



# **Module Information**

**for the Master's Program**

**Technology & Innovation Management  
(M.Sc.) - International**



**Version 2.0 of 08 August 2014**

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# Module Information

This module handbook contains descriptions of the modules used in the Master's course Technology & Innovation Management (M.Sc.). The course by the Department of Industrial Engineering and Technology Management will be available from 2014 onwards. The General Regulations for Examinations at the Wilhelm Büchner University apply to this course with its modular structure. This module handbook is updated regularly. The following table illustrates the structure of the course as well as the available modules with their respective ECTS credit points (CP) points.

Field/Modules	CP	Type of examination <sup>1</sup>	In semester
<b>Technology Fields</b>	<b>24</b>		
Mathematics for Technology Managers	6	B	1
Technology 1: Foundation	6	B	1
Technology 2: Application	6	B	2
Technology 3: Compulsory Elective Module	6	B	3
<b>General Management</b>	<b>18</b>		
International Management & Intercultural Communication	6	B	1
Organizational Development	6	K	2
Collaboration Engineering	6	K	3
<b>Technology and Innovation Management</b>	<b>36</b>		
Quality Management	6	K	1
Innovation Management	6	K	1
Lean Six Sigma	6	B	2
Innovation Strategies	6	K	2
Technology Management	6	K	3
R&D Management	6	K	3
<b>Research Focus and Thesis</b>	<b>42</b>		
Business Research Methods	6	B	2
Research Project Technology & Innovation Management	10	B	3,4
Master's Thesis & Virtual Oral Examination	26	B/M	4

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<sup>1</sup> Key: B – written examination, e.g. assignment, case study, completed at home, K –written examination, M – oral examination, S – credits awarded for attendance, P – project work

## 1. Introduction

The estimated time that a student has to spend at a regular university to complete a course and the examinations is measured in credit points. In Germany it is assumed that students at a regular university spend up to 30 hours to achieve one credit point. These students usually start their course straight after leaving school without or with little prior professional experience.

As a rule, students at the Wilhelm Büchner University have several years of professional experience in addition to their first professional education. They also usually remain active in their profession whilst studying and this strengthens the links between professional work and studying (professional integrated learning). We estimate that our students require considerably less time to gain one credit point during their part-time studies. Experience shows that the required time can be reduced by up to 50%. As a rule, one can estimate that students with relevant professional experience require 25% to 30% less time for their integrated studies.

### 1.1 Competencies in Open Learning Studies

The German Qualifications Framework for Lifelong Learning (known by its German abbreviation DQR) forms the basis for the competency model used by the Wilhelm Büchner University. It is a tool for the allocation of qualifications in the German education system. The objectives of the DQR are increased transparency, mobility, comprehensibility and improved comparability of the German qualifications system – both national and within the European Union in relation to the European Qualifications Framework (EQR).

The basis for the allocation is the idea that qualification processes should be based on learning outcomes (“outcome orientation”). Transparent allocations of learning outcomes allow comparison between differing national educational objectives in the European Union. Because the focus is on learning outcomes, competencies can also be acquired through non-formal and informal learning.

The German Qualifications Framework for Higher Education Qualifications (known as HQR) divides professional competency for level 7 qualifications (Master’s study courses) into two sub-categories:

- Knowledge and Understanding
- Skills

The category Knowledge and Understanding relates to broadening knowledge and deepening knowledge, while the category Skills relates to instrumental, systemic and communicative competencies.

The general competency model is shown in the table.

Knowledge and Understanding	Skills
<p><b>Broadening Knowledge:</b> Master's graduates have a proven level of knowledge and understanding that normally builds on the Bachelor's level and significantly deepens or broadens this. They are able to define and interpret the special features, limits, terminologies and schools of thought in their field of learning. ('Generalist')</p> <p><b>Deepening Knowledge:</b> Their knowledge and understanding form the basis for the development and/or application of independent ideas. This may be more practice-oriented or more research-oriented. They have a broad, detailed and critical understanding of the latest state of knowledge in one or more special areas. ('Specialist')</p>	<p>Master's graduates have acquired the following competencies:</p> <p><b>Instrumental Competencies:</b></p> <ul style="list-style-type: none"> <li>• They can also apply their knowledge and understanding as well as their problem-solving skills to new and unfamiliar situations that lie in a broad or multidisciplinary context relating to their academic subject.</li> </ul> <p><b>Systemic Competencies:</b></p> <ul style="list-style-type: none"> <li>• They can integrate knowledge and handle complexity;</li> <li>• They can make scientifically-founded decisions and draw conclusions, also on the basis of incomplete or limited information, and in so doing can consider social, scientific and ethical insights that also derive from the application of their knowledge and their decisions;</li> <li>• They can independently acquire new knowledge and ability;</li> <li>• They can carry out independent scientific or applied research projects in a largely self-directed and/or autonomous manner.</li> </ul> <p><b>Communicative Competencies:</b></p> <ul style="list-style-type: none"> <li>• They can communicate their conclusions, the under-lying information and their reasons to specialists and non-specialists both clearly and unambiguously on the basis of the state of research and application;</li> <li>• They can discuss information, ideas, problems and solutions at a scientific level with specialists and non-specialists;</li> <li>• They can take on lead responsibility in a team.</li> </ul>

Source: Qualifications Framework for German Higher Education Qualifications, adopted on 21 April 2005 by the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder of the Federal Republic of Germany in consultation with the Federal Ministry of Education and Research and the German Rectors' Conference.

The category Knowledge and Understanding relates to broadening knowledge and deepening knowledge, while the category Skills relates to instrumental, systemic and communicative competencies.

This model with its knowledge and competency categories with their three-level qualitative evaluations is the basis for the allocation of modules to competency profiles. The following

example shows the module *Mathematics for Technology Managers* that focuses primarily on broadening and deepening knowledge acquired on the Bachelor's level. Practice-oriented problem-solving skills (instrumental competency) are of some relevance, whereas the ability to discuss information, ideas, problems and solutions at a scientific level with specialists and non-specialists is of little relevance.

Relevance Competence	+	++	+++
Broadening Knowledge			X
Deepening Knowledge			X
Instrumental Competencies		X	
Systemic Competencies		X	
Communicative Competencies	X		

The individual motivation of learners depends on their performance orientation, interests and intrinsic motivation and reveals itself above all in their **self-regulation** of the learning process. Interdisciplinary competencies, for example the self-regulated learning skills in particular of open learning students, can play a valuable support role in the acquisition of technical and scientific contents. Open learning students arrange their learning environment in collaboration with the university's support services.

**Lifelong learning** requires a persistent ability to learn as well as enthusiasm for learning. Students in open learning depend on good self-assessment; they must be able to analyze and understand information and need staying power in order to complete such a course and often hold a job at the same time. These abilities are an elementary requirement for dealing with the challenges of today's information and knowledge society.

The **employability** of Master's graduates is often associated with the combination of specialist knowledge, project management, team spirit and communication skills. This has great significance in particular for open learning and online students, because in most cases they combine their continuing education with professional development. Optimal learning outcomes can be achieved through integration of learning scenarios in the professional context. The opportunity to use the subjects of home and project work and theses in their professional environment also boosts the employability of open learning students in a particular way. The acquired qualifications and competencies can be displayed and applied in the job directly. This makes supporting of open learning education very interesting for enterprises.

## 2. Technology Fields

<b>Module title</b>	<b>Mathematics for Technology Managers</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Prof. Dr. habil. Guido Walz																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (50%) examinations (10%)																										
<b>Assessment type</b>	B-Type Examination																										
<b>Educational objectives</b>	Students are able to solve mathematical and technical problems with differential and integral calculus methods. The students are expected to demonstrate the abilities to apply mathematical modeling techniques and develop solutions to technical problems. Their knowledge of numerical analysis will allow them to develop problem-solving algorithms. Basic understanding of the mathematical contents provided in this module is required for successful study of the technology tracks.																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>			Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies		X		Systemic Competencies		X		Communicative Competencies	X		
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Instrumental Competencies		X																									
Systemic Competencies		X																									
Communicative Competencies	X																										
<b>Content</b>	<ul style="list-style-type: none"> <li>- Infinite series and integral transformations:</li> <li>- Series, power and Fourier series, Fourier transformations, Laplace transformations</li> <li>- Ordinary differential equations:</li> <li>- Existence and uniqueness of solutions, separation of variables, substitution, variation of parameters, homogeneous and nonhomogeneous linear differential equations, application</li> <li>- Differential calculus:</li> <li>- Multivariable calculus, limits and continuity, partial derivative, exact differential, formula for derivatives, finding the minima and maxima of a function subject to equality constraints, application</li> <li>- Numerical analysis I:</li> <li>- Iteration methods, numerical solution of linear equations, numerical integration</li> </ul>																										
<b>Prerequisites</b>	none																										

<b>Bibliography</b>	<ul style="list-style-type: none"><li>• Burden, R.L.; Faires, J.D.( 2010): Numerical Analysis, Cengage Learning, Boston, 9th ed. Datta, B.N.: Numerical Linear Algebra and Applications, SIAM Press, Philadelphia, 2nd ed. 2010</li><li>• Larson, R., Edwards, B. (2013): Calculus, Cengage Learning, Boston, 10th ed.</li><li>• Larson, R., Edwards, B.(2009): Multivariable Calculus, Cengage Learning, Boston, 9th ed.</li><li>• Sauer, Th. (2011): Numerical Analysis, Pearson, Harlow, 2nd ed.</li><li>• Stewart, J. (2012): Calculus, Cengage Learning, Boston, 7th ed.</li></ul>
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## 2.1 Energy Engineering

