Contents

Contact & Imprint

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

Schlossplatz 19, 76131 Karlsruhe/ Germany

Managing Director: Dr.-Ing. Judith Elsner

Phone: +49-(0)721 608 47880, Fax: +49-(0)721 608 47882, Website: ***www.hectorschool.com***

1 Foreword

Challenges of Electronic Systems Engineering and Management

Electronic systems are omnipresent. Currently they range from portable devices such as digital watches and smart phones to large stationary installations like traffic lights, factory controllers or the systems controlling of power plants. New energy supply systems strongly on the developments in electronic engineering at the interface to information technology. Sustainable mobility concepts integrating electric vehicles and hybrid vehicles are increasingly using embedded electronic systems to maximize efficiency and reduce pollution. Other automotive safety systems are e.g. anti-lock breaking systems, electronic stability control, and automatic four-wheel drive. Medical equipment is continuing to advance with more electronic systems for vital signs monitoring, electronic stethoscopes for amplifying sounds, and various medical imaging for non-invasive internal inspections. Electronic systems are designed to do some specific task, rather than be a general-purpose computer for multiple tasks. Some also have real-time performance constraints that must be met, for reasons such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs.

Reducing the size and cost of the product, increasing the reliability and performance of electronic components such as sensors and controllers enables more and more digital applications. The story goes on.

As a consequence the demand for innovations by society and the raise of new technologies in universities and large scale research institutions offer tremendous opportunities to overcome “historic” electronic development thinking. The Master Program in Electronic Systems Engineering and Management offers a unique combination of courses in emerging technologies, systems engineering know-how and methods as well as management tools.

With its long tradition in electrical, information and communication programs, Karlsruhe Institute of Technology (KIT) provides an ideal environment. Building on the long-established reputation for excellence in business engineering, our master program combines an in-depth knowledge and understanding of fundamental concepts in business, finance and management with the latest developments in Electronic Systems Engineering.

Graduates of the ESEM program will be able to analyze, design and optimize electronic systems with state-of-the art technologies. As project managers they will be able to evaluate the objective of the development engineers, namely on the optimization of heterogeneous and integrated systems regarding production costs, reliability and performance. This would be in accordance with the project and corporate goals. The skills acquired within this M.Sc. degree program encompasses state-of-the-art technology know-how ranging from the component level (Physical Layer) to the module and system level. Participants will be capable of applying methodological tools for integrated product development within innovation processes and to implement and transfer the methods from a TQM approach to the

processes of electronic product development. They will be familiar with the preparation and optimization of strategic business decisions.

Graduates will be able to analyze and evaluate mechatronic product development in relation to economic parameters. They will understand the systems approach behind financial and management accounting and to apply it for controlling purposes within corporate management. They will become familiar to prepare the necessary information on which decisions regarding strategic management will be based and implement them. They are able to integrate team members with different backgrounds due to their multidisciplinary education. Development of new products of part of them is a heterogeneous task. Teams spread all over the world contribute to the final product and the product itself is not more a result of one discipline only. It is an overall system combining mechanical, electrical and electronical parts and communications with nearly everything. This demands new methods, tools, and thinking.

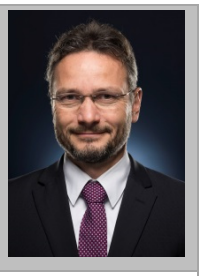
Join us to acquire your tools that will guide your career in this exciting area.

Prof. Dr.-Ing. Eric Sax

Program Director for Electronic Systems Engineering and Management

2 Program Directors

Title/Name	Prof. Dr.-Ing. Eric Sax
Phone	+49 (0) 721 608 42500
E-Mail	***Eric.Sax@kit.edu***
Affiliation	Institute for Information Processing Technologies (ITIV); KIT
Current Position	Head of Institute
Vita	01.10.2014 Head of Institute: Institute for Information Processing Technologies (ITIV), KIT 01.12.2009 – 30.09.2014 Head of Electric/Electronic Engineering world wide at Daimler Busses 01.06.2005 – 31.05.2009 Director “Test-Engineering” at Mbtech Group 01.10.2002 – 31.05.2005 Head of Team “Component Testing” at Mbtech Group
Fields of Interest	Systems Engineering, Life Cycles Models from V-Model to agile, Automotive Standards (ISO26262, Autosar, OSEK, CAN, …)-
Memberships & Awards	01.10.2014 Director at Forschungszentrum Informatik for Electronic Systems and Microsystems Author of the Book:”Automatisiertes Testen Eingebetteter Systeme in der Automobilindustrie”



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 of the Executive Program

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 & Engineering (SME)

The concurrently taught Executive Master Program is designed for working professionals. Block lectures scheduled at intervals allow participants to continue with demanding careers while acquiring new skills. The course program is scheduled to take place over a period of 18-20 months. It officially begins in October of each year and is completed with a Master Thesis. Courses are divided into 10 intensive modules of 14 days each following a timetable of monthly intervals. Each participant will take the same sequence of courses throughout the program. The two-week block lectures allow a complete immersion into the academic environment without long interruption of existing work-related responsibilities.

The following table 3-1 shows the sequence of the modules and the curriculum of the program.

# of Module	Type of Module	Name of Module	Course
1	EM 1	Processes, Methods and Tools of ESEM	1. Introduction to Embedded Software and Systems Engineering
			2. Collaborative Development Processes and Project Management
			3. Process Models and Associated Assessments
			4. Case Study in Embedded Systems Development
			5. Modeling and Simulation
2	EM 2	Components of Electronic Systems	1. Optical Actors and Sensors
			2. Control Systems Development
			3. VLSI-Technology and Nanoelectronics

# of Module	Type of Module	Name of Module	Course
			4. Embedded Systems Computer Architecture
3	MM 1	International Project Management	1. Project Management
			2. Multi-Project Management in an International Setting
			3. Development Management
			4. Intercultural Management
4	MM 2	Finance for Executives	1. Introduction to Finance and Accounting
			2. Financial Accounting
			3. Fundamentals of Finance
5	EM 3	Data Communication Technologies and Systems	1. Integrated Circuit and Systems Signal Processing
			2. Communication Systems and Protocols
			3. Mobile Perception Systems
6	MM 3	Management Accounting, Marketing and Strategy	1. Business Strategy
			2. Management Accounting
			3. Marketing
7	EM 4	Implementation and Component Realization	1. Micro Systems
			2. Roadmap for Electronic Product Development
			3. Electronic Systems Synthesis
			4. Case Study of Electronic Subsystems
			5. Software Development
8	EM 5	Systems Integration and Validation, Total Quality Management of Electronic Systems	1. Quality Assurance and Cost of QA of Electronic Systems
			2. Testing Embedded Systems
			3. Systems Engineering: Integration and Mechatronics Aspects
			4. Case Study: Embedded Systems Testing
9	MM4	Human Resource Management	1. Human Resource Management
			2. Leadership and Conflict Management
			3. Management Training
10	MM 5	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 ESEM

3.2 Academic Calendar Intake 2015

October 2015

Mon	Tue	Wed	Thu	Fri	Sat	Sun
			01	02	03	04
EM 1		07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

November 2015

Mon	Tue	Wed	Thu	Fri	Sat	Sun
						01
02	03	04	05	06	07	08
09	10	11	12	13	14	15
EM 2		18	19	20	21	22
23	24	25	26	27	28	29
30						

December 2015

Mon	Tue	Wed	Thu	Fri	Sat	Sun
	01	02	03	04	05	06
07	08	09	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

January 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
				01	02	03
04	05	06	07	08	09	10
MM 1		13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

February 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
01	02	03	04	05	06	07
08	09	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	MM 2					

March 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
	01	02	03	04	05	06
07	08	09	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

April 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
				01	02	03
04	05	06	07	08	09	10
EM 3		13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

May 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
						01
02	03	04	05	06	07	08
09	10	11	12	13	14	15
16	17	18	19	20	21	22
MM 3		25	26	27	28	29
30	31					

June 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
		01	02	03	04	05
06	07	08	09	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

July 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
				01	02	03
04	05	05	07	08	09	10
EM 4		13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

August 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
01	02	03	04	05	06	07
08	09	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

September 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
			01	02	03	04
EM 5		07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

October 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
					01	02
03	04	05	06	07	08	09
10	11	12	13	14	15	16
17	18	19	20	21	22	23
MM 4		26	27	28	29	30
31						

November 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
	01	02	03	04	05	06
07	08	09	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

December 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
			01	02	03	04
MM 5		07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

MM Management Modules

EM Engineering Modules

CC Crash Course in Probability and Statistics

Date t.b.a.; 2-day seminar for the programs Financial Engineering, Service Management & Engineering and Production & Operations Management.

HECTOR School Master Programs 2015:

- Electronic Systems Engineering & Management
- Energy Engineering & Management
- Green Mobility Engineering
- Management of Product Development
- Production & Operations Managment
- Service Management & Engineering
- Financial Engineering

3.3 Teaching Structure

Our 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 does imply technological and organizational responsibilities as well as requires economical accountability and Human Resource Management know-how. Therefore all programs are based on 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 Masters-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 teach the theoretical background necessary to model and analyze key decision problems in manufacturing sites.

Workshops and case studies allow ample opportunity to explore the direct applications of the modules simulating the real business environment. The programs conclude with an independent 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 Master of Science (M.Sc.) of the Karlsruhe Institute of Technology (KIT).

