

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.

Module Name: Renewables

Module Supervisor: Prof. Dr.-Ing. Hans-Jörg Bauer

Type of Module: Engineering Module 1 (EM1)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Introduction and Scope of EEM, Energy Systems	15	21
Wind and Water Power	30	42
Solar and Geothermal Power	30	42

Major 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.

Performance appraisal for this Module:

Within the first Master-specific Module in EEM the performance appraisal is based on oral exams containing varying components of project work.

Credit Points: 6

6.1.1 Introduction and Scope of EEM, Energy Systems

Lecturer	Prof. Dr.-Ing. Hans-Jörg Bauer
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.
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/ Skills	The Participant ▪ gets an introduction and general overview of the subject current energy supply. ▪ gains insights into the national, European and global energy needs, its supplies and transport. ▪ gains an understanding of conventional power houses and power houses on the basis of renewable energies. ▪ gains knowledge of the energy distribution and storage, power-heat-coupling and central and spread systems.
Pre-Requisites	Basics from the bachelor education and practical experience gained during professional career.

Teaching Method	Oral PowerPoint presentation, active dialogue between lecturer and audience
Performance Appraisal	<table><tr><th></th><th>Written</th><th>Oral</th></tr><tr><td>Participation during course</td><td>-</td><td>100%</td></tr><tr><td>Case Study</td><td>-</td><td>-</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>-</td><td>-</td></tr></table>
Course Material	PowerPoint Handouts
Literature	▪ Bent Soerensen; Renewable Energy, 3rd Edition, Elsevier Academic Press; 2004 ▪ Aldo V. Da Rosa: Fundamentals of Renewable Energy Processes; Elsevier Academic Press, 2005
Contact Lecturer	Prof. Dr.-Ing. Hans-Jörg Bauer, E-Mail: ***Hans-Joerg.Bauer@kit.edu***

6.1.2 Wind and Water Power

Lecturer	Prof. Dr. Josep Bordonau Prof. Dr. Eduard Egusquiza
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 water power: Energy generation and demand; Conventional hydropower and ocean energy; historical review and perspectives. ▪ Basics of energy transfer: Head; power; efficiency; Hill charts; similarity laws. ▪ Conventional Hydro: Operation of hydropower plants; description of Francis Kaplan and Pelton turbines; selection and regulation; transients. ▪ Pumped Storage Plants: Objective and operation of pump-turbine units. ▪ Cavitation: Description of cavitation in hydropower units; instabilities and erosion. ▪ Marine Energy: Tidal; Current and Wave energy devices. ▪ Vibrations, monitoring and maintenance

<table>
<tr><td>Course Objectives</td><td>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

To give a broad perspective about the role of hydropower in the world and the future trends; To describe the main types of hydropower units and to can understand how they operate; To understand the basics of the transfer of hydraulic energy into mechanical energy; To provide a physical understanding of the different phenomena that take place during the operation of these machines (i.e. cavitation); To give a global perspective about ocean energy and to know the main types of machines used in this area. A final objective is to know how machines are monitored and the maintenance practices.</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant

▪ gains a historic overview of the development of the usage of wind power.

▪ gains 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 and water power plants

▪ understands current economic, ecological and legal circumstances.</td></tr>
<tr><td>Pre-Requisites</td><td>Basics from the bachelor education and practical experience gained during their professional career.

Basic knowledge of fluid mechanics and mechanics would be convenient.</td></tr>
<tr><td>Teaching Method</td><td>PowerPoint presentation and discussion between the lecturer and the students; Introduction to HOMER economic planning software.</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>20%</td></tr>
<tr><td>Exam</td><td>-</td><td>80%</td></tr>
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</td></tr>
<tr><td>Course Material</td><td>PowerPoint presentation and a few lecture notes.</td></tr>
<tr><td>Literature</td><td>▪ 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</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr.-Ing. Josep Bordonau; E-Mail: Josep.Bordonau@upc.edu

Prof. Dr.-Ing. Eduard Egusquiza; E-Mail: Egusquiza@mf.upc.edu</td></tr>
</table>

6.1.3 Solar and Geothermal Power

Lecturer	Prof. Dr. Thomas Kohl Prof. Dr.-Ing. Robert Stieglitz
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 guide lines. 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.
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/ Skills	The Participant ▪ gains 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. ▪ gains 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).
Pre-Requisites	Physics, thermodynamics, material sciences, fluid dynamics from the bachelor level, practical