<b>Module title</b>	<b>The Fundamentals of Energy Engineering</b>																														
<b>Duration</b>	1 semester																														
<b>Language</b>	English																														
<b>Responsible</b>	Prof. Dr. Michael Haag																														
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (60%) self-study and practical work (30%) preparation and examination (10%)																														
<b>Assessment type</b>	B-Type Examination																														
<b>Educational objectives</b>	<p>Students know the principle of electric energy production from various primary energy sources. They know the properties of these energy sources and understand their advantages and disadvantages. They can explain the connections between the essential components of energy supply networks and understand the resulting structures whilst also considering the expected load. This refers in particular to the mathematical basic equations that connect the physical properties of the components and machines. Students know the basic principles of production, transmission and distribution of electric energy. They can carry out calculations of basic properties in systems of electric energy production, transmission and distribution. In addition, they have an understanding of electric energy transmission and calculation methods for cables and networks.</p>																														
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Competence</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>			Relevance	+	++	+++	Competence				Broadening Knowledge			X	Deepening Knowledge		X		Instrumental Competencies		X		Systemic Competencies		X		Communicative Competencies	X		
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Competence																															
Broadening Knowledge			X																												
Deepening Knowledge		X																													
Instrumental Competencies		X																													
Systemic Competencies		X																													
Communicative Competencies	X																														
<b>Content</b>	<ul style="list-style-type: none"> <li>- Generation, transmission and distribution of electric energy</li> <li>- Definition of energy and efficiency</li> <li>- Types of power plants and primary energy sources</li> <li>- Operating modes of power plants</li> <li>- Fundamentals of electric energy transmission and distribution</li> <li>- Mathematical concepts</li> <li>- Electrical and electromechanical machines and electricity generation</li> <li>- Components of electrical supply networks</li> <li>- Purpose and importance of electrical power supply</li> <li>- Energy supply</li> <li>- Energy conversion in power plants</li> <li>- Architecture of electrical supply networks</li> </ul>																														

<b>Prerequisites</b>	Module Mathematics for Technology Managers
<b>Bibliography</b>	<ul style="list-style-type: none"><li>• Fricke, J., Borst, W. (2013): Essentials of Energy Technology, Wiley – VCH Verlag GmbH &amp; Co KGaA</li><li>• Muyeen, S.M. (2012): Wind Energy Conversion Systems, Springer</li><li>• Wagner, M., Mathur, J. (2013): Introduction to Wind Energy Systems, Springer</li><li>• Orecctini, F., (2013): Energy Systems in the Era of Energy Vectors: A Key to Define, Analyze and Design Energy Systems beyond Fossil Fuels, Springer</li><li>• Bausiere, R. (2013): Power Eletronic Converters, Springer</li><li>• Canizares, C., Gomez-Exposito, A., Conejo, A. (2008): Electric Energy Systems: Analysis and Operation, CRC Press</li><li>• Gates, E.D. (2013): Introduction to Basic Electricity and Electronics Technology, Delmar Cengage Learning, Clifton Park New York,</li><li>• Cassedy, E.S., Grossmann. P.Z. (1999): Introduction to Energy - Resources, Technology and Society, Cambridge University Press, Cambridge</li></ul>

<b>Module title</b>	<b>Components of Energy Engineering</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Prof. Dr. Michael Haag																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (60%) self-study and practical work (30%) preparation and examination (10%)																										
<b>Assessment type</b>	B-Type Examination																										
<b>Education objectives</b>	Students understand the processes in energy conversion based on their knowledge of the basics of energy technology. They have an overview of the whole range of conventional and renewable sources of energy. This includes the basics of process engineering, knowledge of the components of various power plant types, and distribution and storage of energy. They can apply the engineering basics for testing and sizing of essential components. They know the design and equivalent circuit diagrams of electrical network components. They can carry out load flow and short-circuit current calculations.																										
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Instrumental Competencies		X																									
Systemic Competencies		X																									
Communicative Competencies	X																										
<b>Contents</b>	<p>Engineering assessment of modes of operation and sizing of central components and building of systems:</p> <ul style="list-style-type: none"> <li>- Thermal power plant</li> <li>- Nuclear power plant</li> <li>- Gas turbine power plant</li> <li>- Cogeneration plant</li> <li>- Engines for energy generation</li> <li>- Fuel cell</li> <li>- Block-type thermal power plant and combined heat and power scheme</li> <li>- Hydropower</li> <li>- Solar and wind power</li> <li>- Bioenergy and geothermal energy</li> <li>- Energy distribution and storage</li> <li>- Equipment and operating methods</li> <li>- Calculation of power transmission plants and line networks</li> </ul>																										

	- Load flows, short-circuit current and excess voltage in electrical supply networks
<b>Prerequisites</b>	Module Introduction to Energy Technology
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Zhu, J., Islam, Md.R., Guo, Y. (2014): Power Converters for Medium Voltage Networks, Springer</li> <li>• Rekioua, D. (2014): Optimization of Photovoltaic Power Systems, Springer</li> <li>• Wagner, H., Mathur, J. (2011): Introduction to Hydro Energy Systems, Springer</li> <li>• Priya, S., Inman, D. (2009): Energy Harvesting Technologies, Springer</li> <li>• Lu, K. (2014): Materials in Energy Conversion, Harvesting and Storage, John Wiley &amp; Sons</li> <li>• Petrecca, G. (2014): Energy Conversion and Management, Springer</li> <li>• Struchtrup, H. (2014): Thermodynamics and Energy Conversion, Springer</li> <li>• Gates. E.D. (2013): Introduction to Basic Electricity and Electronics Technology, Delmar Cengage Learning, Clifton Park New York</li> <li>• Cassedy, E.S., P.Z. Grossmann, P.Z. (1999): Introduction to Energy - Resources, Technology and Society, Cambridge University Press, Cambridge,</li> </ul>

<b>Module title</b>	<b>Energy Storage</b>																								
<b>Duration</b>	1 semester																								
<b>Language</b>	English																								
<b>Responsible</b>	Prof. Dr. Michael Haag																								
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (60%) self-study and practical work (35%) preparation and examination (5%)																								
<b>Assessment type</b>	B-Type Examination																								
<b>Educational objectives</b>	The students know all current technologies for energy storage and can describe their advantages and disadvantages as well as explain the technological principles of energy storage. They know the aspects of efficient and sustained use of renewable energy sources and the benefits of storage for optimum energy use. They can determine the best application for different storage technologies.																								
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>	Relevance Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies		X		Communicative Competencies	X		
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Instrumental Competencies			X																						
Systemic Competencies		X																							
Communicative Competencies	X																								
<b>Content</b>	<ul style="list-style-type: none"> <li>- Air as an energy storage medium</li> <li>- Hydrogen as energy source and its storage</li> <li>- Storage of gaseous hydrocarbons</li> <li>- Storage of liquid and solid energy sources</li> <li>- Thermal energy storage</li> <li>- Flywheel energy storage and pumped-storage hydroelectricity</li> <li>- Springs and flywheel energy storage</li> <li>- Electrochemical energy storage</li> <li>- Energy storage in capacitors</li> <li>- Superconducting magnetic energy storage</li> </ul>																								
<b>Prerequisites</b>	Modules Introduction to Energy Technology, Components of Energy Technology																								
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Huggins, R.A. (2010): Energy Storage, Springer</li> <li>• IMechE Seminar Publications (2005): Renewable Energy Storage: Its Role in Renewables and Future Electricity Markets, Professional Engineering Publishing</li> <li>• Kim, Y., Chang, N. (2014): Design and Management of Energy-Efficient Hybrid Electrical Energy Storage Systems, Springer</li> <li>• Demiri, Y. (2012): Energy, Springer</li> </ul>																								

	<ul style="list-style-type: none"><li>• Lee, K. (2013): <i>Underground Thermal Energy Storage</i>, Springer</li><li>• Broom, D. (2011): <i>Hydrogen Storage Materials</i>, Springer</li><li>• Dincer, I., Rosen, M. (eds.) (2002): <i>Thermal Energy Storage: Systems and Applications</i>, Wiley</li></ul>
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<b>Module title</b>	<b>Renewable Energy Systems</b>																								
<b>Duration</b>	1 semester																								
<b>Language</b>	English																								
<b>Responsible</b>	Prof. Dr. Michael Haag																								
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (60%) self-study and practical work (35%) preparation and examination (5%)																								
<b>Assessment type</b>	B-Type Examination																								
<b>Educational objectives</b>	Students understand the basics of energy generation from renewable energy sources. They know the most important renewable energy sources: solar energy, hydropower, wind power and biomass. They have an overview of possible uses for available renewable energy sources. Students have an understanding of energy storage, fuel cells and problems of grid integration of renewable energy plants and energy storage.																								
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>	Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies		X		Communicative Competencies	X		
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Broadening Knowledge			X																						
Deepening Knowledge			X																						
Instrumental Competencies			X																						
Systemic Competencies		X																							
Communicative Competencies	X																								
<b>Content</b>	<ul style="list-style-type: none"> <li>- Basics of renewable energies, energy balance</li> <li>- Solar radiation</li> <li>- Concentrating and non-concentrating solar collectors</li> <li>- Photovoltaics</li> <li>- Wind power</li> <li>- Hydropower</li> <li>- Geothermal energy</li> <li>- Biofuels</li> <li>- Hydrogen production, fuel cells and methanation</li> <li>- Profitability analysis</li> <li>- Power systems of local energy producers</li> </ul>																								
<b>Prerequisites</b>	Modules Introduction to Energy Technology, Components of Energy Technology																								
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Kaltschmitt, M., Streicher, W., Wiese, A. (2007): Renewable Energy, Springer</li> <li>• Dincer, I., Midilli, A., Kucuk, H. (2014): Progress in Sustainable Energy Technologies Vol. 1, Springer</li> <li>• Hossain, J., Mahmud, A. (2014): Renewable Energy Integration, Springer</li> </ul>																								