3.4 Credit Points

The awarded credit points during our 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 (ECTS)	
		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 List of Lecturers of the Program

3.5.1 Courses in Management and Business Administration (Management Modules)

Name	Institute
Program Director	
Prof. Dr. Stefan Nickel	Institute for Operations Research, KIT
Module Supervisors:	
Prof. Dr. Stefan Nickel	Institute for Operations Research, KIT
Prof. Dr. Martin E. Ruckes	Institute for Finance, Banking and Insurance, KIT
Prof. Dr. Martin Klarmann	Institute of Economic Information and Marketing, KIT
Prof. Dr. Petra Nieken	Chair of Human Resource Management, KIT
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 of Entrepreneurship, Technology Management and Innovation, KIT
Dr. Michael A. Buchmann	IMTEAM Intercultural Management Team
Prof. Dr. Barbara Deml	Institute for Industrial Science and Business Organization (ifab), KIT
Dr. Kerstin Fehre	Institute of Applied Business Studies and Management, KIT
Sven Jacobs	Norton Rose Fulbright LLP
Prof. Dr. Anja Kern	Cooperative State University, DHBW Mosbach
Dr.-Ing. Robert Landwehr	Daimler AG
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
Prof. Dr. Orestis Terzidis	Institute of Entrepreneurship, Technology Management and Innovation
Prof. Dr. Berthold Wigger	Institute for Economic Policy Research, KIT

3.5.2 Courses in the Master specific field of ESEM (Engineering Modules)

Name	Institute
Program Directors	
Prof. Dr.-Ing. Eric Sax	Institute for Information Processing Technologies (ITIV), KIT
Prof. Dr. rer. nat. Michael Siegel	Institute of Micro- und Nanoelectronic Systems, KIT

Name	Institute
Module Supervisors	
Prof. Dr.-Ing. Eric Sax	Institute for Technic of Information Processing (ITIV); KIT
Prof. Dr.-Ing. Sören Hohmann	Institut für Regelungs- und Steuerungssysteme, KIT
Prof. Dr. rer. nat. Michael Siegel	Institute of Micro- und Nanoelectronic Systems, KIT
Prof. Dr.-Ing. Dr. h. c. Jürgen Becker	Institute for Information Processing Technologies (ITIV), KIT
Lecturers in Alphabetical Order	
Frank Blucha	Harmann Becker Automotive Systems
Prof. Dr. Martin Heine	Hochschule Furtwangen
Christian Müller	MBtech Group GmbH & Co. KG
Prof. Dr. Cornelius Neumann	Light Technology Institute, KIT
Dr.-Ing. Oliver Sander	Institute for Technic of Information Processing (ITIV); KIT
Prof. Dr. rer. nat. Michael Siegel	Institute of Micro- und Nanoelectronic Systems, KIT
Prof. Dr.-Ing. Christoph Stiller	Institut für Mess- und Regelungstechnik, KIT
Hannes Stoll	Institute for Technic of Information Processing (ITIV); KIT
Prof. Dr. Wilhelm Stork	Institute for Technic of Information Processing (ITIV); KIT

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 Electronic Systems Engineering and Management

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

1. The graduates are able to design, analyze and optimize electronic and mechatronic systems at the level of the latest technologies and tools, thereby taking into account the different stages of the life cycle of a system.
2. They have an overview of current methods and standardized models (e.g. waterfall model, scrum, V-Model), which comprise the development process of an electronic and especially an embedded electronic system (Cyber Physical System, CPS), and in applying them also include market-specific licensing and standardization aspects.
3. Graduates know various components of CPS such as actuators, sensors and processors and their different architectures. Moreover, they have an overview of the communication standards between the components.
4. They are able to independently drive system integration and to assess and evaluate a CPS under quality assurance aspects.
5. Graduates are also able to analyze and evaluate technological problems in the context of electronics development under economics aspects.
6. They are able to thoroughly understand the approach in the internal and external financial reporting and to apply it in the corporate context.
7. Furthermore, they are familiar with approaches to preparing and optimizing a company's strategic decisions.
8. 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.
9. They are able to understand marketing, human resource management, and legal issues approaches in the technological context, to recognize and evaluate interconnections and thus, based on this, 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 of 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 will be conducted by 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*** Dipl.Inform. 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 to 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 of the course “Project Management” is 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. 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.
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: ***Robert@Landw3hr.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 digital form.
Literature	A comprehensive reader will be supplied.
Contact Lecturer	Prof. Dr.-Ing. Albert Albers, E-Mail: ***Albert.Albers@kit.edu***

5.1.4 Intercultural Management

Lecturer	Dr. Michael A. 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) ▪ 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
Course Objectives	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 cooperation's. Participants acquire a clear and manageable system to tell and successfully inter-act with cultural differences in project management.
Learning Targets/ Skills	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.
Pre-Requisites	Open mindedness.
Teaching Method	Power point presentations and lectures with frequent examples, discussions with and contributions by participants, individual survey, exercises and short cases
Performance Appraisal	

	Written	Oral
Participation during course	-	60%
Case Study	-	40%
Project Work	-	-
Exam	-	-

Course Material	▪ Lecture notes and presentations in digital form
Literature	▪ Geert Hofstede: Cultural Dimensions for Project Management, in J. O. Riis, J. Lauridsen, M. Fangel, S. Hildenbrandt and F. Runge (eds): Project Management – Tools and Visions, Proceedings of the 7th Internet Worl 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: Software of the Mind – Intercultural Cooperation and its Importance for Survival, revised and expanded 3. ed., Mc Graw Hill 2010.
Contact Lecturer	Dr. Michael A. Buchmann, E-Mail: ***Buchmann@executivesynergy.net***

5.2 Finance for Executives

"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 acquistition 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 will be conducted by two written exams and a case study work 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.
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 these 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 will take place for *Management Accounting* and *Business Strategy* as a written exam. 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			
Performance Appraisal		Written	Oral
	Assignment 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 is capable 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 measure customer feedback. ▪ Knows the basic personal selling process and the challenges that go with it.
Pre-Requisites	none
Teaching Method	Lecture, cas 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 Human Resource Management

The module deals with the current challenges of human resource management in organizations and companies. The economic analysis of the individual behavior and the individual performance in strategic situations are presented, as well as current empirical research on relevant issues of human research management. Interactive classroom-experiments add to the microeconomic approaches and demonstrate the limits of the traditional economic theory based on individual rationality. The participants monitor the theoretical approaches within the frame of case studies and thereby gain an understanding for the complex challenges and possibilities of the processes and practices in human resource management. The participants rate relevant human resource issues like for example the advantages and disadvantages of pay for performance systems or the special problems in talent management. The effects of business cultures and their role for successful international project management are also analyzed and critically monitored by the participants. Furthermore, the participants learn methods of conflict management and are able to train these in practical sequences. In conclusion, problem solving strategies are presented in the module and applied by the participants.

Module Name: Human Resource Management

Module Supervisor: Prof. Dr. Petra Nieken

Type of Module: Management Module 4 (MM4)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Human Resource Management	37,5	52,5
Leadership and Conflict Management	22,5	31,5
Management Training	15	21

Major Learning Results (LR):

LR-1: To understand problems of human resource management and their relation to the structuring of organizations as well as the relation to the business success and strategic situations in organizations.

LR-2: To know and be able to apply various leadership methods and to be able to apply an approach for avoiding and solving conflict situations.

LR-3: Application of the theoretic knowledge in a specific case studies and a comprehensive management training.

Performance appraisal for this Module:

Within the fourth Management Module the performance appraisal will be based on group project work for Management Training. The written exam for *Human Resource Management* counts 70% and class room participation is a 30% component. The exam for *Leadership and Conflict Management* will be conducted as oral exam.

Credit Points: 6

5.4.1 Human Resource Management

Lecturer	Prof. Dr. Petra Nieken
Content	The course covers relevant topics of human resource management. Microeconomic approaches will be complemented by classroom experiments and empirical research results based on field as well as laboratory data. Experimental research has become increasingly important in recent years. By introducing participants to this research method they are made familiar with some current attempts to integrate insights on human behavior into economic models, e.g., fairness considerations. These approaches are particularly interesting in the context of labor contracts and individual behavior in organizations. We will cover topics such as linking human resource management processes to the company's strategy, compensation and motivation, performance appraisal systems, talent management, recruiting and selecting employees as well as trust, control and the role of corporate culture for organizational performance. Participants will work in teams on case studies that are distributed before the course starts. These real-world examples illustrate a variety of challenges of HR management. Each team will present the results at the end of the course and discuss the analysis with other students in class.
Course Objectives	The course aims at a fundamental understanding of individual behavior and performance in organizations as well as the challenges of human resource management processes. An overview of current research topics in personnel economics is provided
Learning Targets/ Skills	The Participant • understands basic questions of human resources management and their connection to the design of organizations. • has knowledge on applicability and difficulty of scientific research methods in human resources and organizational economic context. • applies the acquired knowledge based on international renowned case studies.
Pre-Requisites	Basics in microeconomic theory and econometrics
Teaching Method	The course structure consists of lectures, case studies, simulations and project work. It explores team and self-awareness.
Performance Appraisal	

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

	Exam	70%	-
Course Material	PowerPoint slides, case studies, accompanying articles, instructions for classroom experiments		
Literature	Cascio, W.F.: Managing Human Resources, McGraw-Hill, 2013 Lazear, E. P. and M. Gibbs: Personnel Economics in Practice. John Wiley & Sons, 2015. Huselid, M.A., Becker, B.E. and Beatty, R.W. (2005): The workforce scorecard: Managing human capital to execute strategy. Harvard Business School Press.		
Contact Lecturer	Prof. Dr. Petra Nieken, E-Mail: ***Petra.Nieken@kit.edu***		

5.4.2 Leadership and Conflict Management

Lecturer	Prof. Dr. Barbara Deml		
Content	The aim of this course is to teach the fundamentals of professionals at work. In order to reach this target participants will become acquainted with the basic concepts of leadership methods and learn techniques of managing conflict situations among staff members. The course deals with agreements on objectives, management techniques in planning, communication and information, decision-making, leadership and teamwork, self-management, conflict resolution and conflict strategy. The use of several case studies reinforces all of these skills and introduces participants to the real-life application of leadership techniques in conflict management.		
Course Objectives	Master difficult leadership situation, e.g., after assuming a new leadership position. Change often produces conflicts or resistance towards new management styles by the new team-members. Conflicts are therefore pre-destined and system based. The course will teach efficient leadership tools and methods in order to achieve a win-win situation for the entire group.		
Learning Targets/ Skills	The Participant ▪ acquires knowledge of different leadership methods and approaches in order to avoid and solve conflict situations and can practice these in practical sequences, is able to identify and apply problem solving strategies. ▪ acquires knowledge of different management techniques (e.g. definition of goals, decision theories, planning techniques, communication, self-management) and is able to analyze and apply tools in their appropriate usage in example situations in this topic. ▪ learns how to apply various leadership methods and -tools (e.g. appraisal interviews, delegation, feedback, self-management and time management).		
Pre-Requisites	Successful participation in the module Project Management. For recommended literature see below.		
Teaching Method	The course structure consists of lectures, case studies, simulations and project work. It explores team and self-awareness.		
Performance Appraisal		Written	Oral
	Participation during course	-	-
	Case Study	-	-
	Project Work	-	-
	Exam	-	100%

Course Material	Lecture notes, homework, case studies and exercises, in printed form
Literature	▪ Drucker, Peter: The Effective Executive, London: Butterworth Heinemann, Revised Edition 2007
Contact Lecturer	Prof. Dr. Barbara Deml, E-Mail: ***Barbara.Deml@kit.edu***