<table>
<tr><td></td><td>technical experience gained during a professional career.</td></tr>
<tr><td>Teaching Method</td><td>The courses will be given as an oral presentation based on PowerPoint, interactive discussion and group work. The course will be supported by tutorials where the participants apply their recently acquired knowledge to solve practical questions and tasks.</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>20%</td></tr>
<tr><td>Exam</td><td>-</td><td>80%</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>PowerPoint handouts.</td></tr>
<tr><td>Literature</td><td>SOLAR POWER
▪ 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.
GEOTHERMAL POWER
Current literature will be given during the course</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr. Thomas Kohl; E-Mail: Thomas.Kohl@kit.edu
Prof. Dr.-Ing. Robert Stieglitz; E-Mail: Robert.Stieglitz@kit.edu</td></tr>
</table>

6.2 Thermal Energy Conversion

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, CO_2 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.

Module Name: Thermal Energy Conversion

Module Supervisor: Prof. Dr.-Ing. Hans-Jörg Bauer

Type of Module: Engineering Module 2 (EM2)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Technical Combustion/ Heat and Mass Transfer	15	21
Thermal Power Plants incl. Coal and Gas Power Plants	15	21
Turbo Machinery	15	21
Carbon Capture and Storage - Underground Gas Storage	15	21
Energy from Biomass	15	21

Major 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.

Performance appraisal for this Module:

Within the second Master-specific Module in EEM the performance appraisal is based on oral exams containing varying components of class room participation and/or project work.

Credit Points: 6

6.2.1 Technical Combustion/ Heat and Mass Transfer

<table>
<tr><td>Lecturer</td><td>Prof. Dr. rer. nat. habil. Ulrich Maas
Prof. Dr. Henning Bockhorn</td></tr>
<tr><td>Content</td><td>▪ 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.</td></tr>
<tr><td>Course Objectives</td><td>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).</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant
▪ gets 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.</td></tr>
<tr><td>Pre-Requisites</td><td>Thermodynamics and Heat Transfer</td></tr>
<tr><td>Teaching Method</td><td>Lecture</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>-</td></tr>
<tr><td>Exam</td><td>-</td><td>100%</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>Class room notes</td></tr>
<tr><td>Literature</td><td>▪ 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</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr. rer. nat. habil. Ulrich Maas; E-Mail: Ulrich.Maas@kit.edu</td></tr>
</table>

	Prof. Dr. Henning Bockhorn; E-Mail: ***Henning.Bockhorn@kit.edu***

6.2.2 Thermal Power Plants incl. Coal and Gas Power Plants

Lecturer	Prof. Dr.-Ing. Thomas Schulenberg
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.
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/ Skills	The Participant • gains insights into the way of functioning of thermal power stations as well as their most important components. • gains 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). • gains 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).
Pre-Requisites	Thermodynamics of Rankine cycle and Brayton cycle
Teaching Method	PowerPoint presentations with drawings, photos or sketches of power plant components, interactive discussion with participants
Performance Appraisal	

	Written	Oral
Participation during course	-	20%

	Case Study	-	-
	Project Work	-	-
	Exam	-	80%
Course Material	Handouts of the PowerPoint presentations		
Literature	▪ M.M. El Wakil, Power Plant Technology		
Contact Lecturer	Prof. Dr.-Ing. Thomas Schulenberg; E-Mail: ***Schulenberg@kit.edu***		

6.2.3 Turbo Machinery

Lecturer	Prof. Dr.-Ing. Hans-Jörg Bauer
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.
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/ Skills	The Participant ▪ gains 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.
Pre-Requisites	Fluid Mechanics, Thermodynamics, Technical Combustion, Thermal Power Plants
Teaching Method	The course will be given as an oral presentation based on PowerPoint. The course will be

	supported by tutorials where the students apply their recently acquired knowledge to solve practical questions and tasks.
Performance Appraisal	<table><tr><th></th><th>Written</th><th>Oral</th></tr><tr><td>Participation during course</td><td>-</td><td>20%</td></tr><tr><td>Case Study</td><td>-</td><td>-</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>-</td><td>80%</td></tr></table>
Course Material	PowerPoint handouts
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
Contact Lecturer	Prof. Dr.-Ing. Hans-Jörg Bauer; E-Mail: ***Hans-Joerg.Bauer@kit.edu***

