Technik
Informatik & Medien
Hochschule Ulm
University of
Applied Sciences

Module Description of the Course of

Computer Science - International Program
Bachelor of Science (B.Sc.

RHIT-Students version
University of Applied Sciences Ulm

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Table of Contents

Compulsory modules

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
OPSYS	5	English	4 (6)	Compulsory module	Summer Semester

Module Title
Operating Systems

Curriculum Assignment
Computer Science (4th semester), Computer Science – International Program (6th semester)

Module Responsibility	**Faculty**
Prof. Dr. Stefan Traub	Prof. Dr. Stefan Traub, Prof. Dr. Markus Schäffter, Prof. Dr. Frank Steiper

Classification and significance of the module relative to the goals of the course
Graduates of computer engineering are expected that they handle the tools of computer science confidently. This implies computers and their operating software.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- select Operating Systems for a specific purpose
- plan a specific purpose of an Operating System
- install and administrate Operating Systems

Methodological Competence
- develop system programs for different Operating Systems
- recognize problems when using the computer systems

Social and Self-competence
- assess Operating Systems in cooperation with the overall IT and discuss their use with all those responsible.

Contents
- Introduction
- Operating System structures
- Command interfaces
- File systems
- Address spaces
- Processes, Threads
- Synchronization and synchronization errors
- Inter-process communication
- System services
- Security

References
- Andrew S. Tanenbaum: *Modern Operating Systems*. 3rd Revised edition, Prentice Hall, 2008. ISBN: 978-0138134594.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)			
Examination method	Oral examination		**Exam prerequisite**	Laboratory work
Recommended modules	Programming 1, Programming 2, Programming 3			
Advanced modules	Information Security, Distributed & Web-based Systems			
Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
PROG3	5	English	3 (5)	Compulsory module	Winter Semester

Module Title
Programming 3

Curriculum Assignment
Computer Science (3rd semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr.-Ing. Klaus Baer	Prof. Dr. Rüdiger Lunde, Prof. Dr.-Ing. Klaus Baer, Prof. Dr.-Ing. Georg Schied, Prof. Dr.-Ing. Thorsten Hasbargen

Classification and significance of the module relative to the goals of the course
The C++ programming language is one of the most widely used and most powerful programming languages. C++ offers a set of concepts that facilitate deeper understanding of programming languages and their applications in object-oriented programming.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- create object-oriented programs using the language resources of C++
- use the C++ programming concepts
- handle templates and use the elements of the STL

Methodological Competence
- independently develop efficient, robust application programs
- assess as to which programming technique is useful for employing it in a particular context.

Social and Self-competence
- develop a software solution in a small group

Contents
- Differences between Java and C++
- C++ concepts of object-oriented programming (classes, objects, inheritance, polymorphism)
- Storage Management
- Multiple inheritance, operator overloading, Friend-concept, exception handling, I/O
- Error analysis of programs
- Template programming and Introduction to C++ - standard template library

References

- P. Prinz, U. Kirch-Prinz: C++ Lernen und professionell anwenden. Bonn: mitp-Verlag, 2002.
- J. Wolf: C++ von A bis Z. Galileo Press, 2006.
- U. Breymann: C++ - Einführung und professionelle Programmierung. Hanser, 2007.
- B. Stroustrup: The C++ Programming Language (4th ed.). Addison Wesley, 2013.
- S. Meyers: Effective C++: 55 Specific Ways to Improve Your Programs and Designs. Addison Wesley, 2005.
- S. Kuhlins, M. Schader: Die C++ Standardbibliothek. Springer Verlag, 2002.
- Lippman, S.; Lajoie, J.; Moo, B.: C++ Primer, 5th Edition. Addison-Wesley, 2012.
- Josuttis, N.: The C++ Standard Library - A Tutorial and Reference, 2nd Edition. Addison Wesley Longman, 2012.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Written examination (90 min)	**Exam prerequisite**	Laboratory work
Recommended modules	Programming 1, Programming 2		
Advanced modules	Machine Vision, Autonomous Systems, Web Engineering, Software Engineering, Software Project, Team-oriented Project, Operating Systems, Real-time Systems		

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
CONE	5	English	2 (6)	Compulsory module	Summer Semester

Module Title
Computer networks

Curriculum Assignment
Computer Science (2nd semester), Computer Science – International Program (6th semester)

Module Responsibility	**Faculty**
Prof. Dr. Frank Steiper	Prof. Dr. Frank Steiper, Prof. Dr. Stefan Traub, Prof. Dr. Markus Schäffter

Classification and significance of the module relative to the goals of the course
The concepts of wired and wireless communications networks are indispensable building blocks of today's information systems. Their implementations represent important key technologies to open up new fields of application, for example, in the field of multimedia applications, the grid computing or networked embedded systems. Due to increasing networking of almost all objects of daily life competencies imparted by the module are indispensable for qualifying the graduates in the job market.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- describe the architectural approaches of common network technologies
- explain and classify basic communication protocols
- describe the functioning of network components and their interaction

Methodological Competence
- apply the acquired knowledge to implement heterogeneous communication networks
- assess the suitability of network technologies for a given application scenario and develop their own solutions

Social and Self-competence
- handle tasks by collaborate in practice mode in small groups

Contents
- Physical principles and limitations of the data transmission
- Concepts of media access, error detection and error handling
- Local Network Technologies for Ethernet and Wi-Fi
- Concepts of routing and of reliable data transport
- Network and transport protocols using the example of the Internet Protocol Suite
- Planning, configuration and administration of computer networks
- Inter-process communication using the example of socket programming
- Introduction to Programming Distributed Applications

References

- Kurose, J.F.; Ross, K.W.: Computer Networks. 05, Addison Wesley, 04/2009. ISBN: 978-0136079675.
- Tanenbaum, A.: Computer Networks 5th edition, Prentice Hall, 2010. ISBN: 978-9332518742.
- Karl, H.; Willig, A.: Protocols and Architectures for Wireless Sensor Networks. 01, John Wiley & Sons, 08/2007. ISBN: 978-0470519233.
- Badach, A.; Hoffmann, E.: Technik der IP-Netze. 02, Hanser Fachbuch, 09/2007. ISBN: 978-3446219359.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)			
Examination method	Written examination (90 min)		**Exam prerequisite**	Laboratory work
Recommended modules	Programming 1			
Advanced modules	Ad-hoc & Sensor Networks, Information Security, Distributed & Web-based Systems			
Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	ECTS	Language	Semester	Type	Term
SEM	5	English	5	Compulsory module	Winter Semester

Module Title
Seminar

Curriculum Assignment
Computer Science (5th semester), Computer Science – International Program (5th semester)

Module Responsibility	Faculty
Prof. Dr. Markus Schäffter	Prof. Dr. Joachim Hering

Classification and significance of the module relative to the goals of the course
The seminar combines and extends the existing knowledge on the basis of practical case studies from current applications of computer engineering. It establishes a link to what has been already learned and opens up new perspectives for practical projects and electives.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- represent complex issues concisely
- report on results in one's own words
- select areas of interest for further consolidation of know-how

Methodological Competence
- replenish expertise didactically meaningfully
- use expertise to practical case studies

Social and Self-competence
- cooperate with others and actively participate in joint findings
- prepare expertise didactically and present the same successfully.

Contents
- Overview of current areas of application of computer engineering
- Presentation of concrete case studies from practical life
- Classification of case studies into the curriculum
- Independent elaboration of concrete case studies
- Presentation of the results
- Presentation of results on paper

References
Bibliographical references will be based on the current state-of-the-art technology and the list will be handed out in the course of the currently held lecture session.