5.4.3 Management Training

Lecturer	Prof. Dr.-Ing. Dr. h.c. Albert Albers
Content	By focusing upon various company objectives and strategies, participants will expand their management competencies in numerous aspects. Particular emphasis is placed on the interrelations between product life cycles - including product launch, entry into a new market, and relaunch - and organizational decisions affecting human resource management, research and development activities and marketing. The fundamental management techniques of competition analysis, portfolio analysis, marketing mix and pricing of special commercial operations are acquired in order to ensure product success. Participants will also become acquainted with and make use of break-even analysis and market research reports as a way of making marketing decisions. In addition, participants learn about supply and stock keeping, particularly covering optimal order quantities. With regard to the important theme of production, participants will be taught about investment, disinvestments, utilization planning, ecological production and rationalization and learning curves, as well as the important decision of whether in-house production or third party supply would be most beneficial. Organizational aspects of research and development is another key area in which participants will expand their knowledge. Finance and accounting also plays a vital role in the education of future managers, therefore a great deal of attention is paid to this subject. Participants are taught about income and financial statements, cash flow, share prices and shareholder value. Furthermore, they benefit from learning the important skills of cost element, cost center and product cost accounting, progressive break-even analysis and financial budgeting. Participants are also trained in the field of human resource management. The crucial topics of personnel planning, qualifications, productivity as well as employee turnover and absences are particularly dealt with, as knowledge of these aspects is key for future managers.
Course Objectives	Management Training provides the knowledge and methods in order to rigorously analyze business situations and then exercise judgment. The broader the range of responsibilities the more it becomes necessary to evaluate and appraise problems.
Learning Targets/ Skills	The Participant ▪ learns how to apply his acquired knowledge of management and business economics in a realistic business game. ▪ experiences the target conflicts that appear during the leadership of a business. ▪ learns how to make decisions under uncertainty and under time pressure and to present them to a management team. ▪ commutes his theoretical knowledge into competency, think and act economically cross-

<table>
<tr><td></td><td>linked.</td></tr>
<tr><td>Pre-Requisites</td><td>Successful participation in the module Project Management.</td></tr>
<tr><td>Teaching Method</td><td>The course structure consists of lectures, case studies, simulations and project work. It explores team and self-awareness.</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>100%</td><td>-</td></tr>
<tr><td>Exam</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>Course Material</td><td>Lecture notes, homework, case studies and exercises, in printed form.</td></tr>
<tr><td>Literature</td><td>None.</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr.-Ing. Dr. h.c. Albert Albers, E-Mail: Albert.Albers@kit.edu</td></tr>
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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 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.

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 student 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 digital 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 working 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.

Performance Appraisal		Written	Oral
	Participation during course	-	20%
	Case Study	-	-
	Project Work	-	-
	Exam	80 %	-
Course Material	▪ Course book (see literature); handouts ▪ Legal Sources (Online) ▪ PowerPoint Presentations ▪ Optional: discussion forum		
Literature	▪ 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).		
Contact Lecturer	Sven Jacobs, E-Mail: ***Sven.Jacobs@nortonrosefulbright.com***		

6 Description of the Engineering Modules

6.1 Processes, Methods and Tools of ESEM

At the beginning an introduction to embedded systems and software engineering is given. Processes, methods and tools from object oriented approaches, via the V-model to agile methods are presented. Among those, HW-/SW-Co-design and rules how to decide which way to go are explained. All these aspects are discussed considering the constraints of distributed development all around the world. How to assess these approaches according to SPICE and CMMI and how to follow the demands of safety (relying on ISO 26262) and security is introduced focusing on the transportation industry.

Module Name: Processes, Methods and Tools of ESEM

Module Supervisor: Prof. Dr.-Ing. Eric Sax

Type of Module: Engineering Module 1 (EM1)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Introduction to Embedded Software and Systems Engineering	22,5	31,5
Collaborative Development Processes and Project Management	7,5	10,5
Process Models and Associated Assessments	15	21
Case Study in Embedded Systems Development	7,5	10,5
Modeling and Simulation	22,5	31,5

Major Learning Results (LR):

LR-1: Knowledge of fundamental characteristics of embedded systems and systems design from requirements to realization, either in hardware or in software.

LR-2: Ability to apply methods and tools for a distributed development process and familiarity with release and configuration management.

LR-3: Ability to identify the key elements of the two main process models and knowledge of the key concepts for process improvement and process assessments.

LR-4: Experience in working in groups on independent case studies in order to cut through the analysis and draft process of electronic systems and ability to apply methods and tools of model based analysis of hard and software.

LR-5: Knowledge of the fundamentals of virtual design and virtual prototypes and capability to differentiate between causal and noncausal modelling.

Performance appraisal for this Module:

Within the first Master-specific Module in ESEM the performance appraisal is based on oral exams containing varying components of class room participation. The exam for the lectures *Introduction to Embedded Software and Systems Engineering* and *Collaborative Development Processes and Project Management* will be combined.

Credit Points: 6

6.1.1 Introduction to Embedded Software and Systems Engineering

Lecturer	Prof. Dr.-Ing. Eric Sax
Content	Embedded Systems are highly complex, safety critical, spatially and functionally distributed electronic control units with hard real time constraints. They interact synchronously with the real nature and get input from sensors and stimulate actuators. All these special conditions for the use of embedded systems will be introduced. Due to those specifics, common approaches for development of software such as in use for desktop applications fail. Precise requirements definition, specification, design and test processes are far more important. An embedded system can't be accessed or updated during operation. No patch or bug fix can be implemented without a lot of efforts such as a recall of thousands of products. Modeling, simulation and hardware-in-the-loop testing (HiL) support these processes and computer aided design tools help as well to a certain extend. Shorter development times, lower product costs while still assuring high quality are further constraints which will be discussed in that lecture. As a consequence rapid control prototyping (RCP) and agile development are introduced as well. And design techniques such as used in the Unified Modeling Language (UML) will show how early executables on desktop level can push the embedded systems design. Standards for embedded systems design such as introduced in AUTOSAR and OSEK and ASIL levels complete the content.
Course Objectives	The course objective is to introduce the approach of systems engineering in electronic systems development. In the end the students choose the right design method for a characteristic challenge and have all the skills to specify an embedded system, model, simulate and test it.
Learning Targets/ Skills	The Participant ▪ understands the analysis and draft process of complex electronic systems development. ▪ is able to apply methods and tools of the model based analysis and the process of hard- and software development. ▪ is able to optimize electronic systems regarding quality, cost and market introduction criteria.
Pre-Requisites	Basic knowledge in electrical engineering, process know how.

Teaching Method	PowerPoint Presentation, smaller tasks in groups
Performance Appraisal	Written / Oral Participation during course: - / - Case Study: - / - Project Work: - / - Exam: - / 100%
Course Material	Script/slides as handouts (web downloads), selected tools (web downloads)
Literature	▪ Automotive Software Engineering (Schäuffele/Zurawka) ▪ Test Process Improvement (Koomen/Pohl)Project manager (Schelle et al.)
Contact Lecturer	Prof. Dr.-Ing. Eric Sax: E-Mail : ***Eric.Sax@kit.edu***

6.1.2 Collaborative Development Processes and Project Management

Lecturer	Prof. Dr.-Ing. Eric Sax
Content	A development process for an embedded system is highly collaborative. Partners from all over the world contribute parts, mostly in SW. This might be co- or sub-modules. The integration can now happen on different levels of abstraction from specification over modeling to source code or even object code. Furthermore, release and configuration management for a single control unit or even a network is a challenge due to different requirements in different countries. Among those are laws, but as well comfort and safety standards. To manage systems engineering under that constraint demands dedicated processes, methods, tools and rules.
Course Objectives	The course objective is to get an idea of the challenges of an distributed development process and learn approaches to solve them.
Learning Targets/ Skills	The Participant ▪ Is able to apply methods and tools for an distributed development process ▪ is familiar with release- and configuration management ▪ knows the importance of a supplier chain ▪ is able to integrate parts of an embedded system on different levels
Pre-Requisites	Requisites Embedded Software and Systems Engineering
Teaching Method	PowerPoint Presentation
Performance Appraisal	Written / Oral Participation during course: - / - Case Study: - / - Project Work: - / - Exam: - / 100%
Course Material	Script/slides as handouts (web downloads), selected tools (web downloads)
Literature	▪ Automotive Software Engineering (Schäuffele/Zurawka)

	▪ Test Process Improvement (Koomen/Pohl) ▪ Project manager (Schelle et al.)
Contact Lecturer	Prof. Dr.-Ing. Eric Sax: E-Mail: ***Eric.Sax@kit.edu***

6.1.3 Process Models and Associated Assessments

Lecturer	Frank Blucha
Content	Embedded systems are getting more complex, the time to market is decreasing, and the pressure on cost is increasing. So the "very flexible" software seems to be a solution to help solving these requests. But the development processes have to fit to these needs. If an organization is not able to handle these conflicting requirements it may lead to quality problems in the product in the field or to big delays in product delivery. As this happened in different industry domains the idea for process models was born to collect good industry practices. CMMI-DEV is one process model which was created to fit to product development in general with focus on software. The course gives an introduction to the history of the model, an overview of the different processes covered, and shows two processes in detail. The overview of the associated assessment method completes the picture of CMMI-DEV. AutomotiveSPICE is another process model which was created to specifically cover embedded product development in Automotive. The course gives an overview of the different processes covered, and shows two processes in detail. The overview of the associated assessment method is also provided. The course shows additionally the commonalities between these two process models and highlights some differences.
Course Objectives	The course objectives are to provide an overview of two world-wide applied process models in industry, CMMI-DEV and AutomotiveSPICE, and their associated assessment methods, to highlight the commonalities as well as the differences and to identify the original intention of these models.
Learning Targets/ Skills	The Participant ▪ is able to identify the key elements of the two process models ▪ is able to locate the relevant processes in the process models ▪ knows the major differences between the associated assessment methods ▪ knows the key concepts for process improvement and process assessments
Pre-Requisites	Basic knowledge in electrical engineering, process know how
Teaching Method	PowerPoint Presentation, small group work
Performance Appraisal	

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

Course Material	Slides as handout

Literature	▪ CMMI for Development: Guidelines for Process Integration and Product Improvement (SEI Series in Software Engineering) ▪ Automotive SPICE in Practice Hoermann, Mueller, Dittmann, Zimmer)
Contact Lecturer	Frank Blucha: E-Mail: ***Frank.Blucha@harman.com***

6.1.4 Case Study in Embedded Systems Development

Lecturer	Prof. Dr.-Ing. Eric Sax Hannes Stoll
Content	Participants complete a final design project as part of a multi-student team. All teams present their project in a verbal presentation to peers, faculty and industry audiences. They define requirements, estimate tasks and resources, engineer design implementations, validate solutions, idea to system perspective, mission analysis, functional analysis, system concept, functional and non-functional requirements specification, project management plan, system design, system analysis, design reviews, risk assessment, safety and security. The prototype to develop is the control of an one-axle vehicle similar to the Segway product. In the end the participants will integrate all the SW to control the system and even ride that vehicle.
Course Objectives	The course objective is to get an expert view into today's design processes and chances by the use of electronics.
Learning Targets/ Skills	The Participant ▪ works in groups on independent case studies in order to cut through the analysis and draft process of electronic systems. ▪ is able to apply methods and tools of model based analysis and draft and inspection procedure of hard- and software. ▪ is able to optimize embedded systems regarding quality and efficiency criteria.
Pre-Requisites	Requisites: "Software and Systems Engineering"; User Requirements for System under Development
Teaching Method	▪ Case Studies in Lab. ▪ Performance Appraisal ▪ Participation during course
Performance Appraisal	

	Written	Oral
Participation during course	-	20%
Case Study	-	60%
Project Work	-	20%
Exam	-	-

Course Material	Script/slides as handouts (web downloads), selected tools (web downloads)
Literature	▪ Automotive Software Engineering (Schäuffele/Zurawka) ▪ Test Process Improvement (Koomen/Pohl) ▪ Project manager (Schelle et al.)