6.2.4 Carbon Capture and Storage – Underground Gas Storage

Lecturer	Prof. Dr. Frank. Schilling
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: o Principles of geological gas storage (caverns, saline aquifers) – the similarities and differences to fluid storage (e.g. oil, waste water) are discussed. o Enhanced oil recovery; enhanced gas recovery; coal bed methane; o Trapping mechanisms (special focus on long term safety): Structural trapping; chemical trapping; physical trapping; solubility trapping. o Exploration & site characterization: Geology, geophysics, geochemical, and geo-mechanical; social aspects. o Site Development; drilling; monitoring; erection of injection facility. o Monitoring – Prior – during and after Injection: Physical; chemical; biological. o Site abandonment. o Risk assessment – risk management.
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/ Skills	The Participant • gains 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. • is taught the basics of the subject CCS and gains following knowledge and competencies: o 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
Pre-Requisites	Interest, basic physics and thermodynamics.
Teaching Method	The course will be given as an oral presentation based on PowerPoint, interactive discussion and intergroup development. The course will be supported by tutorials where the students apply their recently acquired knowledge to solve practical questions and tasks.
Performance Appraisal	<table><tr><th></th><th>Written</th><th>Oral</th></tr><tr><td>Participation during course</td><td>-</td><td>-</td></tr><tr><td>Case Study</td><td>-</td><td>50%</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>-</td><td>50%</td></tr></table>
Course Material	PowerPoint handouts
Literature	▪ IPCC, 2005 - Bert Metz, Ogunlade Davidson, Heleen de Coninck, Manuela Loos and Leo Meyer (Eds.) Cambridge University Press, UK. pp 431.
Contact Lecturer	Prof. Dr. Frank R. Schilling, E-Mail: ***Frank.Schilling@kit.edu***

6.2.5 Energy from Biomass

Lecturer	Prof. Dr.-Ing. Thomas Kolb
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.
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/ Skills	The Participant ▪ gains 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). ▪ gains 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).

<table>
<tr><td>Pre-Requisites</td><td>Bachelor in mechanical or chemical engineering or similar</td></tr>
<tr><td>Teaching Method</td><td>The course will be given as an oral presentation based on PowerPoint, interactive discussion and intergroup development. The course will be supported by tutorials where the students apply their recently acquired knowledge to solve practical questions and tasks.</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>-</td></tr>
<tr><td>Exam</td><td>-</td><td>100%</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>Lecture, overheads</td></tr>
<tr><td>Literature</td><td>

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/

</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr.-Ing. Thomas Kolb; E-Mail: Thomas.Kolb@kit.edu</td></tr>
</table>

6.3 Electricity Generation and Energy Storage

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.

Module Name: Electricity Generation and Energy Storage

Module Supervisor: Prof. Dr.-Ing. Mathias Noe

Type of Module: Engineering Module 3 (EM3)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Power Generators	15	21
Batteries and Fuel Cells	22,5	31,5
Hydrogen Technology	7,5	10,5
Photovoltaics	15	21
Power Electronics	7,5	10,5
Thermal Energy Storage	7,5	10,5

Major 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.

Performance appraisal for this Module:

Within the third Master-specific Module in EEM the performance appraisal is based on oral and written exams. The exams for the lecture *Batteries and Fuel Cells* and *Hydrogen Technology* as well as *Photovoltaics* and *Power Electronics* will be combined. The performance appraisal for the lecture *Power Generators* is a written exam.

Credit Points: 6

6.3.1 Power Generators

Lecturer	Prof. Dr.-Ing. Mathias Noe
Content	Theoretical foundation of synchronous generator, modeling and simulation, construction features, steady state and transient operation, case studies.
Course Objectives	Understanding and knowledge of critical issues related to synchronous generator operation.
Learning Targets/ Skills	The Participant ▪ gains insights into the structure and simulation of the stationary and transient operational behaviour of big power plant generators. ▪ understands structure of high performance generators of the type TLRI. ▪ is able to apply basics of the simulation and modeling of power plant generators. ▪ understands operational behaviour and current research themes in generator technology.
Pre-Requisites	No specific prerequisites are required.
Teaching Method	PowerPoint presentation organized in 5 parts. Each part to be delivered in 90 minutes duration. Recommendation for further studies to deepen the knowledge.
Performance Appraisal	

	Written	Oral
Participation during course	-	-
Case Study	-	-
Project Work	-	-
Exam	100%	-

Course Material	PowerPoint presentation, brief lecture script.
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
Contact Lecturer	Prof. Dr.-Ing. Mathias Noe; E-Mail: ***Mathias.Noe@kit.edu***

