Handbook of Modules
for the Degree Programme

Information Engineering and Computer Science, M.Sc.

Faculty of Communication and Environment

Version 1.3

19.10.2015

Dokumentenhistorie

Version	Datum	Verantw.	Bemerkung
0.1	2013-12-13	TH	Initialversion
0.2	2013-12-16	TH	„Weight towards final grade“ angepasst
0.3	2013-12-17	TH	Module M-IE_EA.02 und M-IE_3.01 eingefügt
1.0	2014-01-13	TH	Version zur Veröffentlichung
1.1	2014-09-24	TH	Bearbeitungszeit Masterarbeit laut PO angepasst
1.2	2015-10-19	SLE	Modulbeschreibungen gem. Akkreditierungsauflagen angepasst
1.3	2015-10-19	TH	deutsche Bezeichnungen ins Curriculum eingeführt redaktionelle Änderungen

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Curriculum of the Master Degree Programme Information Engineering and Computer Science, M.Sc.

Code No (Kennnummer)	Module	SW	Type (Veranstaltungsart)						TE	CP	Sum CP	SS 1	WS 2	SS 3
			L	SL	S	Ex	PT	Pro						
M-IE_1.01	**System Simulation** **System Simulation**	5	2			2	1		E	5	**5**	5		M-IE_3.01 Master Thesis /Masterarbeit (27 CP) and Colloquium/Kolloquium (3 CP)
M-IE_1.02	**Data Analysis / Statistics** **Datenanalyse und Statistik**	4	2			2			E	5	**5**	4		
M-IE_1.03	**Scientific and Technical Communication** **Wissenschaftliche und Technische Kommunikation**	3	3						E	5	**5**	3		
M-IE_1.04	**Applied Research Project A** **Angewandtes Forschungsprojekt A**	4					4		E	5	**5**	4		
M-IE_2.01	**Data Mining** **Data Mining**	4	2			2			E	5	**5**		4	
M-IE_2.02	**Geoinformatics** **Geoinformatik**	4	2			2			E	5	**5**		4	
M-IE_2.03	**Intercultural Management and Intercultural Competence** **Interkulturelles Management und Interkulturelle Kompetenz**	4							E	5	**5**			
	Intercultural Management and Intercultural Competence Interkulturelles Management und Interkulturelle Kompetenz		2			1							3	
	Localisation and Internationalisation Lokalisierung und Internationalisierung						1						1	
M-IE_2.04	**Innovation Management** **Innovationsmanagement**	3							E	5	**5**			
	User-Centred Innovation and Design Management Nutzerzentriertes Innovations- und Design-Management		2										2	
	Digital Culture and New Markets Digitale Kulturen und Neue Märkte		1										1	
M-IE_2.05	Applied Research Project B Angewandtes Forschungsprojekt B	4					4		E	5	**5**		4	
	Specialisation Track (1st semester) **Spezialisierung**	8								10	**10**			
	Course 1 Modul 1		2			2			E			4		
	Course 2 Modul 2		2			2			E			4		
	Specialisation Track (2nd semester) **Spezialisierung**	4								5	**5**			
	Course 3 Modul 3		2			2			E				4	
	Semester hours per week (Semesterwochenstunden)	**47**								**CP**	**60**	**24**	**23**	**30**

47 SW

90 CP

Specialisation Tracks

Module		SW	CP
	Track Computer Science *Informatik*		
M-IE_CS.01	Communication System Security Sichere datenübertragende Systeme	4	5
M-IE_CS.02	Mobile and Internet Computing Mobile und Internet-basierte Systeme	4	5
M-IE_CS.03	Advanced Software Engineering Software Engineering für Fortgeschrittene	4	5
	Track Environmental Analysis *Umweltanalyse*		
M-IE_EA.01	Environmental Analysis, Impact and Risk Umwelt Analytik, Wirkungsabschätzung und Riskoanalyse	4	5
M-IE_EA.02	Environmental Monitoring Research Project Umweltmonitoring	4	5
M-IE_EA.03	Data Procurement and Data Processing in Technical and Ecological Ecosystem Management Datenakquisition und -verarbeitung im technischen Ökosystem Management und Umweltschutz	4	5
	Track Logistics *Logistik*		
M-IE_LG.01	Modelling of Large External Networks Modellierung großer externer Netzwerke	4	5
M-IE_LG.02	Basic Methods of Advanced Logistic Control Grundlegende Methoden fortgeschrittener Logistiksteuerung	4	5
M-IE_LG.03	Advanced Logistics Concepts for Production and Supply Fortgeschrittene Logistikkonzepte für Produktion und Versorgung	4	5
	Track Cyber-Physical Systems *Cyber-Physische Systeme*		
M-IE_CP.01	Distributed Systems Verteilte Systeme	4	5
M-IE_CP.02	Identification and Automation Technologies Indentifizierungs- und Automationstechnologien	4	5
M-IE_CP.03	Real-Time Embedded Systems Echtzeitliche eingebettete Systeme	4	5

Abbreviations

SW	Semester hours per week (Semesterwochenstunden)
WS	Winter semester (Wintersemester)
SS	Summer semester (Sommersemester)
TE	Type of examination (Prüfungsform)
CP	Credit points (Kreditpunkte)
L	Lecture (Vorlesung)
SL	Seminaristic lecture (seminaristische Lehrveranstaltung)
S	Seminar (Seminar)
Ex	Exercise (Übung)
PT	Practical training (Praktikum)
Pro	Project (Projekt)
E	Examination (Prüfung)
C	Certificate (Testat)

M-IE_1.01 System Simulation

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_1.01	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS Practical Training: 15 h / 1 SWS	75 h / 5 SWS	75 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

This module deals with modelling and simulation aspects of real systems, such as technical, natural or economical systems and provides basic methods of modelling and simulation and their applications in different contexts. Having completed this module, students are able to model different aspects of real systems and to analyze them via simulations. In detail, the students are able to apply modelling technologies and techniques to technical, natural and/or economical problems, i.e. they are able to describe the problems mathematically and to find solutions. They know the appropriate use of models and simulations as well as their limitations and understand the steps of the simulation process. Students are familiar with a range of modern modelling and simulation technologies as well as common tools. They are able to develop or apply their own ideas in this field. They understand modelling and simulation as a useful tool to understand real systems and they can apply them in different contexts.

Content

- Meaning of modelling and simulation of real systems such as technical, natural or economical systems; simulation chain
- Discrete and continuous simulations; dimensionless variables; implementation with tools such as Octave, Matlab/Simulink, Scilab, R, Arena, or Dosimis (e.g. signal processing, queuing systems, optimization); introduction to partial differential equations (e.g. solving heat conduction equation by using FEM or FDM, …)
- Stochastic simulations (Monte Carlo simulations, ...)

Teaching methods

Tuition in seminars, lectures and (partially self-organized) practical trainings. Students work individually and in teams.

Entry requirements

None

Types of assessment

Case study and presentation

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

Prof. Dr. Frank Zimmer

Additional information

Recommended readings:

Acevedo, M. F.: Simulation of Ecological and Environmental Models, CRC Press, 2013

Campbell, S.L.; Chancelier, J.-P.; Nikoukhah, R.: Modeling and Simulation in Scilab/Scicos with ScicosLab 4.4, ISBN 978-1441955265, Berlin, Springer, 2nd ed., 2009

Jones, O.; Maillardet, R.; Robinson, A.: Introduction to Scientific Programming and Simulation Using R, CRC Press, Taylor & Francis Group, Boca Raton, FL, 2009

Kreyszig, E.: Advanced Engineering Mathematics: International Edition, ISBN 978-0471728979, John Wiley & Sons, 5th ed., 2005

Quarteroni, A. M. ; Saleri, F. ; Gervasio, P.: Scientific Computing with MATLAB and Octave. 3rd edition, Berlin: Springer, 2009

Stroud, K.A.; Booth, D.J: Engineering Mathematics, ISBN 978-1403942463, Palgrave Macmillan, 6th ed., 2007

Stroud, K.A.; Booth, D.J: Advanced Engineering Mathematics, ISBN 978-0230275485, Palgrave Macmillan, 5th ed., 2011

Tyagi, A.K.: MATLAB and Simulink for Engineers, ISBN 978-0198072447, Oxford Univ Pr, Pap/Cdr, 2011

M-IE_1.02 Data Analysis / Statistics

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_1.02	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

Students are able to analyse and interpret statistical data. In this module, students have deepened their statistical knowledge using the R statistical software, expand existing programming skills with R and acquired and consolidated their knowledge of particular expert data analysis (with R).