Contact Lecturer	Prof. Dr.-Ing. Eric Sax, E-Mail: ***Eric.Sax@kit.edu*** Hannes Stoll; E-Mail: ***Hannes.Stoll@kit.edu***

6.1.5 Modeling and Simulation

Lecturer	Prof. Dr. Sören Hohmann
Content	The course treats fundamentals of the virtual design of prototypes. To this end, methods to describe systems virtually from different perspectives are taught. In order to model the system context, the use cases and the requirements the system has to fulfill, SysML is introduced and explained at examples. The description of the behavior of the systems is shown by the derivation of mathematical models based on the physics of a system. Herein, noncausal as well as causal modelling techniques are introduced and their advantages and disadvantages are discussed. Moreover, tools are presented to implement causal and noncausal models for simulations. Another focus of the lecture is the parameterization of the mathematical models with least squares estimation and the training of artificial neural networks.
Course Objectives	The course objective is to introduce the concept of virtual prototypes on practical examples, to emphasize the characteristics and advantages of different modeling techniques and to show tools to implement virtual prototypes for simulations.
Learning Targets/ Skills	The Participant ▪ knows the fundamentals of virtual design and virtual prototypes ▪ can name the fundamentals of SysML modeling ▪ is capable to differentiate between causal and noncausal modelling ▪ knows different tools to implement virtual prototypes ▪ can apply basic system identification methods
Pre-Requisites	Basic knowledge in electric circuits and physics
Teaching Method	The course consists of lectures, tool demonstrations and exercises.
Performance Appraisal	

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

Course Material	Lecture notes, Slides, Exercises and Case Studies
Literature	• Wellstead, P.E.: Introduction to physical system modelling. Academic Press Ltd., 1979 • Marker, D.: Model Theory: An Introduction. Springer, 2002 • Ljung, L.: System Identification: Theory for the User. Prentice Hall, 1998
Contact Lecturer	Prof. Dr-Ing. Sören Hohmann, E-Mail: ***Soeren.Hohmann@kit.edu***

6.2 Components of Electronic Systems

In order to realize an embedded system in the end concrete components need to be used. Controllers and processors or ASICs and FPGAs will implement the application. The interfaces to the environment is enabled by actuators and sensors. All these technologies will be explained in this module.

Module Name: Components of Electronic Systems

Module Supervisor: Prof. Dr. Sören Hohmann

Type of Module: Engineering Module 2 (EM2)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Optical Actors and Sensors	15	21
Control Systems Development	15	21
VLSI-Technology and Nanoelectronics	22,5	31,5
Embedded Systems Computer Architecture	22,5	31,5

Major Learning Results (LR):

LR-1: Knowledge of the interconnection between sensing and acting to enable an automatic support of the driver and to judge and review the quality of different human-machine interacting methods.
LR-2: Ability to gain knowledge in computer architectures with a special focus on embedded systems.
LR-3: Understanding of systems theory, control theory and process automation.
LR-4: Ability to implement the most modern components in complex circuit architecture.

Performance appraisal for this Module:

Within the second Master-specific Module in ESEM the performance appraisal is based on oral exams containing varying components of class room participation.

Credit Points: 6

6.2.1 Optical Actors and Sensors

Lecturer	Prof. Dr. rer. nat. Cornelius Neumann
Content	The lecture Actors and Sensors includes: ▪ Basics of Automotive Lighting and Vision ▪ Basics of Electromagnetic (ELM) Sensor Systems ▪ Human Machine Interaction (HMI) ▪ ELM Sensors in Automotive ▪ Adaptive Lighting Systems ▪ Applications of Sensor-Actor Systems in Light Based Assisting Systems (LBAS)
Course Objectives	Modern assisting functions in automotive rely on sensors of different range, often based on electromagnetic radiation (e.g. light, infrared- or microwave radiation). The information that is extracted out of the sensor information steer different kind of actors, including adaptive head lamp systems. Actor sensor systems in automotive lighting enable to drive more save at nighttime and help to reduce traffic accidents. Modern applications in light based assisting systems will be the central part of the course.
Learning Targets/ Skills	The Participant ▪ learns the basics of automotive lighting and ELM sensors. ▪ understands the interconnection between sensing and acting to enable an automatic support of the driver. ▪ gains competences for the development of automotive lighting systems. ▪ is able to judge and review the quality of different human machine interacting methods. ▪ gains skills to follow the development in this field of research and application and to judge the safety gain of upcoming lighting systems.
Pre-Requisites	None
Teaching Method	Lecture
Performance Appraisal	

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

Course Material	Slides
Literature	Wördenweber, B., Wallaschek, J., Boyce, P., Hoffman, D.D. - Automotive Lighting and Human Vision; Springer 2007 ISBN 978-3-540-36697-3
Contact Lecturer	Prof. Dr. Cornelius Neumann: E-Mail: ***Cornelius.Neumann@kit.edu***

6.2.2 Control Systems Development

<table>
<tr><td>Lecturer</td><td>Prof. Dr. Sören Hohmann</td></tr>
<tr><td>Content</td><td>The course treats fundamentals of systems theory, control theory and process automation. In order the different levels of automation up to Cyber Physical Systems are described. The steps for a model based control system development are presented. To analyze dynamical systems different mathematical and graphical forms of description like signal flow diagrams are introduced. For systems simulation the fundamentals of working with MATLAB and SIMULINK are shown. Different feedback control design methods for a model based as well as a heuristically control design are demonstrated with practical examples</td></tr>
<tr><td>Course Objectives</td><td>The course objective is to introduce the fundamentals of process automation and systems theory. The basics for analyzing dynamic systems are learnt and then used to examine the characteristics and advantages of different controller design methods applied to practical examples.</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant
knows the fundamentals of systems theory and process automation,
knows different plane models,
knows Cyber Physical Systems,
knows basic control system simulation with MATLAB/SIMULINK,
can name and describe the levels of automation,
understands signal flow diagrams, frequency characteristic and locus curve,
is capable to differentiate signal based and model based methods and
can apply basic controller design methods.</td></tr>
<tr><td>Pre-Requisites</td><td>Basic knowledge in complex analysis and system modelling</td></tr>
<tr><td>Teaching Method</td><td>The course consists of lectures, tool demonstrations and exercises.</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>100%</td><td>-</td></tr></table></td></tr>
<tr><td>Course Material</td><td>Lecture notes, Slides and Exercises</td></tr>
<tr><td>Literature</td><td>R. Dorf, R. Bishop: Modern Control Systems, 11th edition, Addison-Wesley, 2007
C. Phillips, R. Harbor: Feedback Control Systems, 4th edition, Prentice Hall, 2007
M. Blanke, M. Kinnaert, J. Lunze, M. Staroswiecki: Diagnosis and Fault Tolerant Control, Springer Verlag, 2008</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr. Sören Hohmann; E-Mail: Soeren.Hohmann@kit.edu</td></tr>
</table>

6.2.3 VLSI-Technology and Nanoelectronics

Lecturer	Prof. Dr. rer. nat. Michael Siegel
Content	The lecture targets the latest technology, basic knowledge of MOS transistors, device models, and detailed expertise in physical layer design. This knowledge will be applied and trained concurrently in practical lab courses. Focus will be the teaching and understanding of feasible problem and solution strategies, particularly with regard to the time-, cost- and performance optimized design of embedded hardware/software systems. This includes the training of design methods for electronic systems on a chip. The lecture starts from models of semiconductor devices. A short introduction to the MOS manufacturing process will be given. A three-dimensional model of MOS transistors will be introduced. Device parameters and parasitics will be discussed. The concept of design rules as an interface between designers and manufacturers will be introduced. An important part is focusing on MOS transistors as the primary building block of integrated circuits. The main goal is to provide deep understanding of the operation of MOS transistors. Transistor models will be introduced. An important part of the lecture is the careful analysis of interconnects, vias and resistors. A crucial part of the lecture is focusing on the inverter as the main building block of a logical gate. Static and dynamic operation of an inverter is analyzed in detail. Combinational and sequential logic circuits are introduced and analyzed. Timing issues will be discussed from a designer's view. Finally, different memory classes and their operation will be discussed in detail. The peripheral circuitry, such as decoders, sense amplifiers, drivers, and control units will be covered.
Course Objectives	Master the basics and state-of-the-art of very large scale integration technology and physical layer design of analogue and digital circuits; apply newest standard software tools and methods for design of basic cells of microelectronic circuits. Handle physical design styles for the latest technologies.
Learning Targets/ Skills	The Participant ▪ understands very large scale integration technology and physical layer design of analog and digital circuits to be applied in today's and future technologies. ▪ understands the co-design, synthesis and integration properties of microelectronic circuits and systems with corresponding methods and design styles.
Pre-Requisites	Basics in solid state electronics; fundamentals in analogue and digital design
Teaching Method	Power-point presentation, Blackboard, Interactive Case Studies (Project Work) Tool presentation
Performance Appraisal	

	Written	Oral
Participation during course	-	10%
Case Study	-	10%
Project Work	-	-
Exam	-	80%

Course Material	Script/Slides as Handout (and as downloads on the web), Selected Tools (available as downloads on the web)
Literature	▪ Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic´: Digital In-tegrated Circuits,

	Second Edition. Publisher: Prentice Hall, 2003 ISBN: 0-13-090996-3 ▪ R. Jacob Baker, Harry W. Li, David E. Boyce: CMOS Circuit Design, Lay-out, and Simulation. WILEY & SONS, Inc. 2004. ISBN 047170055X
Contact Lecturer	Prof. Dr. rer. nat. Michael Siegel; E-Mail: ***Michael.Siegel@kit.edu***

6.2.4 Embedded Systems Computer Architecture

Lecturer	Dr.-Ing. Oliver Sander
Content	The lecture provides a detailed introduction into computer architectures with a special focus on embedded systems. The knowledge will be applied and trained concurrently in practical lab courses. Focus will be the teaching and understanding of architectural challenges and solution strategies, particularly concerning the time-, cost- and performance-optimized design of embedded hardware/software systems. Specific topics to be covered include: ▪ Fundamentals of processor architecture and classifications ▪ Typical Microarchitectures and optimization techniques ▪ Instruction Set Architecture (ISA) and hardware/software interface ▪ System on Chip (SoC) components and architectures ▪ System design aspects and embedded computers ▪ Complex heterogeneous multicores
Course Objectives	Master the basics and state-of-the-art computer architectures for embedded systems, their characteristics, application fields, limitations, role in modern system architectures, and an introduction to the hardware-software interface.
Learning Targets/ Skills	The Participant ▪ Gains fundamental knowledge of current and future processor and microcontroller architectures, ▪ Knows the architecture, application fields and specific characteristics of modern SoC-based embedded systems, ▪ Understands which properties are important for selecting a microcontroller for a given application and ▪ Gains knowledge about the hardware-software interface and its characteristics.
Pre-Requisites	Digital Design, Basics of Software Programming
Teaching Method	PowerPoint Presentation, Blackboard, Interactive Case Studies (Project Work), tool presentation.
Performance Appraisal	

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

Course Material	Presentation slides will be given as digital handout, description for practical exercises
Literature	Hennessy & Patterson: Computer Architecture (Elsevier, ISBN: 9780123838728)
Contact Lecturer	Dr.-Ing. Oliver Sander; E-Mail: ***Oliver.Sander@kit.edu***

6.3 Data Communication Technologies and Systems

The concrete components work together collaboratively. Data communication between them is needed. Signals carry information to achieve that on a wired bus or even over the air. Communication protocols will be presented for specific demands such as car2car communication or industry 4.0.