6.3.2 Batteries and Fuel Cells

Lecturer	Prof. Dr. Helmut Ehrenberg Dr. Frieder Scheiba
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 batteries, (2) NiCd and NiMH batteries, (3) Sodium-beta alumina batteries (SBB), (4) flow redox batteries (FRB) and the all vanadium redox battery (VRB), (5) 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.
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/ Skills	The Participant ▪ gains an overview of the basics characteristics, manner of functioning and stage of development from batteries and fuel cells to energy storage or energy conversion.. ▪ gains 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.
Pre-Requisites	Basics of electrochemistry and materials science. Basics of thermodynamics.
Teaching Method	BATTERIES The presented material is summarized in hand-outs before the lecture. FUEL CELLS Block lecture to be delivered in one day. PowerPoint presentation organized in 5 parts. Each part to be delivered in 90 minutes duration. Recommendation for further studies to deepen the

<table>
<tr><td></td><td>knowledge.</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>-</td></tr>
<tr><td>Exam</td><td>-</td><td>100%</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>PowerPoint presentation, lecture script</td></tr>
<tr><td>Literature</td><td>BATTERIES
▪ Lithium-ion batteries, Science and Technologies, M. Yoshio, R. J. Brodd, A. Kozawa (eds.), Springer (2009) ISBN: 978-0-387-34444-7.
▪ Carbons for Electrochemical Energy Storage and Conversion Systems, Francois Beguin, Elzbieta Frackowiak. CRC (2009) ISBN: 1420053078.
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</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr. Helmut Ehrenberg; E-Mail: Helmut.Ehrenberg@kit.edu
Dr. Frieder Scheiba; E-Mail: Frieder.Scheiba@kit.edu</td></tr>
</table>

6.3.3 Hydrogen Technology

Lecturer	Dr.-Ing. Thomas Jordan
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. Fundamentals of hydrogen safety engineering, including tools for assessment of parameters of hydrogen jets, fires, explosions, mitigation technique, etc.
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/ Skills	The Participant ▪ gains 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). ▪ gains additional insights into the framework conditions for security technology when handling H2 and technical subsystems**.**
Pre-Requisites	Basics of thermodynamics
Teaching Method	PowerPoint presentation organized in 5 parts. Each part to be delivered in 90 minutes duration. Recommendation for further studies to deepen the knowledge
Performance Appraisal	<table><tr><th></th><th>Written</th><th>Oral</th></tr><tr><td>Participation during course</td><td>-</td><td>-</td></tr><tr><td>Case Study</td><td>-</td><td>-</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>-</td><td>100%</td></tr></table>
Course Material	PowerPoint presentation, lecture script
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
Contact Lecturer	Dr.-Ing. Thomas Jordan; E-Mail: ***Thomas.Jordan@kit.edu***

6.3.4 Photovoltaics

Lecturer	Prof. Dr.-Ing. Michael Powalla Prof. Dr. Uli Lemmer
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

<table>
<tr><td></td><td>systems).
▪ Energy performance, system efficiency and outdoor effects.</td></tr>
<tr><td>Course Objectives</td><td>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</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant
▪ gains knowledge of photovoltaics as an energy source as well as their basic physical characteristics through to the conception of complete photovoltaic energy systems.
▪ gains 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.</td></tr>
<tr><td>Pre-Requisites</td><td>Basics of semiconductor physics, optics, thermodynamics</td></tr>
<tr><td>Teaching Method</td><td>Block lecture (7,5Hrs) to be delivered in one day. PowerPoint presentation, recommendation of literature to be studied</td></tr>
<tr><td>Performance Appraisal</td><td><table><tr><th></th><th>Written</th><th>Oral</th></tr><tr><td>Participation during course</td><td>-</td><td>-</td></tr><tr><td>Case Study</td><td>-</td><td>-</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>-</td><td>100%</td></tr></table></td></tr>
<tr><td>Course Material</td><td>PowerPoint presentation, summary</td></tr>
<tr><td>Literature</td><td>▪ 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)</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr.-Ing. Michael Powalla; E-Mail: Michael.Powalla@kit.edu
Prof. Dr. Uli Lemmer; E-Mail: Uli.Lemmer@kit.edu</td></tr>
</table>

6.3.5 Power Electronics

Lecturer	Prof. Dr.-Ing. Bruno Burger
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.