	<ul style="list-style-type: none"><li>• Kaltschmitt, M., Themelis, N., Bronicki, L., Söder, L. (2013): Renewable Energy Systems, Springer</li><li>• Zango, L. (2011): Energy Efficiency and Renewable Energy through Nanotechnology, Springer</li><li>• Andersen, O. (2013): Unintended Consequences of Renewable Energy, Springer</li><li>• da Rosa, A.V. (2013): Fundamentals of Renewable Energy Processes, Academic Press, Elsevier Inc.</li><li>• Maczulak, A. (2010): Renewable energy: sources and methods, Infobase Publishing, New York</li><li>• Lund, H. (2009): Renewable Energy Systems: The Choice and Modeling of 100% Renewable Solutions Academic Press, Elsevier Inc.</li></ul>
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## 2.2 Materials Science

<b>Module title</b>	<b>Introduction to Materials Science</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Prof. Dr. rer. nat. Johannes Windeln																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (50%) examination (10%)																										
<b>Assessment type</b>	B-Type Examination																										
<b>Educational objectives</b>	Students have an overview of the foundations of the subject of Materials Science. They are familiar with the structures and properties of materials and engineering applications of materials. They have an understanding of how to choose materials based on their suitability, machinability and reaction.																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>			Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge		X		Instrumental Competencies		X		Systemic Competencies		X		Communicative Competencies	X		
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Broadening Knowledge			X																								
Deepening Knowledge		X																									
Instrumental Competencies		X																									
Systemic Competencies		X																									
Communicative Competencies	X																										
<b>Content</b>	<ul style="list-style-type: none"> <li>- Definition of construction materials and functional materials</li> <li>- Metallic materials: primary and secondary crystallization, alloys, phase diagrams, iron-carbon system phase diagram, thermally activated processes</li> <li>- Heat treatments, basics, Time Temperature Transformation (TTT), time-temperature-austenitization diagram (TTA), annealing, hardening, changes of boundary layers, environmental aspects</li> <li>- Production, classification and specific characteristics of steels and cast iron materials,</li> <li>- Classification and specific characteristics of non-ferrous metals and their alloys</li> <li>- Non-metallic materials: Inorganic non-metallic materials (glass, fiber glass, ceramics, oxides, oxide and non-oxide compounds), polymers (thermoplastic, Duroplast, elastomer, influencing of characteristics)</li> <li>- Polymer materials: polymer reactions, polymer characteristics, structural influence, processing of plastics, softening, characteristics of plastic classes, recycling properties</li> <li>- Composites and special materials</li> <li>- Surface engineering and adhesion technology: surface engineering techniques: objectives, advantages and</li> </ul>																										

	<p>disadvantages of methods, environmental engineering</p> <ul style="list-style-type: none"> <li>- Adhesive technology: adhesion/cohesion, adhesive technology, properties, testing</li> </ul>
<b>Prerequisites</b>	Module Mathematics for Technology Managers
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Shakelford, J. (2014): Introduction to Materials Science for Engineers, Pearson Education Limited</li> <li>• Mercier, J., Zambelli, G., Kurz, W. (2003): Introduction to Materials Science, Elsevier Science</li> <li>• Douglas, E.(2013): Introduction to Materials Science, Pearson Education Limited</li> <li>• Callister, W. (2002): Materials Science and Engineering: An Introduction, John Wiley &amp; Sons</li> <li>• Askelang, D., Phule, P. (2006): The Science and Engineering of Materials, Thomson Learning</li> <li>• Courtney, T.H. (2005): Mechanical Behavior of Materials. Waveland Press, Inc., Long Grove, Illinois,</li> <li>• O'Connor, D.J.; Sexton, B. A.; Smart, R. St. C. (2003): Surface Analysis Methods in Materials Science. Springer Verlag,</li> <li>• Ashby, M.F., Jones, D.R.H. (2010): Engineering Materials 1, third edition, Elsevier</li> <li>• Ashby M.F. (2005): Materials Selection in Mechanical Design, third edition. Elsevier</li> <li>• Ashby M.F. D.R.H. (2010): Engineering Materials 2, third edition, Elsevier</li> </ul>

<b>Module title</b>	<b>Materials in Production Technology</b>																								
<b>Duration</b>	1 semester																								
<b>Language</b>	English																								
<b>Responsible</b>	Prof. Dr. rer. nat. Johannes Windeln																								
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (50%) examination (10%)																								
<b>Assessment type</b>	B-Type Examination																								
<b>Educational objectives</b>	Students developed broad specialist knowledge in the area of composite materials, including their interactions, of the tailor-made construction of the materials and their functionality. They know important analytic procedures for materials, especially in the area of surface analysis in mechatronics, which enables them to look for solutions to material problems in practice.																								
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>	Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies		X		Systemic Competencies		X		Communicative Competencies	X		
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Broadening Knowledge			X																						
Deepening Knowledge			X																						
Instrumental Competencies		X																							
Systemic Competencies		X																							
Communicative Competencies	X																								
<b>Content</b>	<ul style="list-style-type: none"> <li>- Significance, characteristics and production methods of important materials in the area of mechatronics</li> <li>- Composite materials (glass and carbon fiber composites) including specific uses as mechanical or electronic build or construction elements</li> <li>- Component design with bonding</li> <li>- Physical and materials design of joints in mechatronics</li> <li>- Specialist analysis in materials science</li> </ul>																								
<b>Prerequisites</b>	Modules Mathematics for Technology Manager, Introduction to Materials Science																								
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Mercier, J., Zambelli, G., Kurz, W. (2003): Introduction to Materials Science, Elsevier Science</li> <li>• Douglas, E.(2013): Introduction to Materials Science, Pearson Education Limited</li> <li>• Callister, W. (2002): Materials Science and Engineering: An Introduction, John Wiley &amp; Sons</li> <li>• Askelang, D., Phule, P. (2006): The Science and Engineering of Materials, Thomson Learning</li> <li>• Courtney, T.H. (2005): Mechanical Behavior of Materials. Waveland Press, Inc., Long Grove, Illinois</li> <li>• O'Connor, D.J.; Sexton, B. A.; Smart, R. St. C. (2003): Surface Analysis Methods in Materials Science. Springer</li> <li>• Coombs, C.F. (2008): Printed Circuit Handbook, McGraw-Hill</li> </ul>																								

	<p>Handbooks</p> <ul style="list-style-type: none"><li>• Ashby, M.F., Jones, D.R.H. (2010): Engineering Materials 1, third edition, Elsevier</li><li>• Ashby M.F. (2005): Materials Selection in Mechanical Design, third edition. Elsevier</li></ul>
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<b>Module title</b>	<b>Non-Destructive Materials Testing</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Prof. Dr.-Ing. Peter Wack																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (50%) examination (10%)																										
<b>Assessment type</b>	B-Type Examination																										
<b>Educational objectives</b>	Students have acquired in-depth knowledge of the relevant studied destructive and nondestructive materials testing processes. They can apply their knowledge to choose the appropriate testing processes to solve practice related problems. Thus they are capable of aligning the testing processes to the respective individual case and to apply them in a target-oriented manner.																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>			Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies		X		Communicative Competencies	X		
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Instrumental Competencies			X																								
Systemic Competencies		X																									
Communicative Competencies	X																										
<b>Content</b>	<ul style="list-style-type: none"> <li>- Destructive and nondestructive materials testing processes</li> <li>- Hardness testing</li> <li>- Ultrasonic testing</li> <li>- Eddy current testing and magnetic particle Inspection</li> </ul>																										
<b>Prerequisites</b>	Modules Mathematics for Technology Manager, Introduction to Materials Science, Materials in Production Technology																										
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Chen, C. (2007): Ultrasonic and Advanced Methods for Non-Destructive Testing and Material Characterization, World Scientific Pub Co</li> <li>• Paipetis, A., Matikas, T., Aggelis, D. (2012): Emerging Technologies in Non-Destructive Testing V, CRC Press</li> <li>• Prakash, R. (2010): Non-Destructive Testing Techniques, New Age International Pvt Ltd Publisher</li> <li>• Zoughi, R: (2010): Microwave Non-Destructive Testing and Evaluation Principles, Springer</li> <li>• Raj, B. (2007): Practical Non-Destructive Testing, Marston Bok Dmarsto Orphans</li> </ul>																										