Students are able to apply statistical methods in different fields such as technical, natural or economical systems in different contexts. Having completed this module, students are able to analyze problems by designing statistical experiments and are able to process and interpret statistical data from such experiments. They know the appropriate use of statistical methods as well as their limitations. Students are familiar with the language R as well as with the development environment and other common tools for R in depth. They are able to develop or apply their own ideas in this field in different contexts.

Content

- Probability theory, statistical methods, exploratory analysis and interferential statistics (goodness of fit, analysis of variance, correlation), regression, time series, spacial point patterns, geostatistics, multivariate analysis
- R computer sessions: Introduction to R (scripts, graphics device, file handling, R console, R commander), programming with R and multiple plots, probability and descriptive statistics, exploratory analysis and inferential statistics, regression, random processes and time series, spatial analysis, multivariate models and analysis, geostatistics

Teaching methods

Tuition in seminars, lectures and (partially self-organized) practical trainings. Students work individually and in teams.

Entry requirements

None

Types of assessment Case study and presentation
Requirements for the award of credit points Passed assessment
Use of module (in other study programs) --
Weight towards final grade 5,42%
Person in charge of module Prof. Dr. Frank Zimmer
Additional information Recommended readings: Acevedo, M. F.: Data Analysis and Statistics for Geography, Environmental Science, and Engineering, CRC Press, 2013 Nisbet, R.; Elder, J.; Miner, G.: Handbook of Statistical Analysis and Data Mining Applications, Academic Press, Elsevier Inc., 2009 Russel, M.A.: Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More, O'Reilly Media, 2013

M-IE_1.03 Scientific and Technical Communication

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_1.03	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 45 h / 3 semester hours per week (SWS)	45 h / 3 SWS	105 h	Lecture: open

Learning outcomes / Competences and qualifications profile

Students have learned to communicate technical information in an easily understandable language. They have internalized the fundamentals of effective scientific writing. They have deepened their knowledge of how to write and revise (technical) reports and manuals and have practiced their skills by completing different hands-on assignments. Students have learned to plan and edit documentation materials and to estimate the effort needed to include illustrations, photographs, charts and diagrams. In addition to the ability to communicate technical knowledge. Students have learned how to document and present research in information engineering and computer science (especially complex systems) in adequate ways to a diverse audience.

Content

- Writing style
- Creative and technical writing
- Illustrations, charts and diagrams
- Presentation techniques
- Editing and publishing
- Experimental design, analysis and documentation

Teaching methods

Tuition in lectures and practical trainings. Students work individually and in teams.

Entry requirements

None

Types of assessment

Written/Oral examination

Requirements for the award of credit points

Passed examination

Use of module (in other study programs)

M. Sc. Usability Engineering

Weight towards final grade

5,42%

Person in charge of module

Prof. Dr.-Ing. Sandro Leuchter

Additional information

Recommended readings:

Albers, Michael J., and Mary Beth Mazur. Content and Complexity: The Role of Content in Information Design. Ed. Michael J. Albers, and Mary Beth Mazur. Routledge, 2003.

Alley, Michael. The Craft of Scientific Writing. 3rd ed. Springer, 1998.

Agarwal, B. L. Theory & Analysis of Experimental Designs. CBS Publishers & Distributors Private Limited, 2010.

Anderson, Paul V. Technical Communication: A Reader-centered Approach. 4th ed. Heinle & Heinle Publishing, 1998.

Cargill, Margaret, and Patrick O'connor. Writing Scientific Research Articles: Strategy and Steps. Wiley-Blackwell, 2009.

Hofmann, Angelika H. Scientific Writing and Communication: Papers, Proposals, and Presentations. OUP USA, 2010.

Katz, Michael Jay. From Research to Manuscript: A Guide to Scientific Writing. 2nd ed. Springer, 2009.

Miller, Frederic P., Agnes F. Vandome, and John McBrewster. Illustration: Information Drawing, Painting, Photograph, Art, Technical illustration. Ed. Frederic P. Miller, Agnes F. Vandome, and John McBrewster. Alphascript Publishing, 2010.

Raman, Meenakshi, and Sangeeta Sharma. Technical Communication: Prinicples and Practice, 2e. 2nd ed. OUP India, 2012.

Surhone, Lambert M., Miriam T. Timpledon, and Susan F. Marseken. Technical Illustration: Technical Drawing, Diagram, Line Drawing, Exploded View Drawing, Cutaway Drawing, Clip-Art, Parallel Projection, Perspective Projection. Ed. Lambert M. Surhone, Miriam T. Timpledon, and Susan F. Marseken. Betascript Publishing, 2010.

M-IE_1.04 Applied Research Project A

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_1.04	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Practical Training: 60h / 4 semester hours per week (SWS)	Depending on individual needs	90 h	25 students

Learning outcomes / Competences and qualifications profile

Students have worked in small groups on a specific topic in applied research from information engineering and computer science in depth. They have experience in finding interesting and realistically to answer research questions, in conducting research, in shaping a plan how to work on the topic in a team, and in how to present and document the results to an audience.

As such students have learned to apply the knowledge they have gained in other courses to their project work. They are able to write a convincing project report and to communicate project results in a professional way. They are used to project management and to procedures of scientific technical gatherings such as company presentations, conference talks, and poster sessions.

Due to this project experience students have improved also their soft skills and their ability to work in a team.

Students are able to apply information engineering and computer science methods in different self-chosen fields such as technical, natural or economical systems in different contexts. They are able to develop or apply their own ideas in this field in different contexts.

Content

Students have to plan, realize, document and present their own projects by applying the knowledge they have gained in accompanying courses. The projects students choose should be related to current research projects of the faculty or can be realised by doing industrial internships.

A focus on information modeling aspects is mandatory.

Students have to analyze the project topic, propose applied research questions that feature a certain complexity, plan how to answer them, conduct applied research in team work, and communicate the results.

In order to communicate, project teams have to prepare a project proposal for a sponsor that has to be approved by the teacher, in regular status meetings project progress is discussed, preliminary findings are presented during a mid-term meeting, the final results are presented in a final meeting when also scientific posters are displayed. Finally the project is documented in a report. In the report there are mandatory sections such as "related work", "data/information model", "methodology", or "discussion of design decisions".

Teaching methods

At the beginning of the semester the different project ideas are developed by students and teams are built. The teacher acts as a facilitator and moderator during this process. Afterwards the teacher becomes project sponsor and needs to approve project proposals and design decisions. He or she also controls deviations from

plan or schedule and modifications of the project scope. In the end of this course the teacher acts as external audience and offers constructive critique as well as feedback according to the process.
Entry requirements None
Types of assessment Project proposal, information model, report, presentation, scientific poster and artifacts as project outcome such as source code and prototype
Requirements for the award of credit points Passed assessment
Use of module (in other study programs) --
Weight towards final grade 5,42%
Person in charge of module Prof. Dr.-Ing. Sandro Leuchter
Additional information Same as Applied Research Project B Literature depending on project

M-IE_2.01 Data Mining

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_2.01	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

Students have been introduced to typical tasks in which data mining techniques can be used effectively. They know models for the data mining process and data mining projects and are familiar with at least one software system to solve data mining tasks. Students have gained an in-depth understanding of concepts, methods, and limitations as well as practical experience in the area of scalable data analysis and data mining.

Students are able to apply data mining methods in different fields such as technical, natural or economical systems in different contexts. They know the appropriate use of data mining methods as well as their limitations. Students are familiar with a range of modern data mining technologies as well as common tools. They are able to develop or apply their own ideas in this field in different contexts.