<table>
<tr><td>Course Objectives</td><td>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.</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant understands and is 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.</td></tr>
<tr><td>Pre-Requisites</td><td>Basics in electrical engineering, basics of active and passive components (transistors, inductors, capacitors)</td></tr>
<tr><td>Teaching Method</td><td>PowerPoint presentation, blackboard, calculations with MathCad or Octave, simulations with Pspice.</td></tr>
<tr><td>Performance Appraisal</td><td><table><tr><td></td><td>Written</td><td>Oral</td></tr><tr><td>Participation during course</td><td>-</td><td>-</td></tr><tr><td>Case Study</td><td>-</td><td>-</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>-</td><td>100%</td></tr></table></td></tr>
<tr><td>Course Material</td><td>Copies of the PowerPoint slides will be provided at the beginning of each lecture.</td></tr>
<tr><td>Literature</td><td>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</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr. Bruno Burger; E-Mail: Bruno.Burger@ise.fraunhofer.de</td></tr>
</table>

6.3.6 Thermal Energy Storage

Lecturer	Dr. Antje Wörner
Content	*Currently under revision*
Course Objectives	*Currently under revision*

<table>
<tr><td>Learning Targets/ Skills</td><td>Currently under revision</td></tr>
<tr><td>Pre-Requisites</td><td>Currently under revision</td></tr>
<tr><td>Teaching Method</td><td>Currently under revision</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>-</td></tr>
<tr><td>Exam</td><td>-</td><td>100%</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>Currently under revision</td></tr>
<tr><td>Literature</td><td>Currently under revision</td></tr>
<tr><td>Contact Lecturer</td><td>Dr. Antje Wörner; E-Mail: Antje.Woerner@dlr.de</td></tr>
</table>

6.4 Smart Networks and Energy Distribution

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.

Module Name: Smart Networks and Energy Distribution

Module Supervisor: Prof. Dr.-Ing. Mathias Noe

Type of Module: Engineering Module 4 (EM4)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Introduction to Power Systems/ High Voltage Engineering	15	21
Components of Power Systems	15	21
Transmission and Distribution	15	21
Smart Grids and Emerging Technologies	30	42

Major 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.

Performance appraisal for this Module:

Within the fourth Master-specific Module in EEM the performance appraisal is based on oral exams containing varying components of class room participation. The exams for the lecture *Power Systems*, *Components of Power Systems* and *Transmission and Distribution* will be combined.

Credit Points: 6

6.4.1 Introduction to Power Systems/ High Voltage Engineering

Lecturer	Prof. Dr.-Ing. Mathias Noe
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.
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/ Skills	The Participant ▪ gains knowledge of the structural principles and calculation methods for the calculation of electric networks. ▪ gains competencies to evaluate the high voltage insulation for various applications.
Pre-Requisites	Basics of electric circuits (Kirchhoff's law, Ohms law, AC current, complex numbers, etc.)
Teaching Method	The course will be given as an oral presentation based on PowerPoint. The course will be supported by tutorials where the students apply their recently acquired knowledge to solve practical questions and tasks.
Performance Appraisal	<table><tr><th></th><th>Written</th><th>Oral</th></tr><tr><td>Participation during course</td><td>-</td><td>20%</td></tr><tr><td>Case Study</td><td>-</td><td>-</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>80%</td><td>-</td></tr></table>
Course Material	PowerPoint hand-outs
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
Contact Lecturer	Prof. Dr.-Ing. Mathias Noe; E-Mail: ***Mathias.Noe@kit.edu***

6.4.2 Components of Power Systems

Lecturer	Dr.-Ing. Michael Schäfer
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.
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/ Skills	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.
Pre-Requisites	Bachelor 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
Teaching Method	PowerPoint presentation, partially blackboard interaction, discussions
Performance Appraisal	

	Written	Oral
Participation during course	-	20%
Case Study	-	-
Project Work	-	-
Exam	-	80%

Course Material	Lecture notes and handout of all presentation slides
Literature	A comprehensive reader will be supplied prior to the beginning of lecture.
Contact Lecturer	Dr.-Ing. Michael Schäfer, E-Mail: ***M.Schaefer@transnetbw.com***

6.4.3 Transmission and Distribution

Lecturer	Dipl.-Ing. (BA) Oliver Deuschle
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