Module Name: Data Communication Technologies and Systems

Module Supervisor: Prof. Dr. rer. nat. Michael Siegel

Type of Module: Engineering Module 3 (EM3)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Integrated Circuit and Systems Signal Processing	30	42
Communication Systems and Protocols	30	42
Mobile Perception Systems	15	21

Major Learning Results (LR):

LR-1: Understanding of the interaction of hardware components and of the hardware to record signals and use them for further processing.

LR-2: Understanding of electronic communication on the system and protocol levels.

LR-3: Development of new approaches to the communication of systems and subsystems via optical components and methods.

LR-4: Knowledge of the importance of perception systems for the safety, comfort, and efficiency of mobile machines.

Performance appraisal for this Module:

Within the third Master-specific Module in ESEM the performance appraisal is based on oral exams containing varying components of class room participation.

Credit Points: 6

6.3.1 Integrated Circuit and Systems Signal Processing

Lecturer	Prof. Dr. rer.nat. Michael Siegel
Content	This course provides the fundamentals of system design for signal processing. After an introduction of integrated circuit design, analog signal processing will be discussed. Key components of appropriate hardware modules, e.g. amplifiers, Analog-to-Digital converters are discussed. This chapter is followed by a discussion of digital signal processing circuits, as Digital-Signal processors, Microcontrollers and FPGA. Especially, the DSP architecture will be discussed as CPU structures for fast „multiply and accumulate“ (MAC) operations, high-speed control and interrupt system architectures, as well as bus systems and memory management technology. Then the implementation of selected signal processing algorithms onto FPGAs or other ASICs is discussed. The course closes with real case studies.
Course Objectives	Course objectives are the analysis and the understanding of analog and digital signal processing circuits as well as the analysis of standard processor architectures and their use for the design of advanced and novel application specific platforms.
Learning Targets/ Skills	The Participant ▪ gains a basic knowledge of signal processing problems including real-time conditions and the formulation and evaluation of algorithms for the usage in hardware. ▪ is made capable of designing analogue and digital signal processing systems and to implement them in solutions with system-on-chip or heterogeneous systems.
Pre-Requisites	Basic logic design experience, familiarity with computer aided design tools, knowledge of digital signal processing theory.
Teaching Method	Lectures and direct interaction via discussions.
Performance Appraisal	

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

Course Material	Lecture notes
Literature	▪ Steven W. Smith, The Scientist & Engineer's Guide to Digital Signal Processing, 1997 ISBN-10: 0966017633 ▪ Richard G. Lyons, Understanding Digital Signal Processing (3rd Edition), 2010, ISBN-10: 0137027419
Contact Lecturer	Prof. Dr. rer. net. Michael Siegel: E-Mail: ***Michael.Siegel@kit.edu***

6.3.2 Communication Systems and Protocols

Lecturer	Prof. Dr.-Ing. Dr. h. c. Jürgen Becker
Content	This course for electrical and information engineers provides an overview in theory and practice of data exchange between computers and dedicated communication devices. The different levels of data communication will be explained, ranging from highly integrated connections on

	micorchips across system busses to wide-area networks. Among criteria like speed and transmission capacity of a communication system, other aspects as security issues and the cost of system are presented as well. Actual implementations will be discussed, amongst others serial and parallel interfaces, PCI, SCSI, FireWire, USB, IEC, CAN, AMBA as well as the networking standards Ethernet, Tokenring, FDDI and ATM. In addition the hardware and lower software levels of local-, wide-area and radio networks will be explained in combination with the presentation of important network topologies and communications devices like repeaters, bridges, routers and gateways.
Course Objectives	In this lecture, basic concepts for methods of broadcast are given and the aspects in common are determined.
Learning Targets/ Skills	The participant gains a deep understanding of communication networks, components and the report level, that stand behind the current technologies and that are used in modern on- and off-chip communication, local and global networks
Pre-Requisites	Fundamentals of digital systems design from „Digital System Design“
Teaching Method	Lecture accompanied by biweekly exercises
Performance Appraisal	

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

Course Material	Downloadable PPT Slides during the course
Literature	Mahalik, N.: Fieldbus Technology: Industrial Network Standards for Real-Time Distributed Control, Springer 2010
Contact Lecturer	Prof. Dr.-Ing. Dr. h. c. Jürgen Becker, E-Mail: ***Becker@kit.edu***

6.3.3 Mobile Perception Systems

Lecturer	Prof. Dr.-Ing. Christoph Stiller
Content	This course provides an overview on sensors that allow perceiving the environment of mobiles. The principles of radar, lidar, and video sensors are presented and their strengths and weaknesses are discussed. The lecture focuses on optical sensors, such as cameras and outlines the fundamentals of image acquisition and perspective projection. Fundamental methods for reconstruction of the 3-dimensional scene and the relevant information for navigation from mono- and stereoscopic camera systems are discussed. The lecture provides an outlook towards applications in driver assistance systems and automated driving.
Course Objectives	The objective of this course is to explain the importance of perception systems for the safety, comfort, and efficiency of mobile machines, to Introduce into the fundamentals of sensor technologies and to provide an overview on methods for scene perception to enable students to assess the uncertainties associated with these.
Learning Targets/ Skills	On successful completion of this course the students understand the principles of radar, lidar, and vision sensors and their potential towards recognition of scene around a mobile. The

<table>
<tr><td></td><td>students know the basic methods for scene reconstruction und are able to quantify the resulting uncertainties in scene representation. The students have gathered first experience with specific methods for environment perception from exercises and hands-on demonstrations.</td></tr>
<tr><td>Pre-Requisites</td><td>Basics in System Theory, Stochastics, and Linear Algebra</td></tr>
<tr><td>Teaching Method</td><td>The course structure consists of lectures as well as accompanying exercises, and discussion sections.</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 notes and exercises in digital form</td></tr>
<tr><td>Literature</td><td>

Maurer, Markus; Stiller, Christoph (eds.): Fahrerassistenzsysteme mit maschineller Wahrnehmung. Heidelberg : Springer-Verlag, 2005
Winner, Hermann; Hakuli, Stephan; Wolf, Gabriele (eds.): Handbuch Fahrerassistenzsysteme. Wiesbaden: Vieweg + Teubner, 2009,
Thrun, Sebastian; Burgard, Wolfram; Fox, Dieter: Probabilistic Robotics, MIT Press, 2005

</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr.-Ing. Christoph Stiller: E-Mail: Stiller@kit.edu</td></tr>
</table>

6.4 Implementation and Component Realization

Now, knowing all the processes, methods and tools, all the components and how to combine them the next step is to implement and realize the embedded mechatronic system. Synthesis in hardware or software must be considered. Especially in the software area coding structures, code generation and clever programming are essential. A case study will help to get used to current standards and quasi-standards.

Module Name: Implementation and Component Realization

Module Supervisor: Prof. Dr.-Ing. Dr. h. c. Jürgen Becker

Type of Module: Engineering Module 4 (EM4)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Micro Systems	15	21
Roadmap for Electronic Product Development	15	21
Electronic Systems Synthesis	22,5	31,5
Case Study of Electronic Subsystems	7,5	10,5
Software Development	15	21

Major Learning Results (LR):

LR-1: Knowledge of technology strategies and their further development for the design of electronic systems.

LR-2: Use of computer-supported methods for the design and optimization of complex electronic systems.

LR-3: Ability to implement an efficient program for an state-of-the-art embedded system.

LR-4: *Micro Systems – Currently under revision*

Performance appraisal for this Module:

Within the fourth Master-specific Module in ESEM the performance appraisal is based on oral exams. The exam for the lectures *Communication Systems and Protocols* and *Integrated Circuit and Systems Signal Processing* will be combined.

Credit Points: 6

6.4.1 Micro Systems

Lecturer	Prof. Dr. Wilhelm Stork
Content	Procedures and methodologies out of the area of micro structure technology as microlithography, edging technologies and ultra-precise cutting machines are presented and the application of these technologies in the area of micromechanics and micro optics are discussed.
Course Objectives	In the beginning history and concept of microsystems technology will be discussed in the context of applications in automotive, production and medical engineering. Then the major technologies in micro structuring, as lithography, thin film techniques, edging procedures and ultra-precise cutting methods are presented. Applications of these technologies especially in the fabrication of micro machining and micro optic components are described. For understanding different classes of micro-optic elements an introduction in optics, diffraction and fiber optics technologies will be given. Various classes of micro-optical components will be explained. In addition, both the concepts of refractive and diffractive optical components and active and passive waveguides belong to integrated optical systems and fibers. Micromechanical manufacturing processes with silicon and plastic using the LIGA procedure will be demonstrated by means of examples from automotive and medical applications.
Learning Targets/ Skills	The lecturer reserves the right to alter the contents of the course without prior notification.
Pre-Requisites	None
Teaching Method	PowerPoint Presentation, Blackboard, Interactive Project Work.
Performance Appraisal	