Content

Recent advances in technology have led to rapid growth of data. This resulted in a need for cost efficient and scalable techniques to analyze data.

A special focus is put on the impact of data models for data mining and accordingly on the extraction, transformation, and loading steps (ETL) in data mining processes.

- Data mining process (standards and typical tasks of data mining such as anomaly detection, association rule learning (dependency modeling), search for relationships between variables, clustering, classification, regression, summarization)
- Data mining and text mining, data mining and web mining, data mining and information retrieval
- Algorithms and tools (e.g. R, Weka)
- Data mining trends and research frontiers
- Data mining applications
- Data mining and society, big data and privacy

Teaching methods

Tuition in seminars, lectures and (partially self-organized) practical trainings. Students work individually and in teams.

Entry requirements

Students should be skilled in Data Management and Statistics

Types of assessment

Case study and presentation

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

--

Weight towards final grade

5,42%

Person in charge of module

Prof. Dr. Frank Zimmer

Additional information

Recommended readings:

Dunham, M. H.: Data Mining Introductory and Advanced Topics, Prentice Hall, New Jersey, 2003

Han, J.; Kamber, M.; Pei, J.: Data Mining: Concepts and Techniques, 3rd revised edition, Morgan Kaufmann, 2011

Nisbet, R.; Elder, J.; Miner, G.: Handbook of Statistical Analysis and Data Mining Applications, Academic Press, Elsevier Inc., 2009

Russel, M.A.: Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More, O'Reilly Media, 2013

Tan, P.-N.; Steinbach, M.; Kumar, V.: Introduction to Data Mining, Addison Wesley, Boston, 2006

Torgo, L.: Data Mining with R: learning with Case Studies, CRC Press, 2011

Witten, I.H.; Frank, E., Hall, M.A.: Data Mining: Practical Machine Learning Tools and Techniques, 3rd edition, Morgan Kaufmann, 2011

M-IE_2.02 Geoinformatics

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_2.02	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

Students have expanded the ability to understand and apply basic and advanced concepts and techniques in geo-informatics and geographical information systems (GIS). With respect to their fields of application students have developed skills to recognize the assumptions, implications, values and limitations of different methods in spatial analysis. They have learned to deploy existing skills in modeling and programming for implementing spatial algorithms and extending existing GIS software.

They are able to oversee the impacts of information modelling decisions on GIS feasibility and performance of GIS systems.

Students are able to apply GIS methods in different fields such as technical, natural or economical systems in different contexts. They know the appropriate use of GIS as well as their limitations. Students are familiar with a range of modern GIS technologies as well as common tools. They are able to develop or apply their own ideas in this field in different contexts.

Content

Basic Concepts

- Information models, spatial data, spatial autocorrelation, error and uncertainty in spatial data

Techniques

- Spatial data models and spatial data modelling, geographic databases, GeoWeb

Analysis

- Map production, geovisualisation, spatial data analysis (e.g. Network analysis. cluster detection, spatial interpolation), spatial modeling with GIS

Teaching methods

Tuition in seminars, lectures and (partially self-organized) practical trainings. Students work individually and in teams.

Entry requirements None
Types of assessment Case study and presentation
Requirements for the award of credit points Passed assessment
Use of module (in other study programs) --
Weight towards final grade 5,42%
Person in charge of module Prof. Dr.-Ing. Sandro Leuchter
Additional information Recommended readings: Acevedo, M. F.: Data Analysis and Statistics for Geography, Environmental Science, and Engineering, CRC Press, 2013 de Smith, MJ, Goodchild M.F., and Longley, P.A.: Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools, 3rd Edition. 2009. Kemp, K.K.: Encyclopedia of Geographic Information Science, Sage Publications. ed. 2008. O'Sullivan, D. and Unwin, DJ.: Geographic Information Analysis, 2nd Edition. John Wiley & Sons. 2010.

M-IE_2.03 Intercultural Management and Intercultural Competence

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_2.03	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excersise: 15 h / 1 SWS Practical Training: 15 h / 1 SWS	75 h / 5 SWS	75 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

Students have gained a good understanding of the basic concepts in the field of cross-cultural differences in business settings. They know the main cultural dimensions developed by different scholars and are familiar with strong and weak points of these approaches. Students are able to conduct a cross-cultural analysis of a case study or a business situation, evaluating potential threats and risks arising from a culture clash. These analytical skills form the basis of their core competences in issues related to intercultural management.

Content

- Definition of culture. The Iceberg Model of Culture
- Sources of cultural diversity
- Culture as mental programming
- G. Hofstede's cultural dimensions
- Power distance (G. Hofstede). Ascribed vs. achieved status (F. Trompenaars)
- Individualism and collectivism as a cultural dimension. Views of Globe study project on this dimension
- Masculinity vs. femininity. Critique of this dimension by other scholars
- Uncertainty avoidance and its importance for crisis management
- Attitide to time (approaches by R. Lewis and F. Trompenaars)
- Culture shock. Stages of a culture shock. Cultural stereotypes
- The role of culture in organizations
- Decision making across cultures
- Negotiating in cross-cultural settings
- Communication patterns and socialising in intercultural management

Teaching methods

The course is held in form of a seminar: lectures are accompanied by various practical activities, discussions and exercises.

Entry requirements

None

Types of assessment

Written examination

Requirements for the award of credit points

Passed examination

Use of module (in other study programs)

M. Sc. Usability Engineering

Weight towards final grade

5,42%

Person in charge of module

Prof. Dr.-Ing. Sandro Leuchter

Additional information

Recommended readings:

Craig Storti. Cross-cultural dialogues. 74 brief encounters with cultural difference. Boston: Intercultural Press, Inc., 1994.

Geert H. Hofstede, Gert J. Hofstede. Cultures and Organizations: Software of the Mind. New York: McGraw-Hill, 2005.

H. Spencer-Oatey, P. Franklin. Intercultural Interaction: A Multidisciplinary Approach to Intercultural Communication. Basingstoke: Palgrave Macmillan, 2009.

Jeremy Comfort, Peter Franklin. The mindful manager: how to work effectively across cultures. London: Kogan Page, 2011.

Michael Kublin. International negotiating: a primer for American business professionals. New York: The Haworth Press, Inc., 1995.

Richard D. Lewis. When cultures collide: managing successfully across cultures. London: Nicholas Brealey Publishing, 2001.

Robert J. House, Paul L. Hanges, Mansour Javidan, Peter W. Dorfmann, Vipin Gupta. Culture, leadership, and organizations: The GLOBE study of 62 societies. London: Sage Publications, 2004.

M-IE_2.04 Innovation Management

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_2.04	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Practical Training: 15 h / 1 SWS	45 h / 3 SWS	105 h	Lecture: open Practical training: 25 students

Learning outcomes / Competences and qualifications profile

Students have learned about the various approaches to innovation focusing on customer-driven and user-driven methodology. They are able to identify opportunities and to transform these opportunities into requirements and concepts for future products that aim to achieve an optimum balance between all functional and non-functional requirements from all stakeholders' perspectives. Students have gained knowledge of various concepts of design, including design activities such as analysis and synthesis. They understand design thinking as a human-centred process of innovation. Students can apply techniques from design thinking and synthesis, are able to balance different design alternatives and can communicate the design rationales appropriately. Students are familiar with the strategy, process and implementation of design thinking and design management. They have gained knowledge of the breadth of principles, methods and practices that shape design management across the different design disciplines.

Content

- Strategic management and design management
- Design thinking and creativity methods
- Open innovation and user-centred innovation
- Innovative business models for new markets and digital culture

Teaching methods

Tuition in seminars, lectures and practical trainings. Students work individually and in teams.

Entry requirements

None

Types of assessment

Written/Oral examination

Requirements for the award of credit points

Passed examination

Use of module (in other study programs)

M. Sc. Usability Engineering

Weight towards final grade

5,42%

Person in charge of module

Prof. Dr.-Ing. Sandro Leuchter

Additional information

Recommended readings:

Ambrose, Paul Harris Gavin. Design Thinking: Fragestellung, Recherche, Ideenfindung, Prototyping, Auswahl, Ausführung, Feedback. Stiebner Verlag Gmbh, 2010.