<table>
<tr><td></td><td>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.</td></tr>
<tr><td>Course Objectives</td><td>Functionality and main characteristics of the transport and distribution networks are understood.</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant
▪ gets an introduction to the regulation and the running of electric networks.
▪ understands and can apply the structural principles of networks and respective calculation methods and safety principles.</td></tr>
<tr><td>Pre-Requisites</td><td>No specific prerequisites are required.</td></tr>
<tr><td>Teaching Method</td><td>Lecture, overheads</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>20%</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>-</td></tr>
<tr><td>Exam</td><td>-</td><td>80%</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>-</td></tr>
<tr><td>Literature</td><td>Elektroenergiesysteme, Adolf J. Schwab; Springer Verlag</td></tr>
<tr><td>Contact Lecturer</td><td>Dipl.-Ing. (BA) Oliver Deuschle, E-Mail: O.Deuschle@enbw.com</td></tr>
</table>

6.4.4 Smart Grids and Emerging Technologies

Lecturer	Prof. Dr. Hartmut Schmeck Johan Söderbom
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).

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<tr><td></td><td>

- 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.

</td></tr>
<tr><td>Course Objectives</td><td>

SMART GRIDS

The objective of this course is to provide some insights on the special impact of an increasing number of electric vehicles on energy distribution and power system management. In particular, it will address the need for an intelligent use of information and communication systems, tools, and services for building and managing a reliable smart power grid which moves from demand-oriented management to supply-oriented demand management.

EMERGING TECHNOLOGIES

The lecture contains the basics of superconductivity for engineers and a state-of-the-art overview about superconducting materials and their characteristics. For the most relevant superconducting applications in power systems the function and the state-of-the-art are given.

</td></tr>
<tr><td>Learning Targets/ Skills</td><td>

The Participant

- gains knowledge for the further development of electric networks through to intelligent grids for the accomplishment of future challenges in efficient use of electricity.
- gets application knowledge into network communication and information as well as Smart Homes.

</td></tr>
<tr><td>Pre-Requisites</td><td>

SMART GRIDS

Some knowledge of electrical power systems and of some fundamentals of information and communication technology.

EMERGING TECHNOLOGIES

Course Power System Components and Transmission and Distribution.

</td></tr>
<tr><td>Teaching Method</td><td>The course will be given as an oral presentation based on PowerPoint. The course will be supported by tutorials where the students apply their recently acquired knowledge to solve practical questions and tasks.</td></tr>
<tr><td>Performance Appraisal</td><td>

<table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>-</td></tr>
</table>

</td></tr>
</table>

	Exam	-	100%
Course Material	PowerPoint hand-outs and hand-outs for practical questions and tasks		
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		
Contact Lecturer	Prof. Dr. Hartmut Schmeck; E-Mail: ***Hartmut.Schmeck@kit.edu*** Johan Söderbom: E-Mail: ***Johan.Soderbom@sp.se***		

6.5 Energy Economics

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.

Module Name: Energy Economics

Module Supervisor: Prof. Dr.-Ing. Hans-Jörg Bauer

Type of Module: Engineering Module 5 (EM5)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Energy Systems Analysis	15	21
Energy Markets	15	21
European Network Regulation	15	21
Energy Efficiency (Supply and Demand Side)	15	21
Integration of Energy Systems and e-Mobility	15	21

Major 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.

Performance appraisal for this Module:

Within the fifth Master-specific Module in EEM the performance appraisal is based on oral exams containing varying components of class room participation and/or project work. The exams for the lecture *Energy Markets* and *Energy Systems Analysis* as well as *Energy Efficiency* and *Integration of Energy Systems and e-Mobility* will be combined.

Credit Points: 6

6.5.1 Energy Systems Analysis

<table>
<tr><td>Lecturer</td><td>Dr. Valentin Bertsch</td></tr>
<tr><td>Content</td><td>▪ 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.</td></tr>
<tr><td>Course Objectives</td><td>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?</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant
▪ acquires knowledge of interdependencies in energy economy.
▪ gets to know various simulation methods and fundamentals (applied game theory, optimizing models, Multi-Agent-Modules) that are based on these.
▪ understands and can apply the possibilities and limits of energy system analysis.</td></tr>
<tr><td>Pre-Requisites</td><td>Basics in energy economics.</td></tr>
<tr><td>Teaching Method</td><td>PowerPoint presentation.</td></tr>
<tr><td>Performance Appraisal</td><td>
<table>
<tr><td></td><td>Written</td><td>Oral</td></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td>-</td></tr>
<tr><td>Exam</td><td>-</td><td>100%</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>Lecture slides will be provided.</td></tr>
<tr><td>Literature</td><td>Will be provided in the lecture</td></tr>
<tr><td>Contact Lecturer</td><td>Dr. Valentin Bertsch, E-Mail: Valentin.Bertsch@kit.edu</td></tr>
</table>

