Informatik
Schnittstelle Zukunft

JOHANNES KEPLER
UNIVERSITÄT LINZ | JKU

Curriculum Guide for the Master Studies

COMPUTER SCIENCE (921)
NETWORKS AND SECURITY (911)
PERVASIVE COMPUTING (938)
SOFTWARE ENGINEERING (937)

at the Johannes Kepler University Linz

valid from winter semester 2012/13

Contents

§1 Qualification Profile

In the area of computer science the Johannes Kepler University Linz offers four master studies: *Computer Science*, *Networks and Security*, *Pervasive Computing* and *Software Engineering*. These studies have the same regular structure but differ in their focus by providing special major and minor subjects. Therefore, the qualification profile consists of a general part, which is identical for all four master studies, and a specific part, which describes the qualifications resulting from the major subject of each master study.

General profile

Computer Science deals with concepts, methods and tools for systematic and automated information processing. It has its roots in mathematics and electrical engineering but has become a scientific discipline in its own right during the last decades. Today it permeates business and technology as well as almost every aspect of our daily life.

The master studies of this curriculum aim at problem solving skills. Based on the bachelor study of Computer Science in Linz, in which the foundations of the discipline are laid, the master studies offer a research-oriented specialisation in selected and current fields of computer science. Graduates are experts in their area. They have a profound IT background and are able to solve complex IT problems using scientific methods.

Computer Science in Linz is an application-oriented engineering discipline