Teaching and learning method	Seminar (4 SWS)		
Examination method	Semester paper, Presentation	**Exam prerequisite**	
Advanced modules			

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	ECTS	Language	Semester	Type	Term
SWEN	5	English	4 (6)	Compulsory module	Summer-semester

Module Title
Software Engineering

Curriculum Assignment
Computer Science (4th semester), Computer Science – International Program (6th semester)

Module Responsibility	Faculty
Prof. Dr.-Ing. Klaus Baer	Prof. Dr. Rüdiger Lunde, Prof. Dr.-Ing. Klaus Baer, Prof. Dr. Philipp Graf

Classification and significance of the module relative to the goals of the course
The module teaches essential knowledge and methods for the analysis of engineering problems as well as for high-quality modelling and development of complex hardware / software systems. Skills imparted during the course are core competencies of any computer engineer.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:

Professional Competence
- explain the importance of software engineering for today's software development and to identify and describe the sub-areas of software engineering
- describe agile development processes and explain the differences with regard to other software development processes
- use the linguistic capabilities of Unified Modelling language to create abstract views of a system
- apply selected design patterns

Methodological Competence
- apply agile development processes in the software development
- analyse problems and develop alternative solutions
- assess software designs in terms of quality criteria and compare various alternative solutions
- plan and implement systematically quality assurance measures in the development of software systems

Social and Self-competence
- discuss alternatives in development results (e.g. software design) with factual arguments in a team and reach decisions

Contents
- Importance of Software Engineering
- Major software development processes such as Unified Process and Agile Software Development
- Unified Modelling Language
- Requirements analysis
- Domain Modelling
- Logical Software Architecture
- Object Design and Design Patterns
- SW Quality Assurance: Inspection / Review, Software Testing

References

- I. Sommerville: Software Engineering. Boston: Pearson, 2011.
- B. Oestereich: Analyse und Design mit UML 2. München: Oldenburg Wissenschaftsverlag, 2009.
- C. Larman: Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development (3rd Edition). , 2004.
- C. Rupp, S. Queins, B. Zengler: UML 2 glasklar. Hanser, 2007.
- E. Gamma, R. Helm, R. Johnson, J. Vlissides: Design Patterns - Elements of Reuseable Object- Oriented Software. München: Addison-Wesley, 1994.
- P. Kruchten: Der Rational Unified Process. München: Addison-Wesley, 2003.
- G. Starke: Effektive Software-Architekturen. München, Wien: Hanser Verlag, 2009.
- M. Fowler, K. Scott: UML konzentriert, Die neue Standard-Objektmodellierungssprache anwenden. Bonn: Addison Wesley, 2003.
- Mike Cohn: Succeeding with Agile: Software Development Using Scrum. Amsterdam: Addison-Wesley Longman, 2009.
- M. Seidl et. al: UML @ Classroom: An Introduction to Object-Oriented Modeling. 978-3319127415: Springer, 2015.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Written examination (90 min)	**Exam prerequisite**	Laboratory work
Recommended modules	Programming 1, Programming 2, Programming 3		
Advanced modules	Software Project, Team-oriented Project		

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	ECTS	Language	Semester	Type	Term
SOPR	5	English	5	Compulsory module	Winter Semester

Module Title
Software Project

Curriculum Assignment
Computer Science (5th semester), Computer Science – International Program (5th semester)

Module Responsibility	Faculty
Prof. Dr. Rüdiger Lunde	All lecturers of the faculty

Classification and significance of the module relative to the goals of the course
The course enables students to implement a demanding project in a group with roles usually found in practice, where all acquired skills (professional, technical and personal skills) come into play. In addition, the methods of project management are applied as close to reality as possible. Therefore, the module is of great importance for the professional qualifications and employability of graduates.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- use the knowledge acquired until then with interdisciplinary approach to solve a complex problem

Methodological Competence
- analyse and manage requirements
- apply methods for project planning and project management
- select suitable modelling techniques (UML) and development tools and use the same pragmatically
- carry out a complete project from the point of vision to its deployment autonomously on the basis of an suitable process model
- apply design patterns sensibly

Social and Self-competence
- develop new topics autonomously
- cooperate in the preparation and implementation of artefacts in groups cooperate with clearly defined roles and jointly work on the results
- master challenges with specific objectives and persistence

Contents
The students acquire the above-mentioned competences and skills by independently implementing a project in a team of 6-8 persons. They can usually select from various project proposals concerning the current application areas of computer engineering according to individual inclinations. The supervising lecturer of a project team sets a content-based and formal framework that includes the project objectives, the superset of the techniques and technologies to be employed and acceptance conditions. He guides the team and takes part in the iteration discussions as a facilitator and advisor.

References

- H. W. Wieczorrek, P. Mertens: Management von IT-Projekten: Von der Planung zur Realisierung. Springer, 2009.
- H. M. Sneed: Software-Projektkalkulation. Praxiserprobte Methoden der Aufwandsschätzung für verschiedene Projektarten. Hanser, 2005.
- I. Sommerville: Software Engineering. Pearson, 2011.
- C. Larman: Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development (3rd Edition). , 2004.
- E. Gamma, R. Helm, R. Johnson, J: Design Patterns - Elements of Reuse. München: Addison-Wesley, 1994.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Seminar (1 SWS),Project thesis (3 SWS),Project thesis (4 SWS)		
Examination method	Practical work/ design and presentation	**Exam prerequisite**	
Recommended modules	Programming 1, Programming 2, Programming 3, Software Engineering		
Advanced modules	Various modules from the focal area of subjects		

Module scope	Attendance	Self-study	Internship	Total time
	120 h	180 h	0 h	300 h

Subjects with special focus

Module Abbreviation ASN	**ECTS** 5	**Language** English	**Semester** 4.	**Type** Specialization, Elective	**Term** Summer Semester

Module Title
Ad-hoc & Sensor Networks

Classification in the curriculum
Computer Science (4th semester), Computer Science – International Program (6th semester)

Module Responsibility	**Faculty**
Prof. Dr. F. Steiper	Prof. Dr. F. Steiper

Classification and significance of the module relative to the goals of the course
The module deepens the knowledge of current technologies and applications in the field of wireless networks. In that, the special technological and algorithmic challenges for the realization of such networks are identified. Competencies in the field of ad-hoc and sensor networks are an important qualification for students of computer science so as to design and implement applications in pioneering new fields such as "Smart Environments", "Internet of Things" or "Industry 4.0".

Educational Objectives and Outcomes
On completion of the module, the students will be able to:

Professional Competence
- assess requirements for software and hardware components for application scenarios
- explain the concepts and technologies for implementing ad hoc and sensor networks and evaluate their suitability for different application scenarios

Methodological Competence
- apply the acquired knowledge for designing a custom application and to implement it as part of a team project

Social and Self-competence
- cooperate in exercise mode in small groups with regard to tasks

Contents
- Typical applications and requirements in the area of ad hoc and sensor networks
- Wireless technologies (WiFi, Bluetooth, ZigBee, UMTS, LTE)
- RFID (Radio Frequency Identification) - and NFC (Near Field Communication) technologies
- Sensor types, sensor properties and sensor data analysis
- Routing protocols for ad hoc and sensor networks
- Hardware platforms and architectures for sensor networks
- Software platforms for sensor networks
- Implementation of an application based on an ad hoc or sensor network in a small team

References

- Holger, K.; Willig, A.: Protocols and Architectures for Wireless Sensor Networks, 1 Edition,John Wiley & Sons 2005, ISBN-13: 978-0470095102
- Waltenegus, D.; Poellabauer, C.: Fundamentals of Wireless Sensor Networks: Theory and Practice (Wireless Communications and Mobile Computing), 1 Edition, John Wiley & Sons 2010, ISBN-13: 978-0470997659
- Finkenzeller, K.: RFID Handbook, 3 Edition, John Wiley & Sons 2010, ISBN-13: 978-0470695067
- Levis, P.; Gay, G.: TinyOS Programming, 1 Edition, Cambridge University Press 2011, ISBN-13: 978-0521896061