6.5.2 Energy Markets

Lecturer	Prof. Dr. rer. pol. Wolf Fichtner
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.
Course Objectives	The students will get acquainted with modern power systems. 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/ Skills	The Participant ▪ gains knowledge of the development of the liberalization in the energy market. ▪ gets to know wholesale markets for electricity. ▪ understands the markets for emission allowances. ▪ gains insights into various products such as Forwards and Futures, Re-serve energy markets and markets for transmission rights. ▪ understands the principles of risk management in energy markets.
Pre-Requisites	Basics in economics
Teaching Method	PowerPoint presentation and case studies
Performance Appraisal	<table><tr><th></th><th>Written</th><th>Oral</th></tr><tr><td>Participation during course</td><td>-</td><td>-</td></tr><tr><td>Case Study</td><td>-</td><td>-</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>-</td><td>100%</td></tr></table>
Course Material	Slides will be provided.
Literature	▪ Steven Stoft (2002): Power System Economics, John Wiley & Sons New York
Contact Lecturer	Prof. Dr. Wolf Fichtner; E-Mail: ***Wolf.Fichtner@kit.edu***

6.5.3 European Network Regulations

Lecturer	Prof. Dr. Kay Mitusch Thomas Fluhrer
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.
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/ Skills	The Participant ▪ gets an overview of economic regulation and natural monopoles. ▪ learns the particular issues of electricity network regulation. ▪ learns the concept of efficient spatial pricing and the practical approaches to congestion pricing in electricity networks.
Pre-Requisites	Basics in micro economics.
Teaching Method	Lectures, case studies, tutorials.

Performance Appraisal	<table><tr><th></th><th>Written</th><th>Oral</th></tr><tr><td>Participation during course</td><td>-</td><td>20%</td></tr><tr><td>Case Study</td><td>-</td><td>-</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>-</td><td>80%</td></tr></table>
Course Material	Lecture slides and case studies will be provided.
Literature	Will be provided during the lecture.
Contact Lecturer	Prof. Dr. Kay Mitusch; E-Mail: ***Kay.Mitusch@kit.edu***

6.5.4 Energy Efficiency (Supply and Demand Side)

Lecturer	Prof. Dr.-Ing. Hans-Jörg Bauer Prof. Dr. rer. pol. Martin Wietschel
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.
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/ Skills	The Participant ▪ views the topic of energy supply from a different perspective than in other modules. ▪ gains knowledge building on the technical basics of business or economic aspects of energy supply. ▪ engages 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.
Pre-Requisites	Fluid Mechanics, Thermodynamics, Technical Combustion, Thermal Power Plants, Thermal Turbomachinery
Teaching Method	The course will be given as an oral presentation based on PowerPoint. The course will be supported by tutorials where the students apply their recently acquired knowledge to solve practical questions and tasks.
Performance Appraisal	<table><tr><th></th><th>Written</th><th>Oral</th></tr><tr><td>Participation during course</td><td>-</td><td>-</td></tr><tr><td>Case Study</td><td>-</td><td>-</td></tr><tr><td>Project Work</td><td>-</td><td>-</td></tr><tr><td>Exam</td><td>-</td><td>100%</td></tr></table>
Course Material	PowerPoint handouts
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
Contact Lecturer	Prof. Dr.-Ing. Hans-Jörg Bauer; E-Mail: ***Hans-Joerg.Bauer@kit.edu*** Apl. Prof. Dr. Martin Wietschel, E-Mail: ***Wietschel@isi.fhg.de***

6.5.5 Integration of Energy Systems and e-Mobility

Lecturer	PD Dr. Patrick Jochem Dr. Russell McKenna
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 provides an introduction to 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.