<b>Module title</b>	<b>Lightweight Fibre Reinforced Plastics</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Prof. Dr. rer. nat. Johannes Windeln																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (50%) examination (10%)																										
<b>Assessment type</b>	B-Type Examination																										
<b>Educational objectives</b>	Students understand the principles of lightweight construction based on materials suitable for lightweight construction. Lightweight construction is highly dependent on materials: Typical classes of fiber-reinforced plastics (FRP) are studied with regard to functions of matrix and fiber materials. Students understand the basics of production methods of the components and the most important processing methods. Knowledge of the construction principles for the use of FRP and consideration of strength, operational stability, chemical and fire resistance are required for the right application of lightweight construction. Typical failure behavior of composite structures are recognized and considered for lightweight construction. Environmental aspects and profitability analysis are also considered in the approach to lightweight construction.																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>			Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies		X		Communicative Competencies	X		
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Systemic Competencies		X																									
Communicative Competencies	X																										
<b>Content</b>	<ul style="list-style-type: none"> <li>- Lightweight constructions concepts</li> <li>- Fiber-reinforced plastic (FRP): classification, production</li> <li>- Design considerations in the use of FRP</li> <li>- Strength/operational stability</li> <li>- Chemical and fire resistance</li> <li>- Profitability analysis</li> </ul>																										
<b>Prerequisites</b>	Modules Mathematics for Technology Manager, Introduction to Materials Science, Materials in Production Technology																										
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Öchsner, A., da Silva, L., Altenbach, H. (2012): Mechanics and Properties of Composed Materials and Structures, Springer</li> <li>• Mercier, J., Zambelli, G., Kurz, W. (2003): Introduction to Materials Science, Elsevier Science</li> <li>• Douglas, E.(2013): Introduction to Materials Science, Pearson</li> </ul>																										

	<p>Education Limited</p> <ul style="list-style-type: none"><li>• Callister, W. (2002): Materials Science and Engineering: An Introduction, John Wiley &amp; Sons</li><li>• Askelang, D., Phule, P. (2006): The Science and Engineering of Materials, Thomson Learning</li></ul>
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## 2.3 Software Technology

<b>Module title</b>	<b>Distributed Information Systems</b>																								
<b>Duration</b>	1 semester																								
<b>Language</b>	English																								
<b>Responsible</b>	Dr. Shakib Manouchehri																								
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (50%) preparation and examination (10%)																								
<b>Assessment type</b>	B-Type Examination																								
<b>Educational objectives</b>	Students have the skills to use the techniques and protocols of all layers of the ISO/OSI protocol stack to develop distributed software. They understand the operation of network operating systems and know the architecture of the Internet that enables them to manage planning, development and application of distributed information systems.																								
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>	Relevance Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge		X		Instrumental Competencies		X		Systemic Competencies		X		Communicative Competencies	X		
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Instrumental Competencies		X																							
Systemic Competencies		X																							
Communicative Competencies	X																								
<b>Content</b>	<ul style="list-style-type: none"> <li>- Application programming interface of network operating systems</li> <li>- Client-server programming based on the transport layer</li> <li>- Utilization of remote procedures and methods</li> <li>- Anatomy of network file systems</li> </ul> Safety & Security in distributed systems																								
<b>Prerequisites</b>	Module Mathematics for Technology Managers																								
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Coulouris, G., Dollimore, J., Kindberg, T., Blair, G. (2011): Distributed Systems, Financial Times Present</li> <li>• Tanenbaum, A., van Stehen, M. (2013): Distributed Systems: Principles and Paradigms, Pearson</li> <li>• Özsu, M., Valduriez, P. (2011): Principles of Distributed Database Systems, Springer</li> <li>• Harris, D., Harris, S. (2012): Digital Design and Computer Architecture, Morgan Kaufmann</li> <li>• Godse, A., Godse D. (2014): Computer Architecture, Technical Publications</li> <li>• Burd, S. (2010): Systems Architecture, Course Technology</li> <li>• Tanenbaum, A., Wetherall, D. (2013): Computer Networks, Prentice Hall International</li> </ul>																								



<b>Module title</b>	<b>Software Architecture and Concepts</b>																								
<b>Duration</b>	1 semester																								
<b>Language</b>	English																								
<b>Responsible</b>	Dr. Shakib Manouchehri																								
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (35%) self-study and practical work (35%) computer work (10%) examinations (20%)																								
<b>Assessment type</b>	B-Type Examination																								
<b>Educational objectives</b>	Students know the current trends in the area of architecture and software concepts. They can estimate and explain the innovation potential and benefit. They can describe and define the fundamental architecture dimensions as well as describe typical application scenarios.																								
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>	Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies		X		Systemic Competencies		X		Communicative Competencies	X		
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Instrumental Competencies		X																							
Systemic Competencies		X																							
Communicative Competencies	X																								
<b>Content</b>	<ul style="list-style-type: none"> <li>- Theoretical introduction to software architecture</li> <li>- Basics, Definitions and Terminology</li> <li>- Framework</li> <li>- Components</li> <li>- Web Services</li> <li>- Cloud Computing</li> <li>- Grid Computing</li> </ul>																								
<b>Prerequisites</b>	Module Distributed Information Systems																								
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Taylor, R., Medvidovic, N., Dashofy, E. (2009): Software Architecture: Foundations, Theory and Practice, John Wiley &amp; Sons</li> <li>• Gorton, I. (2011): Essential Software Architecture, Springer</li> <li>• Qin, Z., Xing, J., Zheng, X. (2008): Software Architecture, Springer</li> <li>• Vogel, O., Arnold, I., Chughtai, A., Kehrer, T. (2011): Software Architecture, Springer</li> <li>• Bass, L., Clement, P., Kazman, R. (2003): Software Architecture in Practice. 2. Edition, Boston, Addison-Wesley.</li> <li>• Bass, L., Kazman, R., Clements, P. (2012): Software</li> </ul>																								

	<p>Architecture in Practice (SEI Series in Software Engineering). Third Edition, Addison Wesley.</p> <ul style="list-style-type: none"><li>• Clements, P., Kazman, R., Kein, M. (2001): Evaluating Software Architectures: Methods and Case Studies (SEI Series in Software Engineering), Addison Wesley.</li><li>• Rozanski, N.; Woods, E. (2011): Software Systems Architecture: Working With Stakeholders Using Viewpoints and Perspectives. 2nd revised edition, Addison Wesley.</li><li>• Sommerville, I. (2007): Software Engineering, 8. Edition, Harlow, Addison-Wesley</li><li>• Clements, P., Bachmann, F., Bass, L., Garlan, D., Ivers, J., Little, R., Merson, P., Nord, R., Stafford, J. (2010): Documenting Software Architectures: Views and Beyond, Second Edition. Addison-Wesley.</li><li>• W3C (Edt.) 2004: Web Services Glossary. W3C Working Group Note 11 February 2004. <a href="http://www.w3.org/TR/ws-gloss/#webservice">http://www.w3.org/TR/ws-gloss/#webservice</a>, 2004.</li><li>• Bell, M. (2008): Service-Oriented Modeling: Service Analysis, Design, and Architecture. Wiley.</li></ul>
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<b>Module title</b>	<b>E-Business Management</b>																														
<b>Duration</b>	1 semester																														
<b>Language</b>	English																														
<b>Responsible</b>	Eva Gattnar																														
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (40%) computer work (10%) preparation and examinations (10%)																														
<b>Assessment type</b>	B-Type Examination																														
<b>Educational objectives</b>	The students know and understand typical e business architectures and the approach to development of an e commerce strategy. They know the attributes and characteristics of different forms of e business (B2B, B2C, etc.) and the different areas of use such as e procurement and e government. The students are able to develop implementation strategies for e business and m business. They know and understand the essential standards, directives and success factors in this area.																														
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Competence</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>			Relevance	+	++	+++	Competence				Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies		X		Communicative Competencies	X		
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Communicative Competencies	X																														
<b>Content</b>	<ul style="list-style-type: none"> <li>- Models and Platforms</li> <li>- Basics of information technology and technologies for e-business</li> <li>- Architecture concepts and business processes in e-business</li> <li>- Integrated information systems</li> <li>- Internet value added chain</li> <li>- Online Marketing</li> <li>- Implementation strategies and business models</li> <li>- e-shops, e-payment, mobile business and mobile commerce, e-procurement, e-contracting, e-distribution, e-CRM, e-community, e-society, e-government</li> </ul>																														
<b>Prerequisites</b>	modules Distributed Information Systems, Software Architecture and Concepts																														
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Chaffey, D. (2009): E-Business and E-Commerce Management: Strategy, Implementation and Practice, Prentice Hall</li> </ul>																														

	<ul style="list-style-type: none"><li>• Chaffey, D. (2014): Digital Business and E-Commerce Management, Pearson Education Limited</li><li>• Schneider, G. (2012): E-Business, Cengage Learning Enea</li><li>• Pechuán, I., Palacios-Marqués, D., Peris-Ortiz M., Vendrell, E., Ferri-Ramirez C. (2014): Strategies in E-Business, Springer</li><li>• Martínez-López, F. (2014): Handbook of Strategic e-Business Management, Springer</li><li>• Klapdor, S. (2013): Effectiveness of Online Marketing Campaigns, Springer</li><li>• Bandyopadhyay, K. (2014): Mobile Commerce, Prentice Hall of India Put. Lhd</li><li>• Koivukoski, U., Räsänen, V. (2005): Managing Mobile Services: Technologies and Business Practices</li></ul>
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<b>Module title</b>	<b>IT Security Management</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Dr. Shakib Manouchehri																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (40%) computer work (10%) preparation and examinations (10%)																										
<b>Assessment type</b>	B-Type Examination																										
<b>Educational objectives</b>	IT security clearly goes further than the provision of software and hardware for virus protection. Students know the needs for an enterprise's continual and cost-effective IT security. They can manage the current IT risks, define necessary organizational measures and support their realization in an advisory capacity. They can create an emergency plan and establish an enterprise security policy. They know the essential legal framework and the influence of corporate policy. They have the required technical and methodical skills to be able to work as an IT security manager with managerial responsibility. The focus is on the management aspects of the subject rather than the technology.																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>			Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies		X		Communicative Competencies	X		
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Deepening Knowledge			X																								
Instrumental Competencies			X																								
Systemic Competencies		X																									
Communicative Competencies	X																										
<b>Content</b>	<ul style="list-style-type: none"> <li>- Significance of information security</li> <li>- Risk and Security</li> <li>- Security organizations</li> <li>- Methodical basics of management</li> <li>- Defining security and recognizing and assessing risks</li> <li>- Reporting</li> <li>- Business Continuity Management</li> <li>- Emergency Management</li> <li>- Incident Handling</li> <li>- Computer Forensics</li> </ul>																										
<b>Prerequisites</b>	Modules Distributed Information Systems, Software Architecture and Concepts																										