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)			
Examination method	Oral examination		**Exam prerequisite**	Laboratory work
Recommended modules				
Advanced modules				
Module scope	**Attendance**	**Self-study**	**Internship**	**Total time**
	60 h	90 h	0 h	150 h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
AUTMS-WATI	5	English	5	Specialization, Elective	Winter Semester

Module Title
Autonomous Systems

Classification in the curriculum
Computer Science (5th semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr. Christian Schlegel	Prof. Dr. Christian Schlegel

Classification and significance of the module relative to the goals of the course
Autonomous mobile systems (e.g. service robots) are an application area of computer engineering with high potential for the future. In addition, computer engineers are increasingly expected to possess technical and methodological competencies in the field of sensorimotor systems and decision-making capacity of technical systems.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- describe and explain algorithms for control, path planning, navigation and architecture as well as behaviour control by external and internal sensor systems for selected robot systems
- describe the basic mechanisms of processing uncertain information in complex systems using the example of mobile robots

Methodological Competence
- apply and discuss the knowledge based on practical tasks and develop their own solutions

Social and Self-competence
- assume (partial) responsibility for a work product of a small group
- contribute their own skills in a team with specific objectives

Contents
- Introduction and basic concepts (history, autonomy, mobility, classic, reactive and hybrid architectures)
- Methodological basics (kinematics, holonomy, reactive behaviour, speed controller, position controller)
- Planned movement (algorithms, work and configuration space, path planning, motion control, mapping)
- Probabilistic approaches in robotics (motion model, sensor model, position tracking)
- Selected topics (e.g. behavioural coordination, symbolic planning, software frameworks)
- Practical exercises on mobile robots, for example, Pioneer P3DX platforms

References

- R. Siegwart, I. Nourbakhsh, D. Scaramuzza: *Introduction to Autonomous Mobile Robots*. 2nd Edition, MIT Press, 2011. ISBN: 9780262015356
- T. Bräunl: *Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems*. 2. Auflage, Springer, 2006.
- J. Hertzberg, K. Lingemann, A. Nüchter: Mobile Roboter. Springer Vieweg, 2012.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Written examination	**Academic performance**	none
Recommended modules	Programming 3, Project Hardware-oriented Programming		
Advanced modules			

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
COAR	5	English	5	Specialization, Elective	Winter Semester

Module Title
Computer Architecture

Classification in the curriculum
Computer Science (5th semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr.-Ing. Manfred Strahnen	Prof. Dr.-Ing. Manfred Strahnen

Classification and significance of the module relative to the goals of the course
As opposed to computer technology, in computer architecture, it is not the technical implementation but operating principles and design concepts of a computer are in the forefront. The acquired skills enable the listener to balance and evaluate the architecture-related advantages and disadvantages for a system to be implemented.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:

Professional Competence
- assess the concepts underlying the modern processors and their impact on an application
- evaluate the architectural features and performance data of memory hierarchies
- identify and evaluate the structural forms and communication structures of multiprocessor and multi-computer systems

Methodological Competence
- determine and apply a suitable method for testing the suitability of a computer for a dedicated application

Social and Self-competence
- compile a common documentation and evaluation of the results achieved in the team

Contents
- Architectural features of modern processors
- Memory hierarchies and memory management
- Performance evaluation of computer systems
- Multiprocessor and multi-computer architectures
- System structure and connecting structures

References

- William Stallings: *Computer Organization & Architecture*. Pearson Education, 2003. ISBN: 0-13-049307-4.
- John L. Hennessy, David A. Patterson: *Computer Architecture - A Quantitative Approach*. Elsevier Science, 2003. ISBN: 1-55860-724-2.
- Andew S. Tanenbaum: *Computerarchitektur*. Pearson Studium, 2001. ISBN: 3-8273-7016-7. Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Oral examination	**Exam prerequisite**	Laboratory work
Recommended modules	Microcomputers		
Advanced modules	Various modules from the compulsory subjects		

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
CGR	5	English	4	Specialization, Elective	Summer Semester

Module Title
Computer Graphics

Classification in the curriculum
Computer Science (4th semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr. R. Lunde	Prof. Dr. R. Lunde

Classification and significance of the module relative to the goals of the course
Computer graphics is an essential sub-field of computer science. It studies image synthesis and manipulation using specialized computer hardware and software. Today, almost every computer provides advanced graphical capabilities and most of the interactions between humans and computers are based on them. This module gives an introduction into the underlying principles and techniques. It deepens the technical understanding for users of graphical applications, communicates basic skills for using tools for modelling, visualization, and animation, and finally enables programmers to profit from standard APIs for rendering. The module focuses on synthesis of realistic two-dimensional images of three-dimensional scenes but other topics are touched as well.

Educational Objectives and Outcomes
On completion of the module, the students will be able to:

Professional Competence
- explain, how photo-realistic images can be synthesized by ray tracing.
- explain, how images are synthesized using the graphic pipeline.
- apply linear algebra to transform three dimensional models, determine angles, and compute intersection points.
- understand, how illumination changes our perception of a scene and how this can be simulated.
- describe, how material aspects and detailed surface structures can be modelled.
- describe, how convolution can be used to post process images.

Methodological Competence
- use a standard modelling tool to create a 3D-scene.
- use a standard tool to render an image from a scene using special camera and lightning settings.
- use an API to control graphic functions of a computer in the context of game programming.
- select appropriate data structures to meet given efficiency requirements in graphical applications.
- select appropriate rendering techniques to meet given requirements with respect to efficiency and image quality.

Social and Self-competence
- experience how to make practical use of mathematical theories ;-)

Contents
- Raster Images
- Ray Tracing
- Transformation Matrices & Viewing
- The Graphics Pipeline
- Signal Processing
- Surface Shading & Texture Mapping
- Data Structures for Graphics
- Light and Colour
- Using a Tool for Modelling Scenes in 3D
- Using a Graphics API for Game Programming

References
- Peter Shirley & Steve Marschner: Fundamentals of Computer Graphics, CRC Press 2009
- John F. Hughes et al.: Computer Graphics - Principles And Practice -Third Edition, Addison-Wesley 2013

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Written examination (90 min)	**Exam prerequisite**	Laboratory work
Recommended modules			
Advanced modules			

Module scope	**Attendance**	**Self-study**	**Internship**	**Total time**
	60 h	90 h	0 h	150 h

Module Abbreviation	ECTS	Language	Semester	Type	Term
CKLM	5	German	3	Compulsory module Specialization, Elective	Summer & Winter Semesters

Module Title
Controlling and Cost Accounting

Curriculum Assignment
International Energy Economics (3rd semester), Computer Science (3rd semester), Computer Science – International Program (3rd semester)

Classification in the curriculum as an elective module
Electrical Engineering and Information Technology

Module Responsibility	Faculty
Prof. Dr. Barbara Gaisbauer-Pointner	Steffen Wettengl, Michael Ribeiro

Classification and significance of the module relative to the goals of the course
In addition to power engineering and computer science, Business Administration is one of the main topics covered in the IEW course. A modern understanding of controlling and in-depth knowledge of cost accounting and performance accounting are the key building blocks for the application of economic methods in all areas of industrial and service provider companies.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence:
- understand the functioning of strategic and operational controlling processes
- understand the relationships of cost types, cost centres and cost accounting
- know the characteristics of different methods of actual and standard costing

Methodological Competence:
- Introduction and correct implementation of modern controlling processes
- systematically develop, discuss and present solutions to cost accounting issues
- use methods such as target costing, overhead value analysis, additional cost calculation and plan costs calculations leading to objectives
- understand sources of operational information from different functional departments and map them to controlling processes