Brown, Tim. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation. HarperBusiness, 2009.

Cooper, Rachel, Sabine Junginger, and Thomas Lockwood. The Handbook of Design Management. Ed. Rachel Cooper, Sabine Junginger, and Thomas Lockwood. Berg Publishers, 2011.

Gray, Dave, Sunni Brown, and James Macanufo. Gamestorming: A Playbook for Innovators, Rulebreakers, and Changemakers. O'Reilly Media, 2010.

Greene, Jay. Design Is How It Works: How the Smartest Companies Turn Products into Icons. Portfolio Hardcover, 2010.

Hippel, Eric Von. The Sources of Innovation. OUP USA, 1995.

Institute., Project Management. A Guide to the Project Management Body of Knowledge. Project Management Institute, 2004.

Johnson, Steven. Where Good Ideas Come From: The Natural History of Innovation. Riverhead Trade, 2011.

Kelley, Tom. The Ten Faces of Innovation: Strategies for Heightening Creativity. Profile Books Ltd, 2008.

Merholz, Peter, Todd Wilkens, Brandon Schauer, and David Verba. Subject To Change: Creating Great Products & Services for an Uncertain World. O'Reilly Media, 2008.

Osterwalder, Alexander, and Yves Pigneur. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons, 2010.

Schilling, Melissa A. Strategic management of technological innovation. 3rd ed. New York: McGraw-Hill/Irwin, 2010.

Tidd, Joseph. Managing innovation. 4th ed. Hoboken, NJ: Wiley, 2009.

Verganti, Roberto. Design Driven Innovation: Changing the Rules of Competition by Radically Innovating What Things Mean. Harvard Business Press, 2009.

M-IE_2.05 Applied Research Project B

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_2.05	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Practical Training: 60h / 4 semester hours per week (SWS)	Depending on individual needs	90 h	25 students

Learning outcomes / Competences and qualifications profile

Students have worked in small groups on a specific topic in applied research from information engineering and computer science in depth. They have experience in finding interesting and realistically to answer research questions, in conducting research, in shaping a plan how to work on the topic in a team, and in how to present and document the results to an audience.

As such students have learned to apply the knowledge they have gained in other courses to their project work. They are able to write a convincing project report and to communicate project results in a professional way. They are used to project management and to procedures of scientific technical gatherings such as company presentations, conference talks, and poster sessions.

Due to this project experience students have improved also their soft skills and their ability to work in a team.

Students are able to apply information engineering and computer science methods in different self-chosen fields such as technical, natural or economical systems in different contexts. They are able to develop or apply their own ideas in this field in different contexts.

Content

Students have to plan, realize, document and present their own projects by applying the knowledge they have gained in accompanying courses. The projects students choose should be related to current research projects of the faculty or can be realised by doing industrial internships.

A focus on information modeling aspects is mandatory.

Students have to analyze the project topic, propose applied research questions that feature a certain complexity, plan how to answer them, conduct applied research in team work, and communicate the results.

In order to communicate, project teams have to prepare a project proposal for a sponsor that has to be approved by the teacher, in regular status meetings project progress is discussed, preliminary findings are presented during a mid-term meeting, the final results are presented in a final meeting when also scientific posters are displayed. Finally the project is documented in a report. In the report there are mandatory sections such as "related work", "data/information model", "methodology", or "discussion of design decisions".

Teaching methods

At the beginning of the semester the different projects are presented and teams are built. Project kickoffs and regular meetings will be initated by the professors in charge who will also support the projects and will be available in case of problems and questions.

Entry requirements None
Types of assessment Project proposal, information model, report, presentation, scientific poster and artifacts as project outcome such as source code and prototype
Requirements for the award of credit points Passed assessment
Use of module (in other study programs) --
Weight towards final grade 5,42%
Person in charge of module Prof. Dr.-Ing. Sandro Leuchter
Additional information Same as Applied Research Project A Literature depending on project

M-IE_3.01 Master Thesis and Colloquium

Code	Workload	Credits	Level of module	Frequency of offer	Duration
UE_3.01	810 h	30 CP (27 + 3 CP)	3rd semester	Winter semester	20 weeks

Courses	Teaching time	Self-study	Planned group size
Master Thesis: 27 CP Colloqium: 3 CP	Depending on individual needs		

Learning outcomes / Competences and qualifications profile

Students have worked on a reseach topic of their interest in the scientific field of Information Engineering and Computer Science. They have conducted intensive studies on literature and developed their research question. Students have developed appropriate methodological strategies concerning that question. They have conducted the approach focusing on specific details of the question, have analyzed the results and transferred their findings to the broader perspective of the field. They have reflected their work and findings critically and have come up with some further research questions. Students have proven that they are able to analyze a complex field of work, find specific new research questions and have been able to answer them.

During the colloquium students have presented their work and have proven their expertise in the field of work. They have been able to defend the topic and to reflect on its impact on real-life problems in a professional way.

Content

Researching and evaluating literature

Developing a research question and deriving hypotheses

Operationalizing constructs

Analyzing methodological strengths and weaknesses of different research approaches

Developing research designs

Conducting the studies

Evaluating the results

Writing the thesis

Presenting and defending the findings

Teaching methods

Individual supervision and support

Entry requirements

60 credits points achieved in other courses of the curriculum

Types of assessment Written Master thesis and oral disputation
Requirements for the award of credit points Passed Master thesis and disputation as well as successful completion of all other modules of the curriculum
Use of module (in other study programs)
Weight towards final grade 35%
Person in charge of module All professors of the faculty
Additional information

Track Computer Science

M-IE_CS.01 Communication Systems Security

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_CS.01	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Lab excercise: 15 h / 1 SWS Project supervision: 15 h / 1 SWS	60 h / 4 SWS	90 h	Lecture: open Lab exercise: 20 students

Learning outcomes / Competences and qualifications profile

Students have gained advanced knowledge of security concepts, such as threats, vulnerabilities, protection and incident handling. They have been provided with a deep understanding of the field of communication / information security and respective implementation issues for communication systems. Students have been exposed to the spectrum of security activities, its methods, methodologies and mechanisms.

Students are able to apply security related methods in different fields of ICT in different contexts. They know the appropriate use of security related activities and components as well as their limitations. Students are familiar with a range of modern ICT security related technologies as well as common tools and processes. They are able to develop or apply their own ideas in this field in different contexts.

Content

Coverage has included advanced cryptographic functions, detection of and reaction to threats to communication systems, and trustworthy computing. Another focus has been set on security related organizational structures and product / system certification with respect to standardized security evaluation criteria.

- Advanced cryptographic protocols
- Mathematical foundations for security
- Communication security concepts:
  - Methods
  - Methodologies
  - Mechanisms
- Perimeters, firewalls and (virtual) private networks
- Penetration testing
- Approaches to intrusion detection

- Privacy and metrics to quantify privacy

- Proving security, logical reasoning models

- Advanced information security management

- Research topics regarding communication security

Teaching methods

Lectures and practical classes

Entry requirements

It is strongly recommended to have attended a bachelor module covering the basics of IT security concepts and methodologies first.

It is expected that students have fluent knowledge of a programming language and of the fundamentals of operating systems.