<table>
<tr><td>Course Objectives</td><td>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.</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant
understands the concept of energy efficiency as applied to specific systems
obtains an overview of the current trends in energy efficiency
is able to determine and evaluate alternative methods of energy efficiency improvement
overviews technical and economical stylized facts on electric mobility
Judges economical, ecological and social impacts through electric mobility</td></tr>
<tr><td>Pre-Requisites</td><td>Energy and Environment, Energy Economics, Thermodynamics, Sustainable Development, Microeconomics</td></tr>
<tr><td>Teaching Method</td><td>Lecture with PowerPoint slides, interactive questions/discussion and integrated tutorials.</td></tr>
<tr><td>Performance Appraisal</td><td><table>
<tr><th></th><th>Written</th><th>Oral</th></tr>
<tr><td>Participation during course</td><td>-</td><td>-</td></tr>
<tr><td>Case Study</td><td>-</td><td>-</td></tr>
<tr><td>Project Work</td><td>-</td><td></td></tr>
<tr><td>Exam</td><td>-</td><td>100%</td></tr>
</table></td></tr>
<tr><td>Course Material</td><td>PowerPoint handouts</td></tr>
<tr><td>Literature</td><td>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</td></tr>
<tr><td>Contact Lecturer</td><td>Dr. Russell McKenna, E-Mail: Mckenna@kit.edu
PD Dr. rer. pol. Patrick Jochem, E-Mail: Patrick.Jochem@kit.edu</td></tr>
</table>

7 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. 7-1) 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. 7-1 Master Thesis scope and process

Further information on the Master Thesis regulations can be found in the General Study and Examination Regulations, § 11 (see also Chap. 9.4).

8 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.

8.1 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

8.2 Department of Economics and Management

Research and teaching at the Department of Economics and Management in 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

8.3 Department of Informatics

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 informatics in 1972. Ever since then, the Department of Informatics is considered a leader in the field and internationally ranked number one in all the major rankings and evaluations.

Research and education in informatics at the Karlsruhe Institute of Technology (KIT) is characterized by its breadth coupled with a strong focus on theoretical and practical aspects. 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

8.4 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

8.5 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.

8.6 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.

9 Appendix

9.1 European Credit Transfer and Accumulation System

9.1.1 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.

9.1.2 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.

9.2 Quality Management

The faculty of the Hector School of Engineering and Management guarantee 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.

9.2.1 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.

9.3 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.

9.4 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: http://www.sle.kit.edu/amtlicheBekanntmachungen2013.php

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

9.5 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.

9.6 Change Management

Corrections regarding content and structure are listed below:

Date	Author	Page	Chapter	Change/Corrections
01.09.2011	EH	All	All	Prelaunch Course Guide Book in Layout and Structure
01.09.2011	EH	26	5.5.3	Change of Performance Appraisal from “Exam Written 100%” to “Exam Written 50% and Project Oral 50%”
07.09.2011	EH	3 + 4	3.	Update vitae Prof. Bauer and Prof. Noe according to *http://www.its.uni-karlsruhe.de/Mitarbeiter_bauer.php* and *http://www.itep.kit.edu/60.php*
15.09.2011	MW	11	5.1.2	Update literature
15.09.2011	MW	12 + 13	5.2.1	Update literature
15.09.2011	MW	14	5.2.2	Update literature
15.09.2011	MW	15 + 16	5.2.3	Update literature
15.09.2011	MW	26	5.5.1	Update literature
15.11.2011	EH	30 – 45	5.4.	Content of ESADE lectures added
15.11.2011	EH	11/12	4.4.1.	Lecturers from ESADE added
13.02.2012	SF	58	5.2.5.	New lecturer for “Energy from Biomass”; Dr. Az-Eddine Al-Khalfi
21.02.2012	SF	27	4.3.3.	New lecturer for “Marketing”: Prof. Dr. Martin Klarmann
01.05.2012	SF	14	4.1.1.	New lecture “Introduction to Accounting and Controlling” added. Lecturer: Prof. Dr. Ir. Marc Wouters
16.10.2012	SF	18	4.2.1.	New lecturers for “Project Management and Scheduling” added. Lecturers: Dr. Silke Heine and Prof. Dr. Stefan Nickel
14.01.2013	SF	All	All	Review of entire program structure, learning results, workload and literature
14.07.2014	SF	11-35	4.0 ff	Review of entire Management Modules
01.09.2015	SF	8	2	One new Program Director added
		12	3.2.	Academic Calendar for Intake 2015 added
		14	3.5.1.	Update of Chart: New program director for Management Modules and adjustment of several lecturers.
		14	4.	New chapter added “Qualification Objectives” Numbers of following chaters changed.
		13ff	5.1. and 5.2.	Change of sequence of Management Module 1 and 2. New MM1 is now “Project Management”; new MM2 is now “Finance

				for Executives".
		30	5.3.2.	New lecturer for Management Accounting: Adjustment of content
		48	5.5.3.	New lecturer for International Intellectual Property Law
		84	7.	Adjustment of master thesis process
		72	9.3., 9.4., 9.5.	Adjustment of links