Social and Self-competence:
- Moderation of introducing and implementing modern controlling processes in interaction with employees of other divisions
- Fact-based reasoning, individually and in small groups

Contents
1 Controlling
1.1 Basics of controlling
1.2 Strategic Controlling
Strategic planning, strategy development, strategic control
1.3 Operations Management
Operational planning, reporting, operational control
1.4 Controlling with performance measurement systems
2 Cost and performance accounting (CPA)
2.1 CPA Basics
CPA and Accounting, Terminology of CPA, Branches of CPA
2.2 Actual cost accounting with full costs
Cost Element Accounting, Cost Center Accounting, Cost Object Controlling (period costing)
2.3 Actual cost accounting with partial costs
Breakeven Analysis, Contribution Accounting, Short-term Pricing decisions
2.4 Standard costing
3 Cost Management
Overhead value analysis, life cycle accounting, target costing, process costing, fixed cost management

References

- Horngreen/Sundem/Burgstahler/Schatzberg: Introduction to Management Accounting. Wiesbaden: Pearson, 2014.
- Lanen/Anderson/Maher: Fundamentals of Cost Accounting. Vahlen: McGraw-Hill International Edition, 2014.
- Weber / Schäffer: Introduction to Controllling. Schäffer-Poeschel: Schäffer-Poeschel, 2008.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (4 SWS)			
Examination method	Written examination (90 min)	**Exam prerequisite**		
Recommended modules	Grundlagen der BWL und VWL			
Advanced modules				
Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
DAPRO	5	English	3 (4)	Compulsory module Specialization, Elective	Summer & Winter Semesters

Module Title
Database Programming

Curriculum Assignment
Business Information Systems (4th semester), Computer Science (3rd semester), Computer Science – International Program (5th /6th semester)

Module Responsibility	**Faculty**
Prof. Dr. Reinhold von Schwerin	Prof. Dr. Reinhold von Schwerin, Prof. Dr. Volker Herbort

Classification and significance of the module relative to the goals of the course
Trained business computer engineers must be in a position to design application systems with a database backend and implement the same. This is often done in an international environment and its aim is the automation of processes or analytical applications. The systems are developed in interdisciplinary teams according to modern project management and development methods. The course thus has a high practical relevance.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- develop PHP applications
- select tools for improving the data quality
- recognize the benefits of stored procedures

Methodological Competence
- apply and discuss the knowledge based on practical tasks and develop their own solutions

Social and Self-competence
- cooperate in the application development
- appreciate the skills of other team members
- assume their own role in small groups

Contents
The following topics are handled to enable students to acquire the above-mentioned competencies and skills:
- PHP
- Stored Procedures (e.g. Cursor concept)
- SQL extensions (e.g. Inline Views, CASE construct)
- Tools for data cleansing (ETL Tools)

References
- Harrison, Feuerstein: *MySQL stored Procedure Programming*. 1, O'Reilly, 2006.
- Theis: *Einstieg in PHP 5.3 und MySQL 5.4*. 6, Galileo Press, 2009.
Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture ,Project thesis		
Examination method	Semester paper + Project thesis	**Exam prerequisite**	
Recommended modules	Databases		
Advanced modules			

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
DAWA	5	English	4 (6)	Compulsory subject, Specialization, Elective	Summer Semester

Module Title
Data Warehousing

Classification in the curriculum
Business Information Systems (4th semester), Computer Science (4th semester), Computer Science – International Program (6th semester)

Module Responsibility	**Faculty**
Prof. Dr. Reinhold von Schwerin	Prof. Dr. Reinhold von Schwerin, Prof. Dr. Markus Goldstein

Classification and significance of the module relative to the goals of the course
A core topic of business information systems is the data warehouse-based analytics or Business Intelligence. Practical experience in this field, as well as in-depth understanding and ability to present (analytical) results according to scientific standards are highly sought after in the job market for professionals of business information systems.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- describe the ETL process
- identify and resolve problems in the integration of operational (database) systems in a data warehouse
- apply the methods of analysis (reporting, OLAP) based on tools
- apply and evaluate basic Data Mining algorithms

Methodological Competence
- apply and discuss the knowledge on the basis of practical tasks and develop their own solutions

Social and Self-competence
- assume (partial) responsibility of a work product of a small group
- contribute their own skills in a team with specific objectives

Contents
The following topics are handled to enable students to acquire the above-mentioned competencies and skills::
- Schema integration and multidimensional data models (star and snowflake schema)
- ETL Process and ETL Tools
- OLAP Operations and Reporting
- Historization
- Data Mining (Supervised and Unsupervised Learning)

References

- Kimball/Ross: The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Wiley, 3rd Edition, 2013
- Duda/Hart/Stork: Pattern Classification, Wiley, 2nd Edition, 2000
- Gabriel/Gluchowski/Pastwa: *Data Warehouse und Data Mining*, w3l Verlag, 1. Auflage, 2010

Other bibliographical references will be provided in the course of a currently held lecture.

Type of course	V+L (4 SWS)		
Teaching and learning method	Lecture cum integrated extensive case studies, preparation of scientific paper		
Examination method	oral (with 5.4 ITANWE)	**Exam prerequisite**	Semester paper
Recommended modules			
Advanced modules	6.2 PPRJ, 7.4 BAS		

Module scope	**Attendance**	**Self-study**	**Internship**	**Total time**
	60 h	90 h	0 h	150 h

Module Abbreviation	ECTS	Language	Semester	Type	Term
DIFO	5	English	4 (6)	Specialization, Elective	Summer Semester

Module Title
Digital Forensics

Classification in the curriculum
Computer Science (4th semester), Computer Science – International Program (6th semester)

Module Responsibility	Faculty
Prof. Dr. M. Schäffter	Prof. Dr. M. Schäffter

Classification and significance of the module relative to the goals of the course
Digital forensics deals with the analysis and detection of fraudulent use of information systems. The module includes the correct action at the digital crime scene as well as the technical implementation of measures to preserve forensic evidence on information systems.

Educational Objectives and Outcomes
On completion of the module, the students will be able to:

Professional Competence
- act appropriately at the digital crime scene
- plan and build independently a Forensics Field Set
- find evidence of unauthorized activities and document the same conclusively
- restore data deleted from the storage media

Methodological Competence
- secure evidence with judicial authorization
- evaluate evidential clues and synthesize simple lines of evidence

Social and Self-competence
- familiarize themselves with new topics independently and in a team and present results

Contents
- Tasks of digital forensics
- The digital crime scene
- The tools of the digital forensics
- Data analysis
- Documentation

References

- Lorenz Kuhlee, Victor Völzow: Computer Forensik Hacks. O'Reilly Verlag GmbH & Co. KG, Mai 2012, ISBN 978-3868991215.
- John R. Vacca: Computer Forensics: Computer Crime Scene Investigation. Charles River Media, Mai 2002, ISBN 978-1584500186.
- John R. Vacca, K. Rudolph: Computer Forensics: Computer Crime Scene Investigation, Jones & Bartlett Publ., Sept. 2010, ISBN 978-0763791346.
- Cory Altheide, Harlan Carvey: Digital Forensics with Open Source Tools. Syngress, ASIN B00LI84Y28.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (4 SWS) cum group practice and presentations			
Examination method	Written examination (90 min)		**Exam prerequisite**	
Recommended modules				
Advanced modules				
Module scope	**Attendance**	**Self-study**	**Internship**	**Total time**
	60 h	90 h	0 h	150 h

Module Abbreviation DIGT	**ECTS** 5	**Language** English	**Semester** 3 (5)	**Type** Specialization, Elective	**Term** Winter Semester

Module Title
Digital Systems

Curriculum Assignment
Computer Science (3rd semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr.-Ing. Herbert Frey	Prof. Dr.-Ing. Herbert Frey