Types of assessment

Project work and presentation

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

--

Weight towards final grade

5,42%

Person in charge of module

Prof. Dr. Ulrich Greveler

Additional information

Recommended readings:

Anderson, R.: Security Engineering: A Guide to Building Dependable Distributed Systems, John Wiley & Sons; 2nd edition, New York, 2008, ISBN 978-0470068526

Paar, C. et al.: Understanding Cryptography: A Textbook for Students and Practitioners, 1st edition, Springer, Heidelberg, 2011, ISBN 978-3642041006

Schneier, B.: Applied Cryptography: Protocols, Algorithms and Source Code in C, John Wiley & Sons; 3rd edition, New York, 2011, ISBN 978-0471117094

Stavroulakis, P et al.: Handbook of Information and Communication Security, 1st edition, Springer, Heidelberg, 2010, ISBN 978-3642041167

M-IE_CS.02 Mobile and Internet Computing

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_CS.02	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Lab excercise: 15 h / 1 SWS Project supervision: 15 h / 1 SWS	60 h / 4 SWS	90 h	Lecture: open Lab exercise: 20 students

Learning outcomes / Competences and qualifications profile

Students have gained advanced knowledge of architectures and software enginering concepts for developing integrated mobile applications with distributed, internet-based backend systems. Furthermore, after practical work they are able to plan and implement multi-tiered information systems consisting of mobile app(s), server-based backends, modern communication protocols, and advanced persistency layers. They have been provided with a deep understanding of mobile and web-based architectures, accompanying frameworks, and the appropriate development and testing techniques. Students have been exposed to the spectrum of development activities, its methods, methodologies and mechanisms.

Students are able to apply appropriate design patterns in different contexts. They know the appropriate use of components as well as their limitations. Students are familiar with a range of modern frameworks as well as common tools and processes. They are able to develop or apply their own ideas in this field in different contexts.

Content

Coverage has included deployment processes, aspects of API-ageing, as well as best practices to handle short release cycles in production environments.

- General concepts of mobile applications
- Software engineering best practices for mobile applications
- User Interface Concepts for mobile applications (native and web interfaces)
- Programming languages and development environments for mobile applications
- Testing mobile applications
- Multi-tier architectures for mobile business information systems
- Design patterns for mobile business information systems
- Backend integration of mobile applications
- Cloud technologies
- Communication strategies

- Web applications as backend technology

- Persistence layers

- Client/Server-stacks for developing web applications

- Cross-plattform approaches

Teaching methods

Lectures and practical classes

Entry requirements

It is strongly recommended to have attended a bachelor module covering the basics of software development and methodologies first.

It is expected that students have fluent knowledge of a programming language and of the fundamentals of operating systems.

Types of assessment

Project work and presentation

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

--

Weight towards final grade

5,42%

Person in charge of module

Prof. Dr. Thomas Richter

Additional information

Recommended readings:

http://developer.android.com

http://developer.windowsphone.com

https://developer.apple.com/

Additional readings:

Han, Choi, Song (eds.): High Performance Cloud Auditing and Applications

Kumar: Fundamentals of Pervasive Information Management Systems

Matera, Rossi (eds.): Mobile Web Information Systems: MobiWIS 2013, International Workshops, Paphos, Cyprus, August 26-28, Revised Selected Papers (Communications in Computer and Information Science)Steinbock, Noam (eds.): Competition for the Mobile Internet

Upadhyaya, Chaudhury, Kwiat, Weiser (eds.): Mobile Computing: Implementing Pervasive Information And Communications Technologies (Operations Research/Computer Science Interfaces Series)

M-IE_CS.03 Advanced Software Engineering

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_CS.03	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Seminar: 15 h / 1 SWS Practical training: 15 h / 1 SWS	60 h / 4 SWS	90 h	Lecture: open Seminar and practical training: 25 students

Learning outcomes / Competences and qualifications profile

In 1968 the term "software engineering" was introduced at a NATO conference on tackling the "software crisis". Since then numerous methodologies for improving the development and implementation of complex software products have been presented.

In that context students have gained an overview of the ten knowledge areas of software engineering as defined by the ACM/IEEE Computer Society Software Engineering Body of Knowledge (IEEE 2013) and have been introduced to selected methods in each knowledge area. Students are able to decide which software engineering methods should be applied in different situations. Students are able to evaluate the appropriateness of specific methods in the context of specific organizational setting and software product requirements. They also have developed the skills to use tools that help introducing specific methods in software development organizations.

Students are able to apply appropriate software engineering methods in different contexts. They know the appropriate use of them as well as their limitations. Students are familiar with a range of common tools and processes. They are able to develop or apply their own ideas in this field in different contexts.

Content

- Management of software development projects
  - Project management: PRINCE2 or PMI model
  - Model based systems engineering and traceability of system elements
  - Quality management in software context: e.g. Maturity Models like CMMI or SPICE
  - Typical organizational structures for software production
  - Development Processes (document-centric: e.g. V-Modell XT or openUP, agile: e.g. SCRUM or Crystal)
- Software engineering knowledge areas (software requirements, software design, software construction, software testing, software maintenance, software configuration management, software engineering management (engineering management), software engineering process, software engineering tools and

methods, software quality), special focus on:

- Software architecture (e.g. quality aspects, description, viewpoints, assessment)
- Requirements engineering (e.g. user/system requirements)
- Test (e.g. white-box/black box, system/component/unit test, test coverage, test documentation), TDD Test-Driven Development
- Integration (e.g. continuous integration, software factories)

- Safety critical software intensive systems: DO-178B/C, software engineering for embedded systems IEC 61508, MISRA-Rule Sets

- Software tools e.g. Eclipse Process Framework Composer

- Implementation of software engineering disciplines in development organizations

Teaching methods

Tuition in seminars, lectures and (partially self-organized) practical trainings. Students work individually and in teams.

During the course an electronic information system describing software engineering methodologies is built using Eclipse Process Framework Composer. This repository is then used to specify different software engineering practices for case study development organizations.

Entry requirements

No formal requirements

Practice in object-oriented programming (e.g. Java, C++, C#), knowledge of UML are expected and needed.

Types of assessment

Case study and presentation

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

Prof. Dr.-Ing. Sandro Leuchter

Additional information

Recommended readings:

IEEE Computer Society (2013): Software Engineering Body of Knowledge (SWEBOK V3).

INCOSE (2013): Guide to the Systems Engineering Body of Knowledge (SEBoK, V. 1.2).

ISO/IEC/IEEE 42010:2011: Systems and software engineering - Architecture description.

ISO/IEC 12207:2008: Systems and software engineering - Software life cycle processes.

Frederick Brooks (1995): The Mythical Man-Month. Addison-Wesley.

Office of Government Commerce (2009): Managing Successful Projects with PRINCE2™, 2009 Edition.

Project Management Institute (2012): A Guide to the Project Management Body of Knowledge (PMBOK Guide, 5th Edition).

Tom de Marco (2009): Software Engineering: An Idea Whose Time Has Come and Gone?. IEEE Software, July/August 2009.

Watts S. Humphrey (2011): Leadership, Teamwork, and Trust: Building a Competitive Software Capability. Addison-Wesley.

Track Environmental Analysis

M-IE_EA.01 Environmental Analysis, Impact and Risk

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_EA.01	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Practical Training: 30 h / 2 SWS	4 SWS / 60 h	90 h	Lecture: open Practical training: 15 students

Learning outcomes / Competences and qualifications profile

Upon completion of this course, students are able to explain the significance of sampling methods and sample preparation for the quality of analytical data. Students have learned to outline and apply an analytical approach for environmental problems, exhaust streams and process evaluation. They can explain and value the application of advanced analytical techniques and methods such as natural radioactivity, isotope analysis, chemical fingerprints and bioassays for the analysis of environmental samples. Students have got the skills to explain the significance of technical and scientific concepts used in environmental impact and risk assessment. Students have learned to explain the significance of risk and impact analysis in planning and decision making processes. They can evaluate and critically discuss environmental impacts on ecosystems regarding interactions of organisms (e.g. vegetation, soil fauna, microorganisms) and abiotic system components. Students are skilled to value and apply selected environmental risk assessment procedures.