<b>Bibliography</b>	<ul style="list-style-type: none"><li>• Partida, A. (2012): IT Security Management (Lecture Notes in Electrical Engineering), Springer</li><li>• Ackermann, T. (2013): IT Security Risk Management, Springer</li><li>• Ackermann, T. (2012): IT Security Risk Management: Perceived IT Security Risks in the Context of Cloud Computing, Springer Gabler</li><li>• Slay, J., Koronios A. (2006): IT Security and Risk Management, John Wiley &amp; Sons</li><li>• Kim, K., Chung, K. (2012): IT Convergence and Security, Springer</li><li>• Jorang, A., Carlsson, B. (2012): Secure IT Systems, Springer</li><li>• Bishop, M. (2003). Computer Security. Boston et al.: Art and Science.</li><li>• Gollmann, D. (2006): Computer Security. 2. Aufl., Chichester: John Wiley &amp; Sons.</li><li>• Pfleeger, C. P.; Pfleeger, S. L. (2007): Security in Computing. 4. Aufl., Upper Saddle River, NJ: Prentice Hall.</li><li>• Straub, D. W.; Goodman, S.; Baskerville, R. (2008): Information Security: Policy, Processes, and Practices. Armonk, NY: M.E. Sharpe.</li><li>• Peltier, T.R. (2010): Information Security Risk Analysis. 3. Aufl., Boca Raton: Auerbach Publications.</li><li>• Pfleeger, C.P.; Pfleeger, S.L. (2012): Analyzing Computer Security: A Threat/Vulnerability/Countermeasure Approach. 2. Aufl., Upper Saddle River: Pearson Education.</li><li>• Casey, E. (Hrsg.) (2011): Digital Evidence and Computer Crime - Forensic Science, Computers and the Internet. 3. Aufl., Burlington, MA: Academic Press.</li></ul>
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### 3. General Management

<b>Module title</b>	<b>International Management and Intercultural Communication</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Prof. Dr. Ulrich Luenemann																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40 %) self-study and practical work (40 %) computer work (10 %) exam (10 %)																										
<b>Assessment type</b>	B-Type Examination																										
<b>Educational objectives</b>	Students know the challenges and characteristics of globalization and internationalization as the basis for an international career. They have the intercultural competency to work and negotiate appropriately with people from various cultural backgrounds. They gain an insight into the relevant cultural differences in communication as well as individual and organizational behaviour in the world's leading economies (focusing on Chinese and US-American culture among other things). Students understand the importance of internationalization for globalization. They can explain historic and current developments and interpret the basic concepts, such as direct investment as well as motives for internationalization. They are aware of the opportunities and risks of global acting companies and know the key indicators of internationalization.																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td></td> <td>X</td> <td></td> </tr> </tbody> </table>			Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge		X		Instrumental Competencies		X		Systemic Competencies		X		Communicative Competencies		X	
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Instrumental Competencies		X																									
Systemic Competencies		X																									
Communicative Competencies		X																									
<b>Content</b>	<ul style="list-style-type: none"> <li>- Strategies and Strategic Dimensions</li> <li>- Basic Terminology and Theories of Intercultural Communication</li> <li>- Methods (Training, Coaching, Mediation et al)</li> <li>- Language, meaning, and cultural pragmatics</li> <li>- Cultural Patterns</li> <li>- Globalization: the Collapse of Culture</li> <li>- Negotiating interculturality</li> <li>- The Power Variable</li> </ul>																										
<b>Prerequisites</b>	English language proficiency at level C1 (CEFR)																										

<b>Bibliography</b>	<ul style="list-style-type: none"><li>• Morschett, D., Schramm-Klein, H., Zentes, J. (2010): Strategic International Management, Springer</li><li>• Mead, R., Andrews, T. (2009): International Management, John Wiley &amp; Sons</li><li>• Schmidt, W., Easton, S., Conaway, R. (2007): Communicating Globally: Intercultural Communication and International Business, Sage Pubn. Inc</li><li>• Mattock, J. (2003): Cross-Cultural Communication: The Essential Guide to International Business, Kogan Page</li><li>• Thomas, D., Peterson, M. (2014): Cross-Cultural Management: Essential Concepts, Sage Publications Inc</li><li>• Sycara, K., Gelfand, M., Abbe, A. (2013): Models for Intercultural Collaborations and Negotiation, Springer</li><li>• Moll, M. (2012): The Quintessence of Intercultural Business Communication, Springer</li><li>• Deresky, H. (2013): International Management: Managing Across Borders and Cultures, Text and Cases, 8 ed., Prentice Hall</li><li>• Lane, H.W.; Maznevski, M. (2014): International Management Behavior: Global and Sustainable Leadership, 7 ed., Wiley</li><li>• Maxwell, J. C. (2010): Everyone Communicates, Few Connect: What the Most Effective People Do Differently, Nelson</li><li>• McFarlin, D.; Sweeney, P. (2010): International Management: Strategic Opportunities &amp; Cultural Challenges Paperback, 4 ed., Routledge</li><li>• Mead, R. (2004): International Management: Cross-cultural Dimensions, 3 ed., Blackwell Business</li></ul>
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<b>Module title</b>	<b>Organizational Development</b>																														
<b>Duration</b>	1 semester																														
<b>Language</b>	English																														
<b>Responsible</b>	Dr. Sabine Landwehr-Zloch																														
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40 %) self study and practical work (40 %) computer work (10 %) lectures and exams (10 %)																														
<b>Assessment type</b>	written examination																														
<b>Educational objectives</b>	This Module helps students to become aware of different personalities and styles and puts them in a position to gain insight at complicated human issues at interpersonal or group level. Furthermore it is aimed at developing analytical skills – both on a strategic and organizational level. Within this context, students will be put in a position to choose between gradual and radical approaches to process improvements. The importance of mastering IT from the business perspective is also referred to.																														
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Competence</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td></td> <td>X</td> <td></td> </tr> </tbody> </table>			Relevance	+	++	+++	Competence				Broadening Knowledge			X	Deepening Knowledge		X		Instrumental Competencies		X		Systemic Competencies		X		Communicative Competencies		X	
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Systemic Competencies		X																													
Communicative Competencies		X																													
<b>Content</b>	<ul style="list-style-type: none"> <li>- Managerial Behaviour</li> <li>- Managing Organizations</li> <li>- Process Management</li> <li>- Information Management</li> </ul>																														
<b>Prerequisites</b>	English language proficiency at level C1 (CEFR)																														
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Schein, E. (1987): Process Consultation: Lessons for Managers and Consultants, Volume II. Prentice Hall Organizational Development Series): Its Role in Organizational Development</li> <li>• Schein, E. (2010): Organizational Culture and Leadership. Jossey-Bass Business &amp; Management</li> <li>• Balzac, S. (2010): Organizational Development, McGraw-Hill</li> <li>• Coplien, O.; Harrison, J. (2004): Organizational Patterns of Agile Software Development, Prentice Hall</li> <li>• Cummings, T.; Worley, C.G. (2008): Organization Development and Change, South Western Educ.</li> <li>• Robbins, S.; Judge, T. A. (2012): Organizational Behavior, 15 ed., Pearson</li> </ul>																														

<b>Module title</b>	<b>Collaboration Engineering</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Dr. Shakib Manouchehri																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40 %) self-study and practical work (40 %) computer work (10 %) exam preparation and exam (10 %)																										
<b>Assessment type</b>	written examination																										
<b>Educational objectives</b>	Students are introduced to the concepts of collaboration. They understand the application of IT and the theoretical concepts for moderation, negotiation and the creative process in collaboration. They know patterns of collaboration and they can identify and explain these. Students understand the procedures to plan and measure collaboration quality. They are equipped with the skills to define and model patterns of collaboration. They know how to identify recurring tasks in collaboration and can analyse and model collaborative work practices. They developed the skills to moderate and model collaboration and to support a creative process. They can apply IT tools to support collaboration. Students can independently and actively evaluate practical methods to analyze, design and model collaboration processes.																										
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Systemic Competencies		X																									
Communicative Competencies		X																									
<b>Content</b>	<ul style="list-style-type: none"> <li>- Introduction to Collaboration</li> <li>- Individual and Group Goals for Collaboration</li> <li>- Patterns of Collaboration</li> <li>- Theoretical Foundations of Collaboration</li> <li>- Collaboration Technologies</li> <li>- CSCW and Groupware</li> <li>- Social Web Applications</li> <li>- Web 2.0 and Social Software</li> <li>- Opportunities in a Corporate Environment</li> <li>- Moderation and Negotiating Skills For Collaboration</li> <li>- Moderation and Facilitation</li> <li>- Goals of Moderation, Methods, Techniques and Tools</li> <li>- Harvard Negotiation Concept</li> <li>- Identifying Recurring Tasks</li> <li>- Developing Collaborative Work Practices</li> <li>- Framework for Collaboration Engineering</li> </ul>																										