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

Course Material	Slides and lecture notes are available online on www.estudium.org Literature:
Literature	▪ Menz, W., Mohr, J., Paul, O.: „Mikrosystemtechnik für Ingenieure“, Wiley-VCH, 3. Auflage, 2005 ▪ Mescheder, U.: „Mikrosystemtechnik“, B.G. Teubner, Stuttgart, 2000 ▪ Gerlach, G. und Dötzel, W.: „Grundlagen der Mikrosystemtechnik“, Hanser, München, 1997 ▪ Hecht, E.: „Optics“. Addison-Wesley, San Francisco, 2002 ▪ Sinzinger, S. und Jahns, J.: „Microoptics“ Wiley-VCH, Weinheim, 1999 ▪ Büttgenbach, S.: „Mikromechanik“ Teubner, Stuttgart, 1994 ▪ Fatikow, S. und Rembold, U.: “Microsystem Technology and Microrobotics”, Springer, Berlin, 1997 ▪ Gardner, J.W. und Varadan, V.K. and Osama O,A.: “Microsensors, MEMS, and Smart Devices”, Wiley-VCH, Weinheim, 2001.
Contact Lecturer	Prof. Dr. Wilhelm Stork, E-Mail: ***Wilhelm.Stork@kit.edu***

6.4.2 Roadmap for Electronic Product Development

Lecturer	Prof. Dr. rer. net. Michael Siegel
Content	The International Technology Roadmap for Semiconductors (ITRS) identifies the technical capabilities that need to be developed for the industry to continue trends such as increased scaling. Smaller, faster, denser, and cheaper semiconductors have helped propel the information revolution, resulting in faster economic growth, greater productivity, higher budget surpluses, and the creation of high-tech, high wage jobs. Continuation of these gains is at risk as we approach fundamental limits when the ITRS projects that progress will stall without research breakthroughs in most technical areas. The ITRS lists dozens of technical barriers that must be overcome. The lecture targets the latest technology, basic knowledge of MOS transistors. This knowledge will be applied and trained concurrently in practical lab courses. Focus will be the teaching and understanding of feasible problem and solution strategies, particularly with regard to the time-, cost- and performance optimized design of embedded systems. The lecture starts from models of semiconductor devices. A short introduction to the MOS manufacturing process will be given. A three-dimensional model of MOS transistors will be introduced. Device parameters and parasitic will be discussed. The concept of design rules as an interface between designers and manufacturers will be introduced. An important part is focusing on MOS transistors as the primary building block of integrated circuits. Different memory classes and their operation will be discussed in detail. We are beginning to reach the fundamental limits of the materials used in the planar CMOS process, the process that has been the basis for the semiconductor industry for the past 30 years. By introducing new materials into the basic CMOS structure and devising new CMOS structures, further improvements in the CMOS process can continue for the next ten to fifteen years, at which time it becomes evident that most of the known technological capabilities of the CMOS device structure will approach or have reached their limits. In order to continue to drive information technology advances, it becomes necessary to investigate new devices that may provide a more cost-effective alternative to planar CMOS in this timeframe.
Course Objectives	Master the basics and state-of-the-art of very large scale integration technology and physical layer design of analogue and digital circuits; apply newest standard software tools and methods for design of basic cells of microelectronic circuits. Handle physical design styles for the latest technologies.
Learning Targets/ Skills	The Participant ▪ gains knowledge of technology strategies for the development of electronic systems. ▪ cuts through the integration technologies of integrated circuits that are being used in current and future technologies. ▪ learns the process of the production and work with roadmaps in the development of components and systems.
Pre-Requisites	Basics in solid state electronics; Fundamentals in analogue and digital design
Teaching Method	The course structure consists of lectures as well as case studies, demonstrations and discussion sections.
Performance Appraisal	

	Written	Oral
Participation during course	-	20%
Case Study	-	-

	Project Work	-	-
	Exam	-	80%
Course Material	Script/Slides as handout, selected tools (available as downloads on the web)		
Literature	▪ Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic´: Digital Integrated Circuits, Second Edition. Publisher: Prentice Hall, 2003 ISBN: 0-13-090996-3 ▪ R. Jacob Baker, Harry W. Li, David E. Boyce: CMOS Circuit Design, Lay-out, and Simulation. WILEY & SONS, Inc. 2004. ISBN 047170055X		
Contact Lecturer	Prof. Dr. rer. nat. Michael Siegel, E-Mail: ***Michael.Siegel@kit.edu***		

6.4.3 Electronic Systems Synthesis

Lecturer	Prof. Dr.-Ing. Dr. h. c. Jürgen Becker		
Content	The lecture targets system and circuit synthesis methods, design styles and tools, based on the newest technology options to be available. This knowledge will be applied and trained concurrently in practical lab courses. Focus will be the teaching and understanding of feasible problem and solution strategies, particularly with regard to the time-, cost- and performance-optimized design of embedded hardware/software systems. This includes the training of automated hardware synthesis methods for electronic systems being used in today's design tools. Specific topics to be covered include: ▪ Hardware architectures, ▪ Co-design and partitioning of hardware/software systems; ▪ Fundamental and advanced algorithmic methods for automated synthesis of microelectronic circuits; ▪ Physical design styles of the latest technologies.		
Course Objectives	Master the basics and state-of-the-art of hardware/software architectures, their co-design, synthesis and application; apply various algorithmic methods for automated synthesis of microelectronic circuits, handle physical design styles of newest technologies.		
Learning Targets/ Skills	The Participant ▪ gains knowledge of current and future hardware and software architectures. ▪ understands Co-Design and integrated characteristics of microelectronic circuits and systems with respective drafting methods.		
Pre-Requisites	Digital design, Fundamentals in hardware architectures, Basics in algorithms		
Teaching Method	PowerPoint Presentation, Blackboard, Interactive Case Studies (Project Work), tool presentation.		
Performance Appraisal		Written	Oral
	Participation during course	-	-
	Case Study	-	-
	Project Work	-	-
	Exam	-	100%

Course Material	Script/slides as handout, selected tools (available as downloads on the web)
Literature	Actual list will be provided e. g. Gerez, Algorithms for VLSI Design Automation, Publisher: John Wiley & Son Ltd; ISBN: 0471984892
Contact Lecturer	Prof. Dr.-Ing. Dr. h. c. Jürgen Becker, E-Mail: ***Becker@kit.edu***

6.4.4 Case Study of Electronic Subsystems

Lecturer	Prof. Dr.-Ing. Dr. h. c. Jürgen Becker
Content	In this course participants will get practical insight into realizing a state-of-the-art digital system using modern circuit synthesis methods, design styles and tools. Aspects that are covered include the modeling of such systems at various levels of abstractions, the representation of selected parts in a standard specification language and the computer-supported synthesis of selected digital hardware units using today's industry design environments with the newest silicon technologies. The following topics will be covered: ▪ System specification based on a hardware description language ▪ Computer-aided synthesis of digital circuit design for standard cells and field programmable devices ▪ Simulation and verification of the system behavior on different levels - RTL, Gate Level before and after place and route ▪ Physical circuit layout based on newest tools and silicon technologies
Course Objectives	In this course the objective is to teach the fundamentals needed to design, implement, analyze, test and verify digital circuit designs in practice. The participants will learn to apply their theoretical knowledge to a real-world example while gaining experience in computer aided design tools. By coping with the design challenge as part of a team participants will experience the' product development flow used in industry and thus become well prepared for their future career.
Learning Targets/ Skills	The Participant ▪ gains knowledge of the development an electric circuit from the description through to the final realization. ▪ gains the ability to express systems in a hardware description language and will gain expert knowledge in a development environment, like it is currently being applied in the industry. ▪ is able to simulate a system in various phases of the development by determining appropriate instruments and required scenarios depending on the chosen goal technology. ▪ synthesizes the gained knowledge in small groups that are capable of optimizing existent systems and optimizing the structure for various situations.
Pre-Requisites	Knowledge of theoretical fundamentals in digital system design, e.g. Boolean algebra, expansion theory and minimization, state machines, basic knowledge in principles of Digital Circuit Design, e.g. VHDL, fundamentals in hardware architectures including simple microprocessors and related communication structures, basics in algorithms.
Teaching Method	Participants complete a final design project as part of a multi-student team. All teams present their project in a verbal presentation to peers, faculty and industry audiences. Participants define

	requirements, estimate tasks and resources, engineer design implementations, validate solutions, employ simulations and prototype their projects. Verbal presentations are evaluated by faculty as well as student peers. Project reports are graded by instructor. Participants must demonstrate proficiency using lab and measurement equipment to verify digital circuit and system characteristics.
Performance Appraisal	

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

Course Material	▪ Script/Slides as Handout (and as downloads on the web) ▪ Selected Tools (available as downloads on the web)
Literature	▪ Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic´: Digital In-tegrated Circuits, Second Edition,Prentice Hall, 2003 - ISBN: 0-13-090996-3 ▪ Bhatnagar, Himanshu: Advanced ASIC chip synthesis : using Synopsys Design Compiler, Physical Compiler, and PrimeTime; Kluwer, 2002 - ISBN: 0-7923-7644-7
Contact Lecturer	Prof. Dr.-Ing. Dr. h. c. Jürgen Becker, E-Mail: ***Becker@kit.edu***

6.4.5 Software Development

Lecturer	Prof. Dr.-Ing. Eric Sax
Content	This lecture introduces the basic knowhow in information technology. Starting with computer architectures such as von Neumann including registers, address management, memory access, calculation units and interfaces, performance optimization is discussed (e.g. pipelining). Then, high level programming languages and object oriented approaches are the next major part. C++ is the example. The next abstraction step is the presentation of algorithms and data structures. Overall, this is embedded into seamless design flow from idea to realization.
Course Objectives	In the end, the students are able to implement an efficient program (e.g. in C++) for an state-of-the art embedded system.
Learning Targets/ Skills	The Participant ▪ is able to build and describe different computer architectures. ▪ can understand and compare programming paradigms, such as object orientation. ▪ can provide solutions for typical software challenges based on various algorithms for searching and structuring of data.
Pre-Requisites	Systems and software engineering, basic programming knowledge.
Teaching Method	PowerPoint Presentation, smaller tasks in groups
Performance Appraisal	

	Written	Oral
Participation during course	-	-

	Case Study	-	-
	Project Work	-	-
	Exam	-	100%
Course Material	Script/slides as handouts (web downloads), selected tools (web downloads)		
Literature	▪ C++ (Stroustrup) ▪ Automotive Software Engineering (Schäuffele/Zurawka)		
Contact Lecturer	Prof. Dr.-Ing. Eric Sax; E-Mail: ***Eric.Sax@kit.edu***		

6.5 Systems Integration and Validation, Total Quality Management of Electronic Systems

Implementation and integration leads to testing the overall system according to the early requirements. During the overall process of engineering, testing has been prepared and done in order to check the maturity level. In simulations and prototyping environments quality assurance has been executed. At the end of those phases for the first time the real system can be tested to check finally the user requirements in a Hardware-in-the-Loop environment or even in real test scenarios.