Classification and significance of the module relative to the goals of the course
Computer-aided designing of digital circuits is a basic discipline of computer engineering and is gaining more and more importance considering the fact that the description of design is being increasingly shifted to higher levels of abstraction. Especially in the highly promising areas of applications such as "Embedded Systems" or "Service Robotics" such modelling methods and the ability to handle appropriate modelling tools represent important skills of a computer engineer.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- understand the principles of programmable logic circuits
- design, simulate, operate and test digital circuits with the hardware description language VHDL

Methodological Competence
- apply and discuss the knowledge based on practical tasks and develop their own solutions
- analyse problems and evaluate alternative solutions comparatively

Social and Self-competence
- discuss work results with fellow students and tutors
- compile the work results in a small team

Contents
1. Programmable logic devices (PLDs)
- Terminology, classification of digital circuits
- Basic architectures
- Complex PLDs
- FPGAs

2. Circuit design with VHDL
- Entity and architecture
- Signals, Data types
- Concurrency
- Selective and conditional signal assignment
- Structural design with components, processes, Sequential Statements
- Synthesis of Registers
- Design of state machines

References

- Hamblen, J.O., Furman, M.D.:: *Rapid Prototyping of Digital Systems.*. Springer, 2007. ISBN: 978-0387726700.
- Reichardt, J., Schwarz, B.:: *VHDL-Synthese*. Oldenbourg, 2009. ISBN: 978-3486589870.
- Sikora, A.: *Programmierbare Logikbauelemente*. Fachbuchverlag Leipzig, 2001. ISBN: 978-3446216075.

Herrmann, G., Müller, D.: *ASIC - Entwurf und Test*. Hanser Fachbuchverlag, 2004. ISBN: 978-3446217096.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Written examination (90 min)	**Exam prerequisite**	Laboratory work
Recommended modules	Technical basics of computer science, Introduction to computer science		
Advanced modules	Microcomputer Technology		

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
EMSYS	5	English	3 (5)	Specialization, Elective	Winter Semester

Module Title
Embedded Systems

Curriculum Assignment
Computer Science (3rd semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr.-Ing. Manfred Strahnen	Prof. Dr.-Ing. Manfred Strahnen

Classification and significance of the module relative to the goals of the course
Embedded systems are mostly microcontroller-based computer systems, which are part of a larger system or installation. The resulting limitations (compact structure, limitations with regard to computational power and storage capacity) require some special features in the design and programming of these systems, which are the subject of this course.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- explain the development and expansion of interface microcontroller-based embedded system
- identify different construction forms of embedded systems and assess their advantages and disadvantages
- classify the problem of hardware / software partitioning
- identify and evaluate typical software structures of embedded systems
- assess the importance of model-driven design

Methodological Competence
- design and develop simple embedded systems

Social and Self-competence
- solve a problem in a small group

Contents
- Introduction
- Embedded Systems Hardware (microcontroller-based systems, use of special processors, Systems on a Programmable Chip, communication and extension interfaces)
- Embedded Systems Software (typical architectures, Embedded Operating Systems)
- Systematic design, modelling Embedded Systems

References

- Michael Barr: *Programming Embedded Systems*. O'Reilly, 10/2006. ISBN: 978-0596009830.
- David E. Simon: *An Embedded Software Primer*. Addison Wesley, 08/1999. ISBN: 978-0201615692.
- Peter Marwedel: *Eingebettete Systeme*. Berlin: Springer, 2007. ISBN: 978-3540340485.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Written examination (90 min)	**Exam prerequisite**	Laboratory work
Recommended modules	Hardware-oriented Programming		
Advanced modules	Real-time Systems		

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
ENPS	4	German	2	Compulsory module Specialization, Elective	Summer & Winter Semesters

Module Title
Entrepreneurship

Curriculum Assignment
International Energy Economics (2nd semester), Computer Science (5th semester), Computer Science – International Program (6th semester)

Module Responsibility	**Faculty**
Prof. Peter Schäfer	Prof. Peter Schäfer

Classification and significance of the module relative to the goals of the course
Today's world of work expects skills in respect of corporate planning and implementation from self-employed as well as from executives. Especially in the energy industry characterized by technological change and dynamic competitive environment, the chances of success for new business ideas and models must be evaluated seriously and, consequently, a bankable business plan must be drawn up. The module aims to impart basic knowledge and skills necessary for the same.

Educational Objectives and Outcomes
Professional Competence
- develop from product and service ideas business models
- evaluate the profitability of a business model
- evaluate different financing and funding opportunities based on projects
- create a bankable business plan

Methodological Competence
- apply and discuss the knowledge based on practical tasks and develop their own solutions
- use the methods of idea generation, evaluation and Service Engineering

Social and Self-competence
- collaborate in the preparation of a business plan in small groups (start-up teams) with result orientation
- pitch in for a business concept as a team before a jury (compelling short presentation to potential investors)

Contents
- Business idea generation and evaluation
- Team Building and matching, legal forms of start-up establishment
- Market (competitive analysis, customer benefits, marketing, etc.)
- Business Organization and Management
- HR development
- Cost and revenue planning, profitability, liquidity
- Financial instruments and planning
- Start-up and SME promotion
- Drawing up a business plan
- Present a business plan

References

- *Osterwalder, Pigneur: Business Model Generation, 1.Aufl. 2011, Campus Verlag*. ,
- *Gassmann et al.: Geschäftsmodelle entwickeln, 1. Aufl. 2013, Carl Hanser Verlag*. ,
- *McKinsey (Hrsg.): Planen, gründen, wachsen,. 4. Auflage 2007, Redline*. ,

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (4 SWS)			
Examination method	Presentation		**Exam prerequisite**	Home assignment
Recommended modules				
Advanced modules				
Module scope	Attendance	Self-study	Internship	Total time
	0h	0h	0h	0h

Module Abbreviation	ECTS	Language	Semester	Type	Term
GM	5	German	4	Elective module	not specified

Module Title
Fundamentals of Marketing

Classification in the curriculum as an elective module
Energy Systems Technology, Electrical Engineering and Information Technology, Automotive Electronics, Automotive Engineering, with focus on Design, Computer Science, Computer Science – International Program, Industrial Electronics, International Energy Economics, Information Management in Health System, Mechanical Engineering, with focus on Automation and Power Technology, Mechatronics, Medical Engineering, Communications Engineering, Production Engineering and Organization, Business Information Systems

Module Responsibility	Faculty
Prof. Dr. Steffen Wettengl	Prof. Dr. Steffen Wettengl

Classification and significance of the module relative to the goals of the course
Marketing is not the task of a group of specialized employees in a company. On the other hand, marketing is seen as a cross-functional form of market-oriented management. With their decisions, future development engineers, sales managers and production planners significantly influence whether or not they succeed in the market. The course lectures provide basic knowledge of a market-oriented management.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence:
- differentiate the consumer, industrial and services marketing requirements
- structure analyses of the global and market-based business environment
- apply portfolio concepts of strategic planning
- differentiate strategic positioning of different companies
- demonstrate directions of growth for businesses
- implement calculations for profit optimized pricing
- estimate advantages and disadvantages of media forms for corporate communications
- differentiate market research methods

Methodological Competence:
- analyse the above and argue systematically
- interpret specific case studies
- apply and discuss knowledge based on practical tasks and develop their own solutions

Social and Self-competence:
- build and convey multi-level reasoning chains
- assess their own capabilities in the area of market-oriented management

Contents
The following topics are handled to enable students to acquire the above-mentioned competencies and skills::
- **Conceptual basics** - Marketing as an integrated customer-oriented business management - customer behaviour and market research
- **Strategic marketing** - Strategic Environmental Analysis – Market Strategies
- **Operational marketing** – Product policy – Price policy – Communications policy- Distribution policy