Content

With the help of case studies the following topics will be covered:

- Analytical techniques for environmental sampling in e.g. in ecosystems, exhaust streams or flue gas or biogas plants with special focus on on-site measurement techniques
- Design of sampling/monitoring plan, choice of analytical technique and data evaluation
- Overview advanced topics of environmental analytics
- Environmental Impact Assessment and Strategic Environmental Assessment, rationale, legal frameworks
- Technological hazards, protection, mitigation, adaptation
- Managing real and perceived risks
- Field and laboratory practicals on environmental analytics and environmental assessment like:
- Methods of environmental sampling, ecosystem assessment, assessment of spatial patterns (e.g. regarding soil and vegetation, exhaust streams, biogas plants)

- Species sensitivity, indicator and sensitive species, bioassays in assessing ecosystem status

- Methods of impact assessment

Teaching methods

Lecture and practical training

Entry requirements

None

Types of assessment

Active participation of practicals is required for the enrollment to the written exam. Proof of participation is required in the form of regular attendance, protocols, and reports. Details to be announced during lecture.

Requirements for the award of credit points

Module exam grade 4.0 or better

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

Prof. Dr. Irmgard Buder, Prof. Dr. Daniela Lud

Additional information

Recommended Readings:

Anthony G. Patt et al. (2011) Assessing vulnerability to global environmental change. Making research useful for adaptation decision making and policy. Earthscan. London.

Douglas A. Skoog, F. James Holler, Stanley R. Crouch (2006) Instrumental Analysis Principles Belmont, Thomson Brooks/Cole

John Glasson, Riki Therivel and Andrew Chadwick (2012) Introduction to environmental impact assessment. Routledge. London.

Paolo F. Ricci (2006) Environmental and health risk assessment and management principles and practices. Dordrecht. Springer.

Robert Kellner, Jean-Michel Mermet, Matthias Otto, Miguel Valcarcel, H. Michael Widmer (2004) Analytical Chemistry: A Modern Approach to Analytical Science Viley VCH GmbH & Co. KGaA Weinheim

M-IE_EA.02 Environmental Monitoring Research Project

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_EA.02	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Seminar and practical training Field campaign remote sens. and ground truthing (Soil & veget.)	4 SWS / 60 h	90 h	15 students

Learning outcomes / Competences and qualifications profile

Students have become familiar with remote sensing focusing on hyperspectral imaging including advanced analysis methods of spatial and temporal environmental data sets. They have been introduced to sensor design and the whole processing chain including ground truthing. They have gained knowledge on the planning of experimental designs for field campaigns. Students have supported current research projects and got insight into scientific practice. Special emphasis has been put on the regionalization of point measurements with support of areal proxy information gained from remote sensing. Students are able to understand the potential of remote sensing on demand with unmanned aerial vehilces and microlight aircrafts. They have learned the application and suitability of various geostatistical methods and are able to critically evaluate interpolated maps. They have a basic understanding about the influence of a selected regionalization method on further modelling of environmental systems.

Content

- Remotely piloted aerial systems (RPAS) and microlight aircrafts for remote sensing on demand
- Spatio-temporal scales of environmental processes
- Scale triplet
- Wireless sensor networks for ground truthing and regionalisation
- Dielectric measuring principles: soil moisture sensors
- Multispectral and hyperspectral imaging: instruments and methods
- Analysis of remote sensing data
- Geostatistical modelling: variogram and Kriging
- Geostatistical modelling with proxy information for sensor fusion
- Stochastic simulation
- Effect of geostatistical modelling in process simulation

Teaching methods

Seminar and practical training in lab and field

Entry requirements

None

Types of assessment

Graded examination

Requirements for the award of credit points

Module exam grade 4.0 or better, sucessful participation in practical training

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

Prof. Dr.-Ing. Rolf Becker

Additional information

Recommended readings:

Kitanidis, P. K. (2008): Introduction to geostatistics, applications in hydrogeology. Cambridge University Press

Tso, B. and Mather, P. M. (2009): Clasification methods for remotely sensed data, 2nd Ed. CRC Press.

Skøien, J. O. and Blöschl, G. (2006): Sampling Scale Effects in Random Fields and Implications for Environmental Monitoring. Environmental Monitoring and Assessment, Volume 114, Issue 1-3, pp 521-552.

Zehe, E., Becker, R., Bardossy, A., Plate, E. (2005): Uncertainty of simulated catchment scale runoff response in the presence of threshold processes: role of initial soil moisture and precipitation. Journal of Hydrology, 315 (1-4), 183 – 202.

M-IE_EA.03 Data Procurement and Data Processing in Technical and Ecological Ecosystem Management

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_EA.03	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: Data Management in Environmental Sciences 30 h / 2 semester hours per week (SWS) Practical Training: Data Procurement 15 h / 1 SWS Computer Lab Training: Data Processing 15 h / 1 SWS	60 h / 4 SWS	90 h	Lecture: open Practical / Lab trainings: 15 students

Learning outcomes / Competences and qualifications profile

Upon completion of this course, students will be able to appreciate the spirit of the European Union's Water Framework Directive and the Habitats Directive as well as the corresponding data requirements. They will have acquired the skills to obtain field data in limnic ecosystems, to assess genetic biodiversity and corresponding habitat requirements for conservation purposes and to understand the demand for data in environmental engineering. In the computer lab, the students will have gained the fundamental knowledge for using EU compliant software for the assessment of limnic ecosystems and for the creation, implementation and use of an environmental data base.

Content

1) Data Management in Environmental Sciences (lecture 2 SWS)

- EU environmental legislation: the Water Framework Directive and the Habitats Directive
- The need for quantitative methods in environmental sciences
- Concepts of data collection, analysis, exploration and pattern identification
- Field data in limnic ecosystems
- Data procurement and processing for conservation
- Data in environmental engineering
- Interpretation, visualization and communication of research outcomes

2) Data Procurement (practical training 1 SWS)

- Data collection in limnic ecosystems
- Data collection for conservation

- Excursion to control rooms of water and / or waste treatment facilities

3) Data Processing (computer lab training 1 SWS)

- Assessment of water body quality: introduction to ASTERICS

- Quantifying biodiversity-• Creating an environmental data base

- IT-based visualization of research outcomes

Teaching methods

Lecture, practical training in field excursions and computer lab training

Entry requirements

None

Types of assessment

Active participation in practical trainings is required for the enrollment to the written exam. Proof of participation is required in the form of regular attendance, protocols, and reports. Details to be announced during lecture.

Requirements for the award of credit points

Successful participation in practical trainings

Module exam grade 4.0 or better

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

Prof. Dr Kai J. Tiedemann

Additional information

Recommended readings:

Bacher, J. et al. (2010): Clusteranalyse. 3. Aufl. Oldenburg.

Bandyopadhyay, S. (2012): Unsupervised Classification. Springer.

Gray, N.F. (2010): Water Technology. Elsevier.

Heisel, D.R.; Hirsch, R. M. (2002): Statistical Methods in Water Resources. U.S. Geological Survey. Available at

http://water.usgs.gov/pubs/twri/twri4a3/ (12.11.2013)

Wildi, O. (2010): Data Analysis in Vegetation Ecology. Wiley.

Track Logistics

M-IE_LG.01 Modelling of Large External Networks

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_LG.01	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

This module covers the model based description (modelling), the analysis and optimisation of large, external logistic networks like worldwide supply-networks, traffic-nets or distribution- and procurement networks.

Having passed this module, students have gained a sound understanding of model based analysing and optimisation of logistic networks.

They are able to describe and analyse the main structures, processes as well as the management and control of large external networks.

They are also able to analyse the main objectives and to define Key Performance Indicators (KPI) to measure and evaluate the cost, service and performance of logistic networks.

Students can acquire the skills they need to optimise and stabilise logistic processes to create optimal and robust external networks.

The successful student can apply his knowledge of analysis and optimisation of logistic networks in the above mentioned areas in a professional context.