Module Name: Systems Integration and Validation, Total Quality Management of Electronic Systems

Module Supervisor: Prof. Dr.-Ing. Eric Sax

Type of Module: Engineering Module 5 (EM5)

Lectures in Module	**Workload Distribution [hrs]**	
	Presence	**Self studies**
Quality Assurance and Cost of QA of Electronic Systems	22,5	31,5
Testing Embedded Systems	22,5	31,5
Systems Engineering: Integration and Mechatronics Aspects	15	21
Case Study: Embedded Systems Testing	15	21

Major Learning Results (LR):

LR-1: Understanding of the total quality management approach in the product development process of electronic systems.
LR-2: Knowledge of the optimization of hardware and software architectures for testing in production.
LR-3: Assessment and optimization of the analysis and design process of electronic systems.
LR-4: Definition of (electronic) target systems.

Performance appraisal for this Module:

Within the fifth Master-specific Module in ESEM the performance appraisal is based on one oral exam. Class room participation will be assessed and contributes to the final grade. The exam for the lectures *Quality Assurance and Cost of QA of Electronic Systems* and *Testing Embedded Systems* as well as the Case Study in Manufacturing of Electronic Systems will be combined.

Credit Points: 6

6.5.1 Quality Assurance and Cost of QA of Electronic Systems

Lecturer	Prof. Dr.-Ing. Martin Heine
Content	The course targets methods and rules for quality assurance management, reliability and cost issues for quality assurance of complex electronics systems. Emphasis will be placed on teaching and understanding feasible problem and solution strategies with regard to time-, cost- and performance optimization for quality assurance and reliability of electronics hardware systems. Use of statistical methods in process control, prototype tests, quality assurance tests and characterization tests, as well as the resulting cost figures, will also be discussed. Specific course topics include electronics hardware IC and PCB design with respect to reliability, manufacturability, quality assurance and cost; methods to improve yield; setting up procedures for prototype tests, production tests and quality assurance tests, obtaining reliability data for hardware components, determining failure rate and system mean time to failure, mean time to repair, and system dependability; performing statistical process control, calculating fixed and variable costs for electronic products.
Course Objectives	Master the state-of-the-art in design for system dependability, manufacturability and cost; apply measures to improve component and system quality; find optimum for system quality under time to market, reliability and cost constraints. Master the use of statistical data.
Learning Targets/ Skills	The participant learns and adapts methodologies how to improve electronics system architectures for quality and manufacturability under time and performance constraints, for application to current and future technologies; capable to interpret and determine reliability and statistical data, understand cost issues in quality assurance for electronics components and systems.
Pre-Requisites	Basics in stochastic, fundamentals in electronics system design, basics in terms of quality evaluation and assessment.
Teaching Method	PowerPoint Presentation, Blackboard, software tool presentation.
Performance Appraisal	

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

Course Material	Script/slides as downloads on the web.
Literature	Birolini, Alessandro: “Reliability Engineering, Theory and Practice”, Springer Verlag Berlin Heidelberg
Contact Lecturer	Dr. Martin Heine: E-Mail: ***Martin.Heine@hs-furtwangen.de***

6.5.2 Testing Embedded Systems

Lecturer	Dr. Christian Müller
Content	Testing of embedded systems gives transparency to the maturity level of a product. Consequently it is the essential basis for quality improvements and final approvals for a release of a product. Test methods and technology have to be continually adapted to any new challenges coming e.g from new technologies, new requirements concerning safety regulations or new applications such as autonomous driving. Since testing usually happens in late phases within the development process, the requirements in regards to cost, time and quality are particularly important. No requirement without test(s) and no test without requirement(s) is the maxime. The course shows different aspects of efficient embedded system testing with a specific focus on the automotive industry: Choosing and defining the right test process as part of the overall development process (s. other lectures) is the fundamental approach. For an overall boost in efficiency all test phases along all integration steps have to be synchronized and linked while taking into account the respective test topics at the right time and using the fitting test technology. The necessity, the advantages but also the limitations of test automation will be discussed. Theory is combined with practical examples based on today's challenges in the automotive EE systems like ADAS or alternative drive trains.
Course Objectives	The course objective is to introduce a structured testing approach based on an efficient combination of different test phases and different test technologies.
Learning Targets/ Skills	The Participant ▪ Is able to analyze and structure test needs concerning the test object, the test reference and the test phases. ▪ gets an overview of state of the art test technologies for automotive EE systems. ▪ is able to sketch the guidelines for new test projects and optimize existing test projects.
Pre-Requisites	Embedded Software and Systems Engineering
Teaching Method	Presentation combined with practical demonstration/training on a real test bench
Performance Appraisal	

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

Course Material	Script/slides as handouts (web downloads), tool presentation
Literature	▪ Automotive Software Engineering (Schäuffele/Zurawka) ▪ Test Process Improvement (Koomen/Pohl) ▪ Automatisiertes Testen Eingebetteter Systeme in der Automobilindustrie (Sax et al.) ▪ Handbuch Fahrerassistenzsysteme (Winner, H., Hakuli, S., Lotz, F., Singer, C. (Hrsg.)
Contact Lecturer	Dr. Christian Müller: E-Mail: ***Christian.Mueller2@partner.kit.edu***

6.5.3 Systems Engineering: Integration and Mechatronics Aspects

Lecturer	Prof. Dr.-Ing. Eric Sax
Content	This lecture picks up the participants in the design phases after the component realization. Now integration aspects are focused. The art of putting it all together and validate it in common. This includes hardware, software and mechanical parts of sensing and acting. Bridging the gap from implementation to testing will be the content. Life cycle process model such as the waterfall model, V-model, spiral model are presented to fulfil this task. Failure rates, statistical reporting and test coverage will show systematically how the customer expectations are fulfilled. System integration and testing conclude the course.
Course Objectives	The course objective is to introduce integration techniques on different levels of abstraction from parts developed independently.
Learning Targets/ Skills	The Participant ▪ understands the additional constraints of hardware components such as sensors and actuators. ▪ is able to apply methods and tools of system integration. ▪ is able to apply calculate failure rates and failure estimations.
Pre-Requisites	“Systems and software engineering”, “Collaborative Development”
Teaching Method	PowerPoint Presentation, smaller tasks in groups
Performance Appraisal	

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

Course Material	Script/slides as handouts (web downloads), selected tools (web downloads)
Literature	▪ Testing embedded software (Bart/Notenboom) ▪ Automotive Software Engineering (Schäuffele/Zurawka)
Contact Lecturer	Prof. Dr.-Ing. Eric Sax: E-Mail: ***Eric.Sax@kit.edu***

6.5.4 Case Study: Embedded Systems Testing

Lecturer	Prof. Dr.-Ing. Eric Sax
Content	In this case study an automotive system will be tested with latest test equipment in the laboratory. Hardware-in-the-Loop will be used for that semi- and fully automated approach for electronic system testing. Participants complete a final test project as part of a multi-student team. All teams present their project in a verbal presentation to peers, faculty and industry audiences. The structured analysis of the requirements of real-time systems, systematic derivation of test

<table>
<tr><td></td><td>cases and pass/fail criteria will lead to a professional test operation.

Test coverage, automation and reporting techniques will furthermore be exercised.

An automatic bus door will be the system-under-test.</td></tr>
<tr><td>Course Objectives</td><td>The course objective is to get an expert view into today's methods on testing automotive systems. Using the state-of-the-art computer-aided-engineering tools will familiarize the students with the latest techniques.</td></tr>
<tr><td>Learning Targets/ Skills</td><td>The Participant
works on independent case studies in small working groups and get used to teamwork
is able to apply methods and tools of hardware in the loop testing
is able to identify bugs systematically within a given period of time.</td></tr>
<tr><td>Pre-Requisites</td><td>Lectures in "Systems Engineering", "Case Study in Systems Engineering", "Testing Embedded Systems", Specification of the System under Test</td></tr>
<tr><td>Teaching Method</td><td>Case Studies in Lab.
Performance Appraisal
Systematic, iterative improvement (inluding fire fighting)
Participation during course</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>60%</td></tr><tr><td>Project Work</td><td>-</td><td>20%</td></tr><tr><td>Exam</td><td>-</td><td>-</td></tr></table></td></tr>
<tr><td>Course Material</td><td>Script/slides as handouts (web downloads), selected tools (web downloads)</td></tr>
<tr><td>Literature</td><td>Automotive Software Engineering (Schäuffele/Zurawka)
Test Process Improvement (Koomen/Pohl)
Testing embedded software (Bart/Notenboom)
Project manager (Schelle et al.)</td></tr>
<tr><td>Contact Lecturer</td><td>Prof. Dr.-Ing. Eric Sax: E-Mail: Eric.Sax@kit.edu</td></tr>
</table>

7 Master Thesis Electronic Systems Engineering and Management

The Master Thesis can be performed either as a research project in one of the institutes at the university or outside the university 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 seen 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 9000 employees and an annual budget of about EUR 730 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 Lecture note evaluation

- Form, volume and content of the lecture notes must comply with scope and number of teaching hours
- Each contribution of the individual lecturers is evaluated by reviewers from the same field

9.2.2 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
- mathematical demands
- 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 Financial Engineering am Karlsruher Institut für Technologie” will be published on http://www.sle.kit.edu/amtlicheBekanntmachungen2013.php

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

9.4 General Study and Examination Regulations

The official “Studien- und Prüfungsordnung des Karlsruher Instituts für Technologie (KIT) für die weiterbildenden Masterstudiengänge Service Management and Engineering und Financial Engineering” will be published on http://www.sle.kit.edu/amtlicheBekanntmachungen2013.php

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

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” will be published on http://www.sle.kit.edu/amtlicheBekanntmachungen2013.php

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

9.6 Change Management

Corrections regarding content and structure are listed below:

Date	Author	Page	Chapter	Change/Corrections
14.09.2011	TH	All	All	Relaunch Course Guide Book in Layout and Structure
22.09.2011	MW	10	5.1.2	Update literature: Horngren, Charles T., Datar, Srikant M., Foster, George, Rajan, Madhav, Ittner, Chris, (2008): Cost Accounting, 13th Ed., Upper Saddle River, Prentice Hall Robbins, Stephen P., Coulter, Mary, (2007): Management, 9th Ed., Upper Saddle River,Prentice Hall.
22.09.2011	MW	11 + 12	5.2.1	Update literature: Neumann, Schwindt, & Zimmermann: Project Scheduling with Time Windows and Scarce Resources, Springer , 2003 Gido, J., Clements. J. P.: Successful Project Management. Thomson, South-Western, 2003. Project Management Institute Inc. (Ed): A Guide to the Project Management Body of Knowledge: PMBOK® guide. 3rd Ed., 2004. Lowe, D.; Leiringer, R. (Eds): Commercial Management of Projects: Defining the Discipline. Blackwell Publishing, 2006. Pinedo, M.: Scheduling: Theory, Algorithms, and Systems. Prentice Hall, 2002. Neumann, K.; Morlock, M.: Operations Research, Hanser, München, 2004.
22.09.2011	MW	13	5.2.2	Update literature: M. Dumas, W. van der Aalst, A. Hofstede (Eds.): Process-Aware Information Systems,John Wiley & Sons, 2005 R. Elmasri, S. B. Navathe, Fundamentals of Database Systems, Fourth Edition, Addison-Wesley, 2003. Sinan Si Alhir, O'Reilly, Learning UML, 1st Ed., 2003 Update literature: F. Baader, D. Calvanese, D.L, Description Logic Handbook, edited by McGuinness, D. Nardi, P.F. Patel-Schneider, Cambridge University Press, 2002 Dieter Fensel, James, A. Hendler, Henry Lieberman , W. Wahlster , Spinning the Semantic Web, MIT Press, 2003
22.09.2011	MW	14 + 15	5.2.3	Update literature: Wolfgang Cronenbroeck: Handbuch Internationales Projektmanagement. Berlin 2004 Heinz-Josef Herten: Internationales Projektmanagement, Gestaltung der grenzüberschreitenden Projektkooperation im Großanlagenbau sowie in der Luft- und Raumfahrtindustrie, Köln 1988 Eberhard Dülfer: Projektmanagement INTERNATIONAL, Stuttgart 1982 Meier: Internationales Projektmanagement, Herne/Berlin 2004 Bennet P. Lientz, Kathryn P. Rea: International Project Management, 2002 David L. Cleland, Roland Gareis: Global Project Management Handbook:

				Planning, Organizing and Controlling International Projects, 1997 Lomnitz, G.: Multiprojektmanagement - Projekte erfolgreich planen, vernetzen und steuern. Frankfurt: Redline Wirtschaft, 2004 Hiller, M.: Multiprojektmanagement - Konzept zur Gestaltung, Regelung und Visualisierung einer Projektlandschaft. FBK- Produktionstechnische Berichte (Hrsg.: Prof. Dr.-Ing. G. Warnecke), Band 43. Kaiserslautern: FBK Universität, Dissertation, 2002. Rickert, D.: Multi-Projektmanagement in der industriellen Forschung und Entwicklung. Wiesbaden: Deutscher Universitätsverlag, 1995
22.09.2011	MW	25	5.5.1	Update literature: WIPO Intellectual Porperty Handbook – Policy, Law and Use, 2nd edition, Geneva, 2004 Wipo Publication No. 489(E)
22.09.2011	MW	29	6.1.1	Update literature: Kingery, Introduction to Ceramics, 1975, John Wiley Moulson, Electroceramics, 1990, University Press Camebridge Ivers-Tiffée, Münch, Werkstoffe der Elektrotechnik, 2004 Teubner Tipler, Physik, 1994, Spektrum Münch, Elektrische und Magnetische Eigenschaften der Materie, 1987 Teubner
22.09.2011	MW	30	6.1.2	Update literature: J. M. Rabaey, A. Chandraskasan, B. Nikolic: A Design Perspective 2nd Edition, Prentice Hall, 2003
22.09.2011	MW	32	6.2.1	Update literature: Hans-Jörg Bullinger: Concurrent Simultaneous, Engineering Systems , 1998, Springer Verlag Ehrlenspiel, K.: Integrierte Produktentwicklung, Carl Hanser Verlag Ehrlenspiel, Klaus: Kostengünstig Entwickeln und Konstruieren, Springer (1998) Jeiter, Wolfram: Das neue Gerätesicherheitsgesetz, Beck (1993) Kirchner, Johannes; Baum, Eckhart: Ergonomie für Konstrukteure und Arbeitsgestalter, Hanser (1990) Mooren, Aart L. van der: Instandhaltungsgerechtes Konstruieren und Projektieren, Springer (1991) Nipperdey, Hans C: Arbeitssicherheit, Beck (1993) Pahl, Gerhard; Beitz, Wolfgang: Konstruktionslehre – Methoden und Anwendung, Springer (1997) VDI 2222 Blatt 1 und 2 VDI 2225 Blatt 1 bis 4 Voegele, Arno: Das grosse Handbuch Konstruktions- und Entwicklungsmanagement, MI moderne industrie AG & Co. KG (1999)
22.09.2011	MW	37	6.3.2	Update literature: Jürgen Teich, Christian Haubelt:

				Digitale Hardware/Software-Systeme - Synthese und Optimierung, 2. Auflage, Springer-Verlag, 2007 Uwe Brinkschulte, Theo Ungerer: Mikrocontroller und Mikroprozessoren Springer-Verlag, 2002 Stephen D. Brown, Robert J. Francis, Jonathan Rose, Zvonko G. Vranesic: Field-Programmable Gate Array, Springer-Verlag, 1992 John Hennessy, David Patterson: Computer Architecture. A Quantitative Approach., 3. Ausgabe, Morgan Kaufmann Publishers
22.09.2011	MW	40	6.4.1	Update literature: G.P. Agrawal; “Fiber-Optic Communication Systems”; Wiley Series 1997 S.V. Kartalopoulos; “DWDM”; Wieley Interscience 2001 W.H. Press, S.A.Teukolsky, W.T. Vetterling, B.P.Flannery; "Numerical Receipes in C"; Cambridge Press
22.09.2011	MW	43	6.5.1.	Update literature: Chonavel, T.: Statistical Signal Processing, Springer, London etc. 2002 Deziel, J.P.: Applied Digital Signal Processing, Prentice Hall, Upper Saddle River, NJ, 2001 Diniz, P.S.R. et al.: Digital Signal Processing, Cambridge University Press, Cambridge 2002 Kammeyer, K.-D.; Kroschel, K.: Digitale Signalverarbeitung, 7th ed., Vieweg+Teubner, Wiesbaden 2009 Kay, S.M.: Modern Spectral Estimation, Prentice Hall, Englewood Cliffs, 1988 Kroschel, K.; Rigoll, G.; Schuller, B.: Statistische Informationstechnik, 5th ed.,Springer Heidelberg, Dordrecht, London, New York 2011
22.09.2011	MW	44	6.5.2	Update literature: Tittes E.: Über die Auswertung von Versuchsergebnissen mit Hilfe der Weibullverteilung. Qualität und Zuverlässigkeit 18 (1973), Heft 5, S. 108-113, Heft 7, S. 163-165 Rudolf M.: Zeitraffende Lebensdauerprüfungen für weibullverteilte Lebensdauer. Wii. Z. Techn. Hochsch. Magdeburg 29 (1985), Heft 5, S. 42-44 Klein H.: Über die Streugrenzen statistischer Verteilungskurven. Mitteilungsblatt für mathematische Statistik –Würzburg (1954) 6, S. 140-169 Bonin v. L., Ganz W.: Wahrscheinlichkeitsverteilungen für die Festigkeitsanalyse. DFVLR-Mitt. 86-17 Dubey S. D.: One Some Permissible Estimators of the Location Parameter of the Weibull and Certain Other Distributions. Technometrics Vol. 9, No. 2, May 1967, p. 293-307 Lawless J. F.: Statistical Methods in Reliaility. Technometrics Vol. 25, No. 4, Nov. 1983, p. 305-335 Dumonceaux R., Antle C., Haas G.: Likelihood Ratio Test for Discrimination

				Between Two Models with Unknown Location and Scale Parameters. Technometrics Vol.15, No. 1, Feb. 1973, p. 19-27 Engelhardt M., Bain L. J.: Tests of Two-Paramter Exponentiality Against Three-Parameter Weibull Alternatives. Technometrics Vol. 17. No. 3, August 1975, p. 353-356 Lawless J. F.: Confidence Interval Estimations for Weibull and Extreme Value Distribution. Technometrics Vol.20, No.4, Nov 1978, p. 355-364 Kaltenborn A.: Mathematische Auswertung von Lebensdauerversuchen mit Computern. Maschinenbautechnik 19 (1970), Heft 8, S. 435-439
22.09.2011	MW	45 + 46	6.5.3	Update literature: P. H. Bardell, W. H. McAnney, J. Savir: Built-in Test for VLSI (Pseudorandom Techniques). John Wiley & Sons 1987 G. W. Roberts: Analog Signal Generation for Built-in Self Test of Mixed-Signal integrated circuits. Kluwer, Academic Publishers 1995 A. K. Sharma: Semiconductor Memories, Technology, Testing, Reliability, IEEE Press 1997 F. Jensen: Electronic Component Reliability. John Wiley & Sons 1995 G. M. Weinberg: Quality Software Management / First-order Measurement. Dorset House Publishing 1993
21.02.2012	SF	26	4.3.3.	New lecturer for “Marketing”: Prof. Dr. Martin Klarmann
01.05.2012	SF	13	4.1.1.	New lecture “Introduction to Accounting and Controlling” added. Lecturer: Prof. Dr. Ir. Marc Wouters
16.10.2012	SF	17	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
03.07.2014	SF	11-35	4.0.ff	Review of entire Management Modules
25.04.2016	SF	6f	2	Two new Program Directors added
		11	3.4.1.	Update of Chart: New program director for Management Modules and adjustment of several lecturers.
		11	3.4.2.	Update of Chart: New Program Director for Engineering Modules and adjustment of several lecturers.
		13ff	4.1. and 4.2.	Change of sequence of Management Module 1 and 2. New MM1 is now “Project Management”; new MM2 is now “Finance for Executives”.
		25	4.3.2.	New lecturer for Management Accounting: Adjustment of content
		27	4.4.	New Module Supervisor for Management Module 4
		28	4.4.1.	New lecturer for “Human Resource Management”: Prof. Dr. Petra Nieken
		38	4.5.3.	New lecturer for International Intellectual Property Law
		37ff	5.1.	Renaming of Engineering Module 1 Adjustment of introductory text. New Module Supervisor: Prof. Sax.

				Adjustment of Learning Results. Adjustment of Performance appraisal. Adjustment and redevelopment of lectures
		43ff	5.2.	Renaming of Engineering Module 2 Adjustment of introductory text. New Module Supervisor: Prof. Hohmann. Adjustment of Learning Results Adjustment of Performance appraisal. Adjustment and redevelopment of lectures
		48ff	5.3.	Renaming of Engineering Module 3 Adjustment of introductory text. New Module Supervisor: Prof. Siegel. Adjustment of Learning Results. Adjustment of Performance appraisal. Shift of lectures from EM4 to EM3. Creation of one new lecture: “Mobile Perception Systems”.
		52ff	5.4.	Renaming of Engineering Module 4 Adjustment of introductory text. New Module Supervisor: Prof. Becker. Adjustment of Learning Results. Adjustment of Performance appraisal. Shift of lectures from EM3 to EM4. Creation of two new lecture: “Micro Systems” and Software Development.
		58ff	5.5.	Renaming of Engineering Module 5 Adjustment of introductory text. New Module Supervisor: Prof. Sax. Adjustment of Learning Results. Adjustment of Performance appraisal. Shift of two lectures from EM2 to EM5: “Systems Engineering” and “Case Study in Testing Embedded Systems”
		72ff	8.3., 8.4., 8.5.	Adjustment of links