References
- Scharf, A.; Schubert, B.; Hehn, P.: *Marketing. Einführung in Theorie und Praxis*. 4. Aufl., Stuttgart: , 2009.
- Kreutzer, R. T.: *Praxisorientiertes Marketing. Grundlagen - Instrumente - Fallbeispiele*. 3. Aufl., Wiesbaden: , 2010.
Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (4 SWS)			
Examination method	Written examination (90 min)		**Exam prerequisite**	
Advanced modules				
Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation HDAN	**ECTS** 5	**Language** German	**Semester** 3 (5)	**Type** Compulsory module Specialization, Elective	**Term** Summer & Winter Semesters

Module Title
Health Data Analytics

Classification in the curriculum
Information Management in Health System (3rd semester), Computer Science (4th semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr. Reinhold von Schwerin	Prof. Dr. Reinhold von Schwerin

Classification and significance of the module relative to the goals of the course
Successful graduates should be able to turn the tide of data in the healthcare into valuable information. On this basis, good decisions for action can be taken. Thus, the skills acquired in this module are suited to enhance the job opportunities for the graduates.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- distinguish Data Mining from simple analytical tasks such as reporting and OLAP
- solve analytical tasks using appropriate methods and tools
- identify and troubleshoot typical problems with regard to data quality

Methodological Competence
- apply and discuss the knowledge based on practical tasks and develop their own solutions

Social and Self-competence
- cooperate in elaborations on simple tasks and prepare them jointly
- assume their role in small groups

Contents
The following topics are handled to enable students to acquire the above-mentioned competencies and skills:
- Assessment and improvement of data quality
- Tools for creating standard reports
- Fundamentals of analytical databases
- Guided data analysis using OLAP tools
- Presentation and visualization of analysis results
- Methods and tools of data mining in the strict sense (e.g. decision trees, association analysis, clustering) with examples from the healthcare system
- Data Mining as a Project or Process

References

- Gabriel/Gluchowski/Pastwa: Datawarehouse und Data Mining, 1. Auflage 2009, Verlag w3l, ISBN: 978-3-9371-3766-7.
- Runkler: Data Mining, 1. Auflage 2001, Vieweg+Teubner Verlag, ISBN: 978-3-8348-0858-5.

Other bibliographical references will be provided in the course of a currently held lecture.

Type of course		V+Ü (4 SWS)			
Teaching and learning method		Lecture cum integrated practice, preparation of case studies			
Examination method		Written examination (90 min)	**Exam prerequisite**	Laboratory work	
Prerequisite modules		none			
Advanced modules		4.5 OPCO			
Module scope	5 ECTS	Attendance	Self-study	Internship	Total time
		60 h	90 h	0 h	150 h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
INSI	5	English	3 (5)	Specialization, Elective	Winter Semester

Module Title
Information Security

Classification in the curriculum
Computer Science (3rd semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr. M. Schäffter	Prof. Dr. M. Schäffter

Classification and significance of the module relative to the goals of the course
No modern information system is 100% secure; there is always a residual risk in an enterprise. The analysis and need-based improvement of the safety level of an IT system requires a systematic approach and the knowledge to detect potential security vulnerabilities.

Educational Objectives and Outcomes
On completion of the module, the students will be able to:

Professional Competence
- systematically analyse and assess specific risks of distributed systems
- derive and justify concrete protective measures
- complete an existing safety concept and justify additional measures

Methodological Competence
- implement a safety analysis in conformity with standards
- generate and defend a coherent security policy

Social and Self-competence
- familiarize themselves with new topics independently and present the results in a team

Contents
- Safety objectives of information security
- Information Security Management System - ISMS
- Hazards and typical attack patterns
- Risk analysis and safety concept
- Current topics on the subject

References

- Securing Systems: Applied Security Architecture and Threat Models. Brook S. E. Schoenfield. Apple Academic Press Inc., Mai 2015. ISBN 978-1482233971.
- Information Risk Management: A practitioner's guide. David Sutton. Bcs Learning & Development Limited, November 2014. ISBN 978-1780172651
- ISO 27001, ISO 27002, ISO 27019, ISO 27799, www.iso.org
- Heinrich Kersten et al.: IT-Sicherheitsmanagement nach ISO 27001 und Grundschutz. Springer Vieweg; 4. Auflage, 2014, ISBN 978-3658017231.
- Sebastian Klipper: Information Security Risk Management: Risikomanagement mit ISO/IEC 27001, 27005 und 31010, Vieweg+Teubner Verlag, Februar 2012, ISBN 978-3834813602.
- ISO 27001, ISO 27002, www.iso.org

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (4 SWS) cum group practice and presentations			
Examination method	Written examination (90 min)		**Exam prerequisite**	
Recommended modules				
Advanced modules				
Module scope	**Attendance**	**Self-study**	**Internship**	**Total time**
	60 h	90 h	0 h	150 h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
MVIS	5	English	4 (6)	Specialization, Elective	Summer Semester

Module Title
Machine Vision

Classification in the curriculum
Computer Science (4th semester), Computer Science – International Program (6th semester)

Module Responsibility	**Faculty**
Prof. Dr.-Ing. Herbert Frey	Prof. Dr.-Ing. Herbert Frey

Classification and significance of the module relative to the goals of the course
Digital image processing (e.g. industrial quality control) is an important area of applications of computer engineering with high potential for the future. In addition, computer engineers are increasingly expected to possess technical and methodological skills in pattern recognition and decision-making capacity of technical systems.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- describe and explain the basic principles of digital image processing
- evaluate different methods of image processing
- design, build and operate an industrial image processing system

Methodological Competence
- apply and discuss the knowledge based on practical tasks and develop their own solutions

Social and Self-competence
- assume (partial) responsibility of a work product of a small group
- contribute their own skills in a team with specific objectives

Contents
- Introduction: terminology, history, applications, the human visual system
- Image acquisition: light, lighting, video standard, colorimetry, development of machine vision systems
- Signals and Systems: System Definition, Dirac function, convolution and correlation, Fourier transformation
- Image preprocessing: Operators, amplitude scaling, Pseudo-colour, image arithmetic, shading correction, smoothing operators, high-pass filter, Geometric transformations
- Image segmentation: thresholding, edge detection, contour tracking, field-oriented method, detection filtering, texture analysis
- Binary image: neighbourhood, erosion and dilation, opening and closing, object numbering, filling holes, separation of objects
- Measuring in images: calibration, features

References

- Bruce G. Batchelor: Machine Vision Handbook. , 2012.
- Emaduldeen AL-Dargazly Matheel: The Principles of Machine Vision. , 2013.
- Carsten Steger: Machine Vision Algorithms and Applications. , 2007.
- Russ, C. R.: The Image Processing Handbook. , 2006.
- Hornberg A.: Handbook of Machine Vision. , 2017.
- Vaclav Hlavac: Image Processing, Analysis, and Machine Vision. , 2014.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Written examination (90 min)	**Exam prerequisite**	
Recommended modules	Programming 3		
Advanced modules			

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
MEDOK	5	German	3 (5)	Specialization, Elective	Summer & Winter Semesters

Module Title
Medical Documentation

Classification in the curriculum
Data Science in Medicine, Computer Science (3rd semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr. Tibor Kesztyüs	Prof. Dr. Tibor Kesztyüs, Prof. Dr. Bernd Vögel

Classification and significance of the module relative to the goals of the course
The medical documentation is one of the core aspects within the course of study. It is essential for students to possess competencies in the areas of structures and methods of medical documentation.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence:
- explain structure and importance of the basic classifications and nomenclatures in medicine such as ICD, ICPM / OPS and SNOMED
- acquire knowledge of secondary classifications and scores such as TNM, AO classification, neutral zero division
- carry out advanced database modelling in the field of medical documentation

Methodological Competence:
- select the right tools for described documentation requirements
- shape the medical subject matter into an appropriate form of documentation
- create complex databases for relevant requirements of the medical documentation

Social and Self-competence:
- solve problems independently and / or in teams concerning medical documentation

Contents
The following topics are handled to enable students to acquire the above-mentioned competencies and skills:
- Why is medical documentation needed? Different motivations for medical documentation (insurance companies, doctors, documentation in hospitals on behalf of doctors or nursing personnel, etc.)
- Classification / Nomenclature: International Classification of Diseases (ICD) tumour classification (TNM, FAB, Ann Arbor, etc.) AO classifications of fractures SNOMED
- Legal requirements for medical documentation
- Database modelling examples of clinical documentation: laboratory data, procedures, data acquisition, patient master data, diagnostic data, treatment documentation, etc.