Content

- Process-chain based description and analysis of logistic networks
- Definition, measurement and controlling of logistik key-performance indicators (KPI) for external logistic networks
- Balanced scorecards and tracking&tracing systems for controlling external logistic networks
- Strategies and algorithms for solving complex external network problems like flexible resource allocations, rich vehicle routing or p-hub problems
- Strategies to measure and to improve the security and robustness of networks
- Opportunities and boundaries of using discrete event simulation methods to analyse and optimise external

logistic networks

- Architecture and applications of model based assistance systems for the design and management of external networks

Teaching methods

Lectures and practical classes

Entry requirements

None

Types of assessment

Graded examination

Requirements for the award of credit points

Passed examination

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

Prof. Dr. Bruckmann

Additional information

Recommended readings:

- Buchholz, Peter; Clausen, Uwe (Herausgeber): Große Netze der Logistik: Die Ergebnisse des Sonderforschungsbereichs 559; Springer-Verlag Berlin Heidelberg 2009; ISBN 978-3-540-71047-9
- Clausen, Uwe; ten Hompel, Michael; Klumpp, Matthias (Eds.): Efficiency and Logistics; Springer-Verlag Berlin Heidelberg 2013; ISBN 978-3-642-32837-4
- Michael Essig, Michael Hülsmann, Eva-Maria Kern, Stephan Klein-Schmeink (Eds.): Supply Chain Safety Management: Security and Robustness in Logistics; Springer-Verlag Berlin Heidelberg 2013; ISBN 978-3-642-32020-0

M-IE_LG.02 Basic Methods of Advanced Logistic Control

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_LG.02	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS)	60 h / 4 SWS	90 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

Students having attended this module are able to model, analyze, optimize and control logistics processes by using IT-based methods. The capability to implement and manage electronic control systems for logistic processes (centralized as well as decentralized) in existing logistics networks (such as supply, production and procurement networks) has been in the focus of this learning unit.

In addition to this, students have gained knowledge about information technologies, optimization methods, and control approaches, that provide the basis for fifth party logistics concepts guaranteeing a real-time fully integrated procurement, production and distribution process in industry environments.

Successful students also acquired knowledge and experiences in:

- information technology for decentralized logistics systems such as location-based and ICT-supported online systems and multi agent systems.
- on and off-line optimization methods for logistics and production processes (based on classical operations research as well as exact and heuristic problem solution methods).
- ability to model and solve a real-world logistics problem by using the concepts described above.
- developing own approaches of IT-based logistics applications by studying and using domain-specific scientific literature.
- implementing and evaluating the advanced logistics control concepts and assessing/defending the related ideas and concepts.

Content

The content will be extended according to current developments:

- Multi agent systems and distributed intelligent problem solving
- Information and communication technology in advanced logistics systems

- Application domain example: The case of German parcel delivery services

- Exact methods and heuristic algorithms for problem solving in logistics

- Technologies for geographical information systems

- ITC-based tracking and tracing methods

- Fundamental modeling of advanced logistics processes with operations management methods

- Basics of scheduling and routing algorithms

- Application domain example: An auction-based exchange of transportation services

- Big data and data mining for logistics control applications

Teaching methods

Lecture, exercises (including programming solutions), case studies.

Entry requirements

None

Types of assessment

Graded examination

Requirements for the award of credit points

Passed Examination

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

Prof. Dr. Schwind

Additional information

Recommended readings:

FR. Jacobs & RB. Chase; Operations and Supply Chain Management: The Core, McGraw-Hill, NY, 2008, ISBN: 0073525227.

F. Rothlauf, Design of Modern Heuristics: Principles and Application (Natural Computing Series), Springer, ISBN: 3642270700.

G. Cachon & C. Terwiesch; Matching Supply with Demand: An Introduction to Operations Management,

McGraw-Hill, NY, 2009, ISBN: 0073525200.

M. Christopher, Supply Chain Management, Financial Times, 4th edition, ISBN: 0273731122.

M. Fasli, Agent Technology for e-Commerce, Wiley, Chichester, Sussex, 2007, ISBN: 0470030305

Russel & Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, New Jersey, 3rd edition 2009, ISBN: 0136042597.

Stevenson; Operations Management, McGraw-Hill, NY, 2009, ISBN: 0073525251.

W. L . Whinston, Operations Research: Applications and Algorithms, Cengage Learning; 4th edition, ISBN: 0534380581.

M-IE_LG.03 Advanced Logistics Concepts for Production and Supply

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_LG.03	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Seminar 60 h / 4 semester hours per week (SWS)	60 h / 4 SWS	90 h	25 students

Learning outcomes / Competences and qualifications profile

Students having attended this module are able to identify, to describe and to present new logistic concepts for production processes and supply chain management (SCM). They know about present and future challenges and opportunities of new, for instance decentral logistic process control and advanced supply-chain strategies.

In addition to this they know about new technologies, processes and concepts, which could be used for instance to secure or to improve existing supply processes or to decentrally control and manage production processes.

Successfull students also have got knowledge and experiences in:

- present research in advanced strategies of production logistics and supply chain management

- finding/understanding and summarizing main ideas of scientific articles

- preparing a scientific presentation about current topics and themes of production logistics and SCM

- presenting topics in a broader context or own/foreign ideas to a larger audience.

- discussing and defending own/foreign ideas or concepts

Content

The professional subjects of the module depend on current topics of interest and research, which are related to production logistics and supply chain management. Present examples are:

- The internet of things and their influences on production and logistics

- Innovative production concepts of and around "Industry 4.0"

- Decentral control by software agents

- Algorithms of swarm intelligence and ant algorithms

- Supply chain disposition strategies

- Developing of robust supply chains

- Collaborative supply chain strategies

- Supply Chain controlling with network balanced scorecards

- Design and management of redistribution processes and redistribution networks

- Application of discrete event simulation to analyse and optimise large external networks
Teaching methods Tuition in seminars and presentations
Entry requirements None
Types of assessment Graded seminar paper and its presentation
Requirements for the award of credit points Passed assessment
Use of module (in other study programs) --
Weight towards final grade 5,42%
Person in charge of module Prof. Dr. Schürholz
Additional information Literature differs between courses and depends on the selected topics of the seminar.

Track Cyber-Physical Systems

M-IE_CP.01 Distributed Systems

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_CP.01	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Practical training: 15 h / 1 SWS Seminar: 15 h / 1 SWS	60 h / 4 SWS	90 h	Lecture: open Practical Training, Seminar: 25 students

Learning outcomes / Competences and qualifications profile

This module focuses on data centric aspects of distributed systems. The application focus is on domains which are dealing with spatial information. Having completed this module students know a variety of different data driven approaches for complex distributed systems. They are able to analyze application problems in this context, deduce requirements and evaluate architectural approaches. They have gained experience and in-depth knowledge in selected architectures, protocols, frameworks, and tools.

An explicitly data centric approach to distributed systems is used in this course. As such information models are the foundation of communication and integration aspects here. One core outcome of this course is thus experience in designing information models as well as in analyzing effects of design decisions of the information model to feasibility and performance of communication in distributed systems.

Students are able to apply appropriate design patterns in different contexts. They know the appropriate use of components as well as their limitations. Students are familiar with the OMG Data Distribution Service architecture and common tools such as Enterprise Architect for information modeling in depth. They are able to develop or apply their own ideas in this field in different contexts.

Content

- Technologies (theory, methodology, design patterns, capabilities, performance):
  - Enterprise architecture design patterns
  - Distributed object models
  - Near real time publish-subscribe: OMG Data Distribution Service
  - Model-based systems engineering of distributed applications: Enterprise Architecture Frameworks (e.g. TRAK)
  - System-of-Systems engineering

- Semantic sensor networks (knowledge representation, ontologies, inference, RDF, OWL, SPARQL)

- Application domains (specific protocols, frameworks, and tools):

  - The Internet of services and things

  - Smart Cities/Connected Living

  - Global Earth Observation System of Systems

  - Services computing for data centric applications with spec. focus on environmental monitoring (i.e. Open Geospatial Consortium framework for Sensor Web Enablement: Sensor Observation Service, Sensor Alert Service, Sensor Planning Service, Sensor Markup Language)

Teaching methods

Tuition in seminars, lectures and (partially self-organized) practical trainings. Students work individually and in teams.

Entry requirements

No formal requirements

Practice in object-oriented programming (e.g. Java, C++, C#), knowledge of UML, knowledge of relational databases and practice in using SQL or object-relational mappings, as well as basic knowledge of software engineering (processes, disciplines) are assumed and needed.