	<ul style="list-style-type: none"> <li>- Thinklets</li> <li>- Collaboration Process Design</li> </ul>
<b>Prerequisites</b>	English language proficiency at level C1 (CEFR)
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Boughzala, I. (2012): Collaboration Engineering: A contribution to its foundations through the 2.0 era, LAP LAMBERT Academic Publishing</li> <li>• Olsen, C., Namara, S. (2014): Collaborations in Architecture and Engineering, Routledge Chapman &amp; Hall</li> <li>• Deek, F. (2003): Computer-Supported Collaborations, Springer</li> <li>• Kock, N. (2010): E-Collaboration Technologies and Organizational Performance: Current and Future Trends, Idea Group Reference</li> <li>• Breslin, J., Burg, Th.N., Kim, H.-G., Rajtey, T., Schmidt, J.-H. (2010): Recent Trends and Developments in Social Software, Springer</li> <li>• Doorley, S.; Plattner, H.; Witthoft, S. (2012): Make Space: How to Set the Stage for Creative Collaboration, Wiley</li> <li>• Johnson, J. (2010): Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules, Morgan Kaufmann</li> <li>• Mac Namara, S.; Olsen, C. (2014): Collaborations in Architecture and Engineering Paperback, Routledge</li> <li>• Moaveni, S. (2010): Engineering Fundamentals: An Introduction to Engineering, 4 ed., Cengage Learning</li> <li>• Tabaka, J. (2006): Collaboration Explained: Facilitation Skills for Software Project Leaders, Addison-Wesley Professional</li> <li>• Vreede, G.J. de. And Briggs, R.O. (2011): Facilitation of Technology Supported Collaboration. Omaha, NE: Center for Collaboration Science.</li> <li>• Briggs, R.O. &amp; Vreede, G.J. de (2009): ThinkLets: Building Blocks for Concerted Collaboration. Omaha, NE: Center for Collaboration Science.</li> <li>• Kolschoten, G. L. (2007): Theoretical foundations for collaboration engineering. Department of Systems Engineering Faculty of Technology Policy and Management Delft University of Technology.</li> <li>• Fisher, R.; Ury, W. (1981): Getting to Yes – negotiating agreement without giving in. Houghton Mifflin &amp; Co, Boston Massachusetts.</li> <li>• Wilson, P. (1991). Computer Supported Cooperative Work: An Introduction. Kluwer Academic Pub.</li> </ul>

## 4. Technology and Innovation Management

<b>Module title</b>	<b>Quality Management</b>																								
<b>Duration</b>	1 semester																								
<b>Language</b>	English																								
<b>Responsible</b>	Dr. Matthias Scheiblich																								
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (40%) computer work (10%) preparation and examinations (10%)																								
<b>Assessment type</b>	written examination																								
<b>Educational objectives</b>	Research results show increased competitiveness of enterprises that adhere to the principles of modern quality management. Students have an understanding of these principles; they can think in a customer- and process-oriented manner, and recognize and utilize complex interdependence in systems within the objectives of quality management. In addition, students understand the essential duties of a quality manager and have the skills to set up, implement and develop quality management systems. They are aware of the many facets of quality management and can thus address current approaches to quality management, such as Total Quality Management or Six Sigma. They are competent to identify solutions and make decisions in quality management and can help to organize and develop an enterprise in relation to quality management.																								
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Communicative Competencies</td> <td></td> <td>X</td> <td></td> </tr> </tbody> </table>	Relevance Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge		X		Instrumental Competencies			X	Systemic Competencies			X	Communicative Competencies		X	
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Systemic Competencies			X																						
Communicative Competencies		X																							
<b>Content</b>	<ul style="list-style-type: none"> <li>- Defining the concept of quality</li> <li>- Tasks and organization of quality control</li> <li>- Introduction to quality management (QM)</li> <li>- History of QM</li> <li>- Quality policy and product quality requirements</li> <li>- Basics of process management</li> <li>- Process quality requirements</li> <li>- (QM) Systems based on DIN EN ISO 9000 series</li> <li>- Integrated management systems</li> <li>- Audits as management tools</li> </ul>																								

	<ul style="list-style-type: none"><li>- Introduction to product liability</li><li>- Quality and profitability, quality control</li><li>- Basics of modern QM techniques (Kaizen, Total Quality Management, Six Sigma, Total Productive Maintenance, other techniques)</li></ul>
<b>Prerequisites</b>	none
<b>Bibliography</b>	<ul style="list-style-type: none"><li>• Das, B. (2013): Quality Management, Gazelle Book Services</li><li>• Peris-Ortiz, M., Alvarez-Garcia J. (2014): Action-Based Quality Management, Springer</li><li>• Low, S., Ong, J. (2014): Project Quality Management, Springer</li><li>• Rose, K: (2014): Project Quality Management, Roundhouse Publishing Group</li><li>• Zairi, M. (1991): Total Quality Management for Engineers, CRC Press</li></ul>

<b>Module title</b>	<b>Innovation Management</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Dr. Frank Bescherer																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (40%) computer work (10%) preparation and examinations (10%)																										
<b>Assessment type</b>	written examination																										
<b>Educational objectives</b>	Students have an understanding of the important concepts of innovation management and can explain the various innovation types. They can define what constitutes an innovation process and innovation management, and can adjust these to industry sectors. Moreover, they have an insight into success factor research and can identify the success factors for innovative strength. The students know the planning steps in the innovation process and can explain different process models with examples. In addition, they learn various methods to support an innovation strategy that is oriented towards a corporate strategy. Common innovation success factors are understood. They know the early phases of the innovation process up to the market launch and the related methods and techniques for process design. They can define standardized process workflows and typical organization forms. They can describe current approaches to innovation management and justify their use.																										
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Systemic Competencies			X																								
Communicative Competencies		X																									
<b>Content</b>	<ul style="list-style-type: none"> <li>- Introduction and basics</li> <li>- Strategic innovation management</li> <li>- Conception phase</li> <li>- Product development</li> <li>- Market launch</li> <li>- Organization</li> <li>- Current approaches</li> <li>- Government funding for innovation</li> </ul>																										
<b>Prerequisites</b>	none																										

<p><b>Bibliography</b></p>	<ul style="list-style-type: none"> <li>• Trott, P. (2011): Innovation Management and New Product Development, Financial Times Prent.</li> <li>• Ahmed, P. (2010): Innovation Management: Context, Strategies, Systems and Processes, Prentice Hall</li> <li>• Shane, S. (2008): The Handbook of Technology and Innovation Management, John Wiley &amp; Sons</li> <li>• Afuah, A. (2003): Innovation Management, Oxford University Press</li> <li>• Sattler, M. (2011): Excellence in Innovation Management, Springer</li> <li>• Brown S. L., Eisenhardt, K. M. (1995): Product development: Past research, present findings, and future directions. Academy of Management Review. Vol. 20, Iss. 2, pp. 343-378.</li> <li>• Cooper, R. G. (2011): Winning at New Products: Creating Value Through Innovation; Basic Books,</li> <li>• Cooper, R. G. (2009): How companies are reinventing their idea-to-launch methodologies. Research Technology Management, Vol. 52, Iss. 2, March/April 2009, pp. 47-57.</li> <li>• Cooper, R., Slagmulder R. (1997): Target costing and value engineering. Productivity Press, Portland, Oregon.</li> <li>• Ernst, H. (2002): Success factors of new product development: a review of the empirical literature. International Journal of Management Reviews, Vol. 4, Iss. 1, pp. 1–40.</li> <li>• Kim, J., Wilemon, D. (2002): Focusing the fuzzy front-end in new product development. R &amp; D Management, Vol.32, Iss. 4, pp. 269-279.</li> <li>• Roberts, E. B. (2007):. Managing invention and innovation. Research Technology Management, Vol. 50, Iss. 1, Jan-Feb 2007, pp. 35-54.</li> <li>• Stevens, G. A., Burley, J. (1997): 3000 raw ideas = 1 commercial success! Research Technology Management, Vol. 40, Iss. 3, May/Jun 97, pp. 16-27.</li> <li>• Ulrich, K. T., Eppinger, S. D. (2011): Product Design and Development. McGraw-Hill, Boston.</li> <li>• Wheelwright, S. C., Clark, K. B. (2011): Revolutionizing Product Development. Free Press, New York.</li> <li>• Academy of Management Review. Vol. 20, Iss. 2, pp. 343-378.</li> <li>• Management, Vol. 52, Iss. 2, March/April 2009, pp. 47-57.</li> <li>• Von Hippel, (1986): Lead users: A source of novel product concepts</li> </ul>
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<b>Module title</b>	<b>Lean Six Sigma</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Dr. Matthias Scheiblich																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (40%) computer work (10%) examinations (10%)																										
<b>Assessment type</b>	B-Type Examination																										
<b>Educational objectives</b>	Students have an insight into the range of Lean Six Sigma concepts and the opportunities for their use in an enterprise. They know how Lean management and Six Sigma can be combined effectively to achieve zero defect quality without waste. They are familiar with value stream mapping and the interaction of DOE, QFD and TRIZ within the scope of Design for Six Sigma (DFSS) and Lean Manufacturing. They know about project choice for Business Process Excellence in industry sectors, Lean concepts as well as integration of DFSS in the product development process. They have the skills to analyze the impact of the introduction of Lean Six Sigma. They understand the direct connection between the success of product and process innovations and the application of the learnt methods. They can draw up concrete proposals for improvement within the project environment. They achieve with efficient resource allocation the defined efficiency and productivity targets through the implementation and use of Lean Six Sigma and its preventive methods (e. g. DFSS).																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Communicative Competencies</td> <td></td> <td>X</td> <td></td> </tr> </tbody> </table>			Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies			X	Communicative Competencies		X	
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Broadening Knowledge			X																								
Deepening Knowledge			X																								
Instrumental Competencies			X																								
Systemic Competencies			X																								
Communicative Competencies		X																									
<b>Content</b>	<ul style="list-style-type: none"> <li>- Lean Management</li> <li>- Six Sigma</li> <li>- Green Six Sigma</li> <li>- Lean Six Sigma</li> <li>- Product and Process Management</li> <li>- Quality Management</li> <li>- Lean Six Sigma and Innovation Success</li> </ul>																										
<b>Prerequisites</b>	Module Quality Management																										