References

- Leiner, Gaus, Haux: *Medizinische Dokumentation*. Schattauer, 2011, ISBN: 3794524578.
- *DIMDI*.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)			
Examination method	Written examination (90 min)		**Exam prerequisite**	
Recommended modules				
Advanced modules				
Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
MEDI	5	English	5	Specialization, Elective	Summer & Winter Semesters

Module Title
Medical Information Systems

Classification in the curriculum
Data Science in Medicine, Computer Science (5th semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr. Tibor Kesztyüs	Prof. Dr. Tibor Kesztyüs, Prof. Dr. Bernd Vögel

Classification and significance of the module relative to the goals of the course
For the students, it is important to obtain a wider view of the information systems in medicine. The topics learned until then will now be seen in a larger context of understanding the technologies used.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence:
- substantiate their knowledge of information systems in different areas of healthcare system
- demonstrate their knowledge of the issues and challenges in this area (e.g. electronic health records, information retrieval from the patient's perspective)

Methodological Competence:
- analyse complex information systems in the medical environment
- analyse requirements in given situations, for example, in a medium-sized hospital, and formulate them into user requirements (specifications)
- design complex information systems in the medical environment
- correctly apply appropriate technologies (multi-tier systems, Thin Client, distributed systems, SOA)

Social and Self-competence:
- solve problems independently and / or in teams

Contents
The following topics are handled to enable students to acquire the above-mentioned competencies and skills:
- Architecture and functioning of hospital information systems
- Data traffic in the healthcare system
- Special application systems: patient management, surgical documentation systems, PACS
- Documentation systems of diagnostic findings, document management and archive systems
- Information systems for medical practices
- Electronic patient record, electronic health record
- Modelling of information systems in the health sector
- Standards for data exchange: HL7, EDIFACT, xDT, XML

References
- P. Haas: *Medizinische Informationssysteme und elektronische Krankenakten*. Springer, 2005. ISBN: 3-540-20425-3.
- *verschiedene Materialien aus Journals und Publikationen von offiziellen Stellen (z.B. FDA, DIMDI)*.
Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)			
Examination method	Written examination (90 min)		**Exam prerequisite**	
Recommended modules				
Advanced modules				
Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
MCOM	5	English	4 (6)	Specialization, Elective	Summer Semester

Module Title
Microcomputer Technology

Classification in the curriculum
Computer Science (4th semester), Computer Science – International Program (6th semester)

Module Responsibility	**Faculty**
Prof. Dr. M. Strahnen	Prof. Dr. M. Strahnen, Prof. Dr. H. Frey

Classification and significance of the module relative to the goals of the course
The microcomputer technology deals with the technical design and the basic functioning of microcomputer systems. Examples of these are the functioning and structure of typical I /O units or of microprocessors. The knowledge is primary for those working in the hardware-oriented environment.

Educational Objectives and Outcomes
On completion of the module, the students will be able to:

Professional Competence
- identify and describe the components of the programming model of a microprocessor
- identify the advantages and disadvantages of different I/O modes (polling, interrupt, DMA)
- select an operating mode suitable for the respective I/O component

Methodological Competence
- analyse data sheets for components / assemblies of microcomputer technology and implement the findings in appropriate program sequences
- program microprocessors and their peripheral components in C / Assembler language

Social and Self-competence
- solve problems in small groups

Contents
- Programming model of a microprocessor
- Case study: instruction set of current microprocessor
- Program interruption system of a microprocessor (Vectored Interrupt Controller)
- I/O subsystem (polling, interrupt, DMA operation)
- System bus, Address Management
- Storage subsystem (SRAM, DRAM, ROM, Basics: cache, virtual memory)

References

- Altera Corporation: DE1-SoC Computer System with ARM Cortex-A9.
- David A. Patterson, John L. Hennessy: Computer Organization & Design - The Hardware/Software Interface. Morgan Kaufmann, 2014.
- Klaus Wüst: Mikroprozessortechnik. Vieweg, 2011.
- Altera Corporation: Tutorial: Introduction to the Altera Nios II Soft Processor.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Written examination (90 min)	**Exam prerequisite**	Laboratory work
Recommended modules	Technical basics of computer science, Hardware-oriented Programming		
Advanced modules	Computer Architecture		

Module scope	**Attendance**	**Self-study**	**Internship**	**Total time**
	60 h	90 h	0 h	150 h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
MOAD	5	English	3 (5)	Specialization, Elective	Summer Semester

Module Title
Mobile Application Development

Classification in the curriculum
Computer Science (3rd semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr. P. Graf	Prof. Dr. P. Graf

Classification and significance of the module relative to the goals of the course
As computers are experiencing a tremendous advancement in networking and energy efficiency, *Mobile Computing*, that is the use of a computer as a mobile device, is an important topic of practical computer science. Mobile applications are typically deeply embedded in the everyday user and environment. However, they are also subject to some technical constraints such as the required energy efficiency, less computing power, scarce resources and insecure communication channels. Computer engineers who design applications for mobile systems, therefore, require in-depth knowledge of the specific features and specific engineering and programming techniques.

Educational Objectives and Outcomes
On completion of the module, the students will be able to:

Professional Competence
- describe the characteristics and constraints of mobile applications
- implement applications on at least one current platform (e.g. Android)
- select and use sensor, localization and networking technologies
- design and implement graphical user interfaces
- integrate mobile applications in server-based environments
- understand and apply techniques for energy efficiency

Methodological Competence
- conceptualize, design and implement own mobile applications in various application fields

Social and Self-competence
- develop work products independently and in small groups
- develop solutions for design tasks independently

Contents
- Mobile devices: platforms and Operating Systems, features of mobile applications
- Engineering mobile applications: methods, development and testing tools
- User interfaces and multimedia
- Networking in mobile applications (Internet, PAN)
- Use of sensors (camera / audio, Location / Accelerometer, etc.), localization and location-based services
- Energy Management
- Integration with Web applications (Web APIs)

References

- J. Roth: *Mobile Computing: Grundlagen, Technik, Konzepte*. dpunkt.verlag, 2005. ISBN: 978-3898643665
- T. Bollmann, K. Zeppenfeld: *Mobile Computing*. W3L, 2010. ISBN: 978-3868340051
- Z. Mednieks: *Programming Android*. O'Reilly, 2012. ISBN: 978-1449316648

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Written examination (90 min)	**Exam prerequisite**	Laboratory work
Recommended modules	Programming 2, Algorithms & Data structures		
Advanced modules			

Module scope	**Attendance**	**Self-study**	**Internship**	**Total time**
	60 h	90 h	0 h	150 h