Types of assessment

Case study and presentation

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

Prof. Dr-Ing. Sandro Leuchter

Additional information

Recommended readings:

Andreev (2012): Internet of Things, Smart Spaces, and Next Generation Networking.

Chakravarthy & Jiang (2010): Stream Data Processing: A Quality of Service Perspective: Modeling, Scheduling,

Load Shedding, and Complex Event Processing.

Daigneau (2011): Service Design Patterns: Fundamental Design Solutions for SOAP/WSDL and RESTful Web Services.

Denecke (2012): Event-Driven Surveillance: Possibilities and Challenges.

Etzion & Niblett (2010): Event Processing in Action.

Hersent et al. (2012): The Internet of Things: Key Applications and Protocols.

Hohpe & Woolf (2003): Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions.

Hossain & Poor (2012): Smart Grid Communications and Networking.

Lankhorst (2012): Enterprise Architecture at Work: Modelling, Communication and Analysis.

Luckham (2011): Event Processing for Business: Organizing the Real-Time Enterprise.

Luckham (2002): The Power of Events: An Introduction to Complex Event Processing in Distributed Enterprise Systems.

Pfister (2011): Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud.

Ranadive (2013): Enterprise Application Integation: Enabling the Event-Driven Enterprise with CDROM.

Taylor et al. (2009): Event-Driven Architecture: How SOA Enables the Real-Time Enterprise.

Uckelmann et al. (2011). Architecting the Internet of Things.

Wang et al. (2009): Quantitative Quality of Service for Grid Computing: Applications for Heterogeneity, Large-Scale Distribution, and Dynamic Environments.

Weber (2012): Complex Event Processing - Unabridged Guide.Fowler (2002): Patterns of Enterprise Application Architecture.

Wyszkowski (2012) ESB in effective synchronization of large volume measurements data: Exploiting ESB facilities to build effective and scalable, service-oriented data distribution application.Zhou (2012): The Internet of Things in the Cloud: A Middleware Perspective.

M-IE_CP.02 Identification and Automation Technologies

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_CP.02	150 h	5 CP	1st semester	Summer semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

Having passed this module, students are able to specify and implement simple automation systems using sensor and identification technologies. Furthermore the module enables students to specify systems for the automation of process of variant application areas (like logistical processes) based on the needs and specifications of the customer's application. They can be employed as system or software engineers.

Students are able to develop or apply their own ideas in this field in different contexts.

Content

Identification technologies

- Optical identification systems
- Radio frequency identification

Automation technologies

- Sensors
- Control theory and control systmes (Logic controls, workflow, control loop, feedback)
- Proportional–integral–derivative controller

Knowledge based systems

- Expert systems
- Reasoning systems and their components (Knowledge baser, inference engines)
- Machine learning approaches

Internet of Things

Outlook: The Industry 4.0 approach

Teaching methods

Tuition in seminars, lectures and (partially self-organized) practical trainings. Students work individually and in

teams to build up parts of the systems discussed.

Entry requirements

It is strongly recommened that students attending this module have advanced knowledge in object oriented programming. Most examples presented to the students are Java or C++ based. The ability to use higher mathematical concepts is expected. Furthermore students attending this course should have an elementary knowledge of physical principles. They should be able to solve problems including electrical and magnetic fields as well as basic electrical circuits.

Types of assessment

Case study or projects and presentation

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

Prof. Dr Christian Ressel

Additional information

Recommended readings:

Finkenzeller, K.: RFID Handbook. ISBN 0470695064, Chichester, Wiley, 2010

Fraden, J.: Handbook of modern sensors. ISBN 1441964657, New York, Springer, 2010

Lutze, J.: Automatisierungstechnik – Methoden für die Überwachung und Steuerung kontinuierlicher und ereignisdiskreter Systeme, München, Oldenburg Verlag, 2012

Nof, S.Y.: Springer Handbook of Automation. ISBN 3540788301, Berlin, Springer, 2009.

Pearce, S.; Bushnell, R.D.: The Bar Code Implementation Guide: Using Bar Codes in Distribution. ISBN 0941668061,Tower Hill Pr., 2010.

M-IE_CP.03 Real-Time Embedded Systems

Code	Workload	Credits	Level of module	Frequency of offer	Duration
M-IE_CP.03	150 h	5 CP	2nd semester	Winter semester	1 semester

Courses	Teaching time	Self-study	Planned group size
Lecture: 30 h / 2 semester hours per week (SWS) Excercise: 30 h / 2 SWS	60 h / 4 SWS	90 h	Lecture: open Exercise: 25 students

Learning outcomes / Competences and qualifications profile

The term embedded system specifies a computing unit which is in general not directly visible as a computer. Typical examples for embedded systems are mobile phones. Today's mobil phones include a very powerful central processing unit (CPU), which for state-of-the-art phones might be a dual core processor with a maximum clock frequency of larger than 1 GHz. Besides this CPU the mobile phone - and thus typical embedded systems - include a lot of sensors and actuators to allow user and environmental input and give user feedback. A typical example is the camera available in nearly all today's mobile phones. This camera is the sensor which interacts with the environment (i.e. taking a picture). The actuator in this example might be the screen of the phone which displays the picture and thus gives a feedback of the last action (i.e. taking a picture) to the user.

The number of embedded systems has increased dramatically over the last decade. Nevertheless, the development of embedded systems needs some special engineering abilities which include at least basic knowledge in the processing and sensor hardware, software development and user interaction.

Having passed this module, students are able to specify and implement simple embedded systems based on the needs and specifications of the customer's application. Moreover, they know details related to the implementation of embedded systems and the associated costs as well as the differences between embedded systems and common personal computers and the close relationship of embedded systems` hardware and software. They can be employed as application, hardware or software engineers in companies working in the wide field of embedded systems (e.g. manufacturers in the automobile industry or manufacturers of medical equipment.

Students are able to develop or apply their own ideas in this field in different contexts.

Content

- Embedded systems
  - General idea
  - Typical applications
  - Specification
  - Hardware and software design
- Case study: Satellite navigation receivers

- Hardware architecture of a simple receiver embedded system

- Basic software development

- Applications

- Real-time receiver implementation

Teaching methods

Tuition in seminars, lectures and (partially self-organized) practical trainings. Students work individually and in teams to develop to develop for instance own receiver applications or receiver enhancements.

Entry requirements

It is strongly recommened that the students attending this module know basics of programming (e.g. C / C++) or hardware description languages (e.g. VHDL) or mathematical simulations tools (e.g. Matlab, Octave, Scilab)

Types of assessment

Case study and presentation

Requirements for the award of credit points

Passed assessment

Use of module (in other study programs)

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Weight towards final grade

5,42%

Person in charge of module

N.N.

Additional information

Recommended readings:

Ashenden, P., The Designer's Guide to VHDL (Morgan Kaufmann Series in Systems on Silicon), Morgan Kaufmann, 2008.

Borre, K. et al.; A Software-Defined GPS and Galileo receiver: A Single Frequency Approach (Applied and Numerical Harmonic Analysis), Boston, Birkhäuser, 2007.

Hamacher, C., et al., Computer Organization and Embedded Systems, 6th Edition, McGraw Hill, 2012.

Kaplan, E.D., Hegarty, C.J., Understanding GPS: Principles and Applications, 2nd Edition, Boston, Artech House, 2006.

Marwedel, P., Embedded System Design: Embedded Systen Foundations of Cyber-Physical Systems, 2nd Edition, Springer, 2010.

Misra, P., Enge, P., Global Positioning System: Signals, Measurements, and Performance, 2nd Edition, Licoln: Ganga-Jamuna Press, 2006.

Parkinson, B., Spilker, J.J., Global Positioning System: Theory and Application Vol. I and Vol II., Washington: American Institute of Aeronautics and Astronautics, Inc., 1996.

Press, W.H. et al., Numerical Recipies: The Art of Scientific Computing, 3rd ed., Cambridge University Press, 1992.

van Diggelen, F., A-GPS: Assisted GPS, GNSS, and SBAS (GNSS Technologiy and Applications), Boston, Artech House, 2009.