<b>Bibliography</b>	<ul style="list-style-type: none"><li>• Meran, R., John, A., Roenpage, O., Staudter C., Lunau S. (2013): Six Sigma + Lean Toolset</li><li>• Chiarini, A. (2012): From Total Quality Control to Lean Six Sigma</li><li>• George, M.L., Maxey, J., Rowlands, D.T., Upton, M. (2004): The Lean Six Sigma Pocket Toolbox: A quick Reference Guide to 70 tools for Improving Quality and Speed, Mcgraw-Hill Publ.Comp.</li><li>• George, M.L. (2002): Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed, Mcgraw-Hill Professional.</li><li>• George, M.L. (2003): What is Lean Six Sigma?, Mcgraw-Hill Publ.Comp.</li></ul>
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<b>Module title</b>	<b>Innovation Strategies</b>																								
<b>Duration</b>	1 semester																								
<b>Language</b>	English																								
<b>Responsible</b>	Dr. Frank Bescherer																								
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (40%) computer work (10%) preparation and examinations (10%)																								
<b>Assessment type</b>	written examination																								
<b>Educational objectives</b>	Students have an understanding of the innovation strategies of globally oriented and multinational enterprises. They have an overview of the structure and the mode of action of innovation networks and of the methods and measures in global innovation management processes. In addition, they understand the tools and methods of international innovation controlling as well as the qualitative assessment procedures and economy calculations. They are familiar with the accounting treatment of R&D services in various judicial systems. Students know how cultural frameworks are connected to innovation management. They can explain and categorize the mechanisms of actions of intercultural innovations in connection with the different ways of problem solving in other cultures.																								
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Communicative Competencies</td> <td></td> <td>X</td> <td></td> </tr> </tbody> </table>	Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies			X	Communicative Competencies		X	
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Systemic Competencies			X																						
Communicative Competencies		X																							
<b>Content</b>	<ul style="list-style-type: none"> <li>- Innovation strategy as part of corporate strategy</li> <li>- Ideal type innovation strategies</li> <li>- Supporting methods (matrix approaches, portfolio approaches)</li> <li>- Trend analysis, scenario technique</li> <li>- Innovation strategy und brand development</li> <li>- Wording of innovation strategies</li> </ul>																								
<b>Prerequisites</b>	Module Innovation Management																								
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• West A. (1992): Innovation Strategy, Phillip Allan</li> <li>• Cooper R.G., Edpett S.J. (2009): Product Innovation and Technology Strategy, BookSurge Publishing</li> <li>• Afuah A. (2003): Innovation Management: Strategies Implementations and Profits, Oxford University Press</li> </ul>																								

	<ul style="list-style-type: none"><li>• Jöstingmeier, B., Boeddrich, H.-J. (2007): Cross-Cultural Innovation - New Thoughts, Empirical Research, Practical Reports, Oldenbourg-Verlag.</li><li>• Anderson and Tushman (1990): Technological discontinuities and dominant designs: A cyclical model of technological change; Administrative Science Quarterly, Vol. 35, No. 4</li><li>• Christensen, C. M. 2013. The Innovators dilemma: When new technologies cause great firms to fail. Harvard Business School Press, Boston, MA.</li><li>• Geroski, P.A. (2003): The evolution of new markets. Oxford University Press, New York.</li><li>• Lieberman, M. B. (1987): The learning curve, diffusion, and competitive strategy. Strategic Management Journal, Vol. 8, Iss. 5, Sep / Oct 1987, pp. 441-452.</li><li>• Malham, H. J. (2013): I Have a Strategy (No, You Don't): The Illustrated Guide to Strategy, Wiley</li><li>• Mintzberg, H., Ahstrand, B., Lampel, J. (2009): Strategy safari: A guide through the wilds of strategic management. Free Press, New York.</li><li>• Murmann, J. P.; Frenken, K. (2006): Toward a systematic framework for research on dominant designs, technological innovations, and industrial change. Research Policy, Sep2006, Vol. 35, Iss. 7, pp. 925-952.</li><li>• Porter, M. E. (1998): Competitive Strategy: Techniques for Analyzing Industries and Competitors, Free Press, New York.</li><li>• Teece (2010): Business models, business strategy and innovation, Long Range Planning 43,172-194</li><li>• Tushman, M., Nadler, D. (1986): Organizing for innovation. California Management Review, Vol. 28, Iss. 3, Spring 1986, pp. 74-92.</li><li>• Von Hippel (1986): Lead users: A source of novel product concepts;</li><li>• (optional) Cohen, W, &amp; Levinthal, D. (1990): Absorptive capacity, A new perspective on Learning and Innovation, Administrative Science Quarterly, 35, 128-152</li></ul>
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<b>Module title</b>	<b>Technology Management</b>																								
<b>Duration</b>	1 semester																								
<b>Language</b>	English																								
<b>Responsible</b>	Dr. Frank Bescherer																								
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (40%) computer work (10%) preparation and examinations (10%)																								
<b>Assessment type</b>	written examination																								
<b>Educational objectives</b>	Students have an understanding of the relevant basics and terminology of technology management. They can categorize and assess technological activities in terms of planning. In addition, they have an insight into market-oriented positioning of technology management and they understand the steps of relevant technology tracking. They can describe the different types of technology and explain the phases of the technology development. Additionally, they have an overview of strategic technology management.																								
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Communicative Competencies</td> <td></td> <td>X</td> <td></td> </tr> </tbody> </table>	Relevance Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge		X		Instrumental Competencies			X	Systemic Competencies			X	Communicative Competencies		X	
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Instrumental Competencies			X																						
Systemic Competencies			X																						
Communicative Competencies		X																							
<b>Content</b>	<ul style="list-style-type: none"> <li>- The term „technology“ and the basics of technology management</li> <li>- Technology development in the enterprise</li> <li>- Technology development in research institutes and universities</li> <li>- Technology diffusion (incl. technology lifecycle)</li> <li>- Methods of technology management</li> <li>- Technology strategies</li> <li>- Technology transfer</li> <li>- Social acceptance of new technologies (incl. technology assessment)</li> </ul>																								
<b>Prerequisites</b>	None																								
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Sudhakar G.P. (2012): Technology Management, Gazelle Book Services</li> <li>• Dankbaar B., Cannell W. (1996): Technology Management, Oxford University Press</li> <li>• White, M. (2010): Strategic Management of Technology and Innovation, International Edition, Cengage Learning Emea</li> </ul>																								

	<ul style="list-style-type: none"><li>• Cetindamar D., Phaal R., Probert D. (2010): Technology Management Activities and Tools, Palgrave</li><li>• White M., Bruton G. (2006): The Management of Technology and Innovation: A Strategic Application, Thomson Learning</li><li>• Cooper, R. G. (2006): Managing technology development projects. Research Technology Management, Nov/Dec 2006, Vol. 49, Iss. 6; pp. 23-31.</li><li>• Groenveld, P. (1997): Roadmapping integrate business and technology. Research Technology Management, Vol. 40, Issue 5, pp. 48-55.</li><li>• Iansiti, M. (1998): Technology integration: making critical choices in a dynamic world. Harvard Business School Press, Boston.</li><li>• Pavitt, K. (1990): What we know about the strategic management of technology. California Management review, Spring 1990, Vol. 32, Iss. 3, pp. 17-26.</li><li>• Rinne, M. (2004): Technology roadmaps: Infrastructure for innovation. Technological Forecasting and Social Change, Vol. 71, Iss. 1, pp. 67–80.</li><li>• Whalen, P. J. (2007): Strategic and Technology Planning on a Roadmapping Foundation. Research- Technology Management. Vol. 50, Issue 3, pp. 40-51.</li><li>• (optional) Chiles; J.R. (2002): Inviting Disaster: Lessons from the edge of technology.</li><li>• (optional) Lichtenthaler, U., Ernst, H.( 2008): Innovation Intermediaries: Why internet market places for technology have not yet met the expectations, Creativity and Innovation Management, 1, 14-25.</li></ul>
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<b>Module title</b>	<b>R&amp;D Management</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Dr. Frank Bescherer																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40%) self-study and practical work (40%) computer work (10%) preparation and examinations (10%)																										
<b>Assessment type</b>	written examination																										
<b>Educational objectives</b>	Students understand the importance of R&D for the national economy and businesses, and can explain the different forms. They know the tools for project management and controlling as well as the methods for design of R&D planning processes and their application in research and development projects. They are familiar with the structural elements of research-oriented enterprise design, which includes external research and development units. In addition, they have an overview of the available options for promotion and funding of research.																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Communicative Competencies</td> <td></td> <td>X</td> <td></td> </tr> </tbody> </table>			Relevance \ Competence	+	++	+++	Broadening Knowledge			X	Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies			X	Communicative Competencies		X	
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<b>Content</b>	<ul style="list-style-type: none"> <li>- Basics of R&amp;D management</li> <li>- Significance and characteristics of R&amp;D for national economy and businesses</li> <li>- R&amp;D forms</li> <li>- Tools and methods for R&amp;D planning</li> <li>- R&amp;D project management</li> <li>- R&amp;D controlling</li> <li>- Organizational R&amp;D integration into the enterprise (macrostructure, microstructure)</li> <li>- Internationalization of R&amp;D</li> <li>- External R&amp;D</li> <li>- Funding and promotion of research</li> </ul>																										
<b>Prerequisites</b>	Module Technology Management																										
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Akhilesh K.B. (2014): R&amp;D Management (Management for Professionals), Springer</li> <li>• Wei C. (2012): R&amp;D Project Management Body of Knowledge, CreateSpace Independent Publishing Platform</li> </ul>																										