Module Abbreviation OR	**ECTS** 5	**Language** German	**Semester** 5	**Type** Compulsory module, Specialization, Elective	**Term** Summer & Winter Semesters
Module Title Operations Research					
Curriculum Assignment Business Information Systems, Computer Science (5th semester), Computer Science – International Program (5th semester)					
Module Responsibility Prof. Dr. Günter Gramlich, Prof. Dr. Harald Groß		**Faculty** Prof. Dr. Günter Gramlich, Prof. Dr. Harald Groß			
Classification and significance of the module relative to the goals of the course Issues, which can be handled using methods of Operations Research, occur in IT and business applications. Confidently mastering these basic approaches of thinking and methods is a prerequisite for any activity in the field of business information systems.					
Educational Objectives and Outcomes On completing the module successfully, the students will be able to: **Professional Competence** • possess adequate knowledge in the field of optimization • possess adequate knowledge in the field of graphs • possess adequate knowledge of stochastic processes • makes models mathematically, use mathematical representations **Methodological Competence** • analyse and discuss scientific bibliographies **Social and Self-competence** • mutually support in solving problems and in the context of self-learning units • assess their own skills in analysing problems and in devising solutions					
Contents **The following topics are handled to enable students to acquire the above-mentioned competencies and skills:** • Linear optimization. Models. Applications. • Integer, dynamic and stochastic optimization. • Non-linear optimization. • Optimal controls. • Graphs. Shortest paths and flow optimization. • Stochastic Processes. Simulation. MATLAB.					
References • Domschke, Drexl: *Einführung in Operations Research*. Springer, Other bibliographical references will be provided in the course of a currently held lecture.					
Teaching and learning method	Lecture , Tutorial				
Examination method	Written examination (90 min)		**Exam prerequisite**		
Recommended modules					
Advanced modules					
Module scope	Attendance	Self-study	Internship	Total time	
	60h	90h	0h	150h	

Module Abbreviation PENTE	**ECTS** 5	**Language** English	**Semester** 5	**Type** Specialization, Elective	**Term** Winter Semester

Module Title
Pentesting

Classification in the curriculum
Computer Science (5th semester), Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr. M. Schäffter	Prof. Dr. M. Schäffter

Classification and significance of the module relative to the goals of the course
In order to adequately protect information systems from unauthorized access, knowledge in the field of offensive information security is indispensable. The module provides an insight into the mindset of hackers and crackers, and provides commercial work tools in the area of offensive security and describes how incidents compromising security can be dealt with.

Educational Objectives and Outcomes
On completion of the module, the students will be able to:

Professional Competence
- select typical types of attack on concrete information systems
- demonstrate practically vulnerabilities under laboratory conditions

Methodological Competence
- analyse the results of a penetration test and justify specific measures of protection
- prepare a management report

Social and Self-competence
- familiarize independently and in team with new topics and present the results

Contents
- Typical security vulnerabilities
- Types of attack, attack vectors, Top 10 list of common attacks
- The most important tools of a penetration tester
- Practical implementation of attacks
- Selected topics on the subject

References

- Michael Messner: Metasploit: Das Handbuch zum Penetration-Testing-Framework. dpunkt.verlag GmbH, 2011.
- Peter Kim: The Hacker Playbook: Practical Guide to Penetration Testing. Independent Publishing Platform, 1700.
- Daniel Dieterle: Basic Security Testing with Kali Linux. CreateSpace Independent Publishing Platform, 1700.
- Robert W. Beggs: Mastering Kali Linux for Advanced Penetration Testing. Packt Publishing, 2014.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (4 SWS) cum group practice and presentations		
Examination method	Written examination (90 min)	**Exam prerequisite**	
Recommended modules			
Advanced modules			

Module scope	**Attendance**	**Self-study**	**Internship**	**Total time**
	60 h	90 h	0 h	150 h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
RSYS	5	English	4 (6)	Specialization, Elective	Summer Semester

Module Title
Real-time Systems

Curriculum Assignment
Computer Science (4th semester), Computer Science – International Program (6th semester)

Module Responsibility	**Faculty**
Prof. Dr. Christian Schlegel	Prof. Dr. Christian Schlegel

Classification and significance of the module relative to the goals of the course
Real-time software is a core component of many areas of applications of computer engineering, particularly those with a high potential for the future. Technical and methodological expertise in the field of real-time systems is mandatory and strongly in demand in the job market for computer engineers.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- select the real-time scheduling procedures adequate for the problems
- implement principles of real-time programming in typical programming languages
- apply methods for the identification of time-related correctness of systems of moderate complexity for the system design

Methodological Competence
- apply and discuss the knowledge based on practical tasks and develop their own solutions

Social and Self-competence
- assume (partial) responsibility for a work product of a small group
- contribute their own skills in a team with specific objectives

Contents
- Features and characteristics of real-time systems
- Real-time Operating Systems (e.g. real-time Linux) and real-time programming languages (e.g. RT Java)
- Real-time programming and modelling (Design Pattern for real-time systems)
- Scheduling in Real-Time Systems (Rate Monotonic Scheduling, Rate Monotonic Analysis)
- Synchronization (priority inversion, Priority Inheritance, Priority Ceiling Protocol, calculation of blockade times)
- Hybrid Task Sets
- Applications (alternatively, e.g. real-time communications, control engineering, signal processing, multimedia, robotics, automation)

References

- Jane W. S. Liu: *Real-Time Systems*. Prentice Hall, 2000. ISBN: 0-13-099651-3.
- Giorgio C. Buttazzo: *Hard Real-Time Computing Systems - Predictable Scheduling Algorithms and Applications*. Second Edition, Springer, 2005. ISBN: 0-387-23137-4
- Qing Li: *Real-Time Concepts for Embedded Systems*. CMP Books, 2003. ISBN: 1-57820-124-1.
- Jürgen Quade, Michael Mächtel: *Moderne Realzeitsysteme kompakt*, dpunkt Verlag, 2012
- Peter C. Dibble: *Real-Time JAVA Platform Programming*. Prentice Hall, 2002. ISBN: 0-13-028261-8.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)		
Examination method	Oral examination	**Academic performance**	Laboratory work
Recommended modules	Programming 3		
Advanced modules			

Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h

Module Abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Term**
WEBE	5	English	5	Specialization, Elective	not specified

Module Title
Web Engineering

Classification in the curriculum
Computer Science International Bachelor, Data Science in Medicine, Computer Science, Computer Science – International Program (5th semester)

Module Responsibility	**Faculty**
Prof. Dr. Stefan Traub	Prof. Dr. Stefan Traub, Andreas Buchenscheit

Classification and significance of the module relative to the goals of the course
Increasingly, many systems are equipped with a web interface and extensive expertise is necessary in the development of web-based applications. Therefore computer engineers must possess the appropriate skills in this subject area.

Educational Objectives and Outcomes
On completing the module successfully, the students will be able to:
Professional Competence
- identify the basics of web logs and standards
- describe the specific features of web-based applications compared to normal applications
- apply the different programming interfaces

Methodological Competence
- analyse the special requirements of web applications and implement them in a project
- plan and apply the right web frameworks

Social and Self-competence
- discuss and plan with the various project participants about the optimal use of a web project

Contents
- Introduction
- Basics of HTML and XML
- XSLT Transformations
- XML Scheme
- Protocols in HTTP
- CGI Scripts, Servlets
- JSP, PHP, ASP
- ASP.NET, JSF
- Browser code
- Security aspects

References

- Castelyn, S.; et.al.: Engineering Web Applications. Springer, 2012. ISBN: 9783642269196.
- H. Wöhr: *Web-Technologien*. Dpunkt Verlag, 2004. ISBN: 978-3898642477.
- R. Dumke, M. Lother, C. Wille, F. Zbrog: *Web Engineering*. Pearson Studium, 2003. ISBN: 978-3827370808.

Other bibliographical references will be provided in the course of a currently held lecture.

Teaching and learning method	Lecture (3 SWS), Laboratory work (1 SWS)			
Examination method	Written examination (90 min)		**Exam prerequisite**	
Recommended modules	Programming 3, Programming 2			
Advanced modules				
Module scope	Attendance	Self-study	Internship	Total time
	60h	90h	0h	150h