	<ul style="list-style-type: none"><li>• Corre, A., Mischke, G. (2005): <i>The Innovation Game</i>, Springer</li><li>• Gaubinger K., Rabi M., Swan S., Werani T. (2014): <i>Innovation and Product Management: A Holistic and Practical Approach to Uncertainty Reduction</i>, Springer</li><li>• Beattie C.J., Reader R.D. (1971): <i>Quantitative Management in R&amp;D</i>, Springer</li><li>• Brown S. L., Eisenhardt, K. M. (1995): Product development: Past research, present findings, and future directions. <i>Academy of Management Review</i>. Vol. 20, Iss. 2, pp. 343-378.</li><li>• Cohen, W, &amp; Levinthal, D. (1990): Absorptive capacity, A new perspective on Learning and Innovation, <i>Administrative Science Quarterly</i>, 35, 128-152</li><li>• Cooper, R. G. (2011): <i>Winning at New Products: Creating Value Through Innovation</i>; Basic Books</li><li>• Kim, J., Wilemon, D. (2002): Focusing the fuzzy front-end in new product development. <i>R &amp; D Management</i>. Sep 2002, Vol.32, Iss. 4, pp. 269-279.</li><li>• Shalley and Gilson (2004): What leaders need to know: A review of social and contextual factors that can foster or hinder creativity; <i>The Leadership Quarterly</i> 15, 33–53</li><li>• Stevens, G. A., Burley, J. (1997): 3000 raw ideas = 1 commercial success! <i>Research Technology Management</i>, Vol. 40, Iss. 3, May/Jun 97, pp. 16-27.</li><li>• Teece (2010): Business models, business strategy and innovation, <i>Long Range Planning</i> 43,172-194</li><li>• (optional) Drummond, H. (1996): <i>Escalation in Decision-making: The Tragedy of Taurus</i>, Oxford University Press</li><li>• (optional) Schenk, E. &amp; Guittard, C. (2011): Towards a characterisation of crowdsourcing practices. <i>Journal of Innovation Economics</i>. 1, 7, 93-107</li></ul>
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## 5. Research Focus and Thesis

<b>Module title</b>	<b>Business Research Methods</b>																										
<b>Duration</b>	1 semester																										
<b>Language</b>	English																										
<b>Responsible</b>	Prof. Dr. Gernot Langenbacher																										
<b>Workload / Credit points</b>	total: 180 h (6 CP) independent reading (40 %) self study and practical work(40 %) computer work (10 %) lectures and exams (10 %)																										
<b>Assessment type</b>	B-Type Examination																										
<b>Educational objectives</b>	This Module supports students in understanding the research process: It provides a basic understanding of what research is and how it is carried out. It is particularly useful if students have not undertaken any postgraduate research before. Furthermore it considers research methodology and literature review. It explains how to carry out a business-related literature review and then use it to develop a hypothesis or theory about a business issue. Additionally, the module concentrates on statistical techniques for data collection, analysis and drawing conclusions.																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance \ Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>			Relevance \ Competence	+	++	+++	Broadening Knowledge		X		Deepening Knowledge			X	Instrumental Competencies		X		Systemic Competencies		X		Communicative Competencies	X		
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Systemic Competencies		X																									
Communicative Competencies	X																										
<b>Content</b>	<ul style="list-style-type: none"> <li>- Research Planning</li> <li>- Quantitative Research</li> <li>- Qualitative Research</li> <li>- Mixed Methods Research</li> <li>- E-Research: Internet Research Methods</li> <li>- Writing up Business Research</li> </ul>																										
<b>Prerequisites</b>	English language proficiency at level C1 (CEFR)																										
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Bryman, A. &amp; Bell, E. (2011): Business Research Methods, Oxford University Press, 3rd edition.</li> </ul>																										



<b>Module title</b>	<b>Research Project Technology &amp; Innovation Management</b>																										
<b>Duration</b>	2 semesters																										
<b>Language</b>	English																										
<b>Responsible</b>	Prof. Dr. Gernot Langenbacher																										
<b>Workload / Credit points</b>	total: 300 h (10 CP / thereof 4 CP Research Proposal and 6 CP Literature Review) independent reading (40 %) self study and practical work (40 %) computer work (10 %) lectures and exams (10 %)																										
<b>Assessment type</b>	B-Type Examination (40% Research Proposal, 60% Literature Review)																										
<b>Educational objectives</b>	On completion of the module on Business Research Methods, students will discuss their research interests with a Senior Mentor. The mentor will work with students in the preparation of a research proposal. The mentor will be a senior academic with experience of mentoring M.Sc. students. Once the research proposal has been approved, students work under the direction of the mentor to conduct a literature review that supports their chosen area of research and underpinning methodology.																										
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Communicative Competencies</td> <td></td> <td></td> <td>X</td> </tr> </tbody> </table>			Relevance Competence	+	++	+++	Broadening Knowledge		X		Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies		X		Communicative Competencies			X
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Communicative Competencies			X																								
<b>Content</b>	<ul style="list-style-type: none"> <li>- Research Questions, Aims, Objectives and Hypotheses</li> <li>- Research Paradigm and Theoretical Framework</li> <li>- Research Methodology, Data Collection and Analysis</li> <li>- Accessibility</li> <li>- Research Ethics ("Code of Conduct")</li> <li>- Deliverables, Timetable</li> <li>- Literature Review and Synthesis</li> <li>- Pilot Study and formal Research Theory</li> </ul>																										
<b>Prerequisites</b>	English language proficiency at level C1 (CEFR) / Module Business Research Methods																										
<b>Bibliography</b>	<ul style="list-style-type: none"> <li>• Bryman, A. &amp; Bell, E. (2011): Business Research Methods, Oxford University Press, 3rd edition.</li> </ul>																										

<b>Module title</b>	<b>Master's Thesis &amp; Virtual Oral Examination</b>																								
<b>Duration</b>	1 semester																								
<b>Language</b>	English																								
<b>Responsible</b>	Prof. Dr. Gernot Langenbacher																								
<b>Workload / Credit points</b>	total: 780 h (26 CP) independent reading (25%) scientific work and documentation (65%) presentation and defense (10%)																								
<b>Assessment type</b>	The overall result is determined by the grade of the Master's thesis as well as the oral examination.																								
<b>Educational objectives</b>	Students write independently a research-based final examination work on the basis of the previously compiled Research Proposal and Literature Review. They have the ability to carry out independent study and research, to gather and evaluate scientific evidence, and to judge and apply the results of scientific research responsibly. The targets, results and approach to the Master's thesis form the basis of the virtual oral examination. Students must be able to justify and defend their overall concept against critical question on the part of the examiners.																								
<b>Competencies</b>	<table border="1"> <thead> <tr> <th>Relevance Competence</th> <th>+</th> <th>++</th> <th>+++</th> </tr> </thead> <tbody> <tr> <td>Broadening Knowledge</td> <td></td> <td>X</td> <td></td> </tr> <tr> <td>Deepening Knowledge</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Instrumental Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Systemic Competencies</td> <td></td> <td></td> <td>X</td> </tr> <tr> <td>Communicative Competencies</td> <td></td> <td></td> <td>X</td> </tr> </tbody> </table>	Relevance Competence	+	++	+++	Broadening Knowledge		X		Deepening Knowledge			X	Instrumental Competencies			X	Systemic Competencies			X	Communicative Competencies			X
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Systemic Competencies			X																						
Communicative Competencies			X																						
<b>Content</b>	<ul style="list-style-type: none"> <li>- Selecting a topic</li> <li>- Master's thesis</li> <li>- Oral examination</li> </ul>																								
<b>Prerequisites</b>	<ul style="list-style-type: none"> <li>- See relevant Examination Regulations</li> <li>- Modules Business Research Methods and Research Project, Technology &amp; Innovation Management</li> </ul>																								
<b>Bibliography</b>	Depending on previous experience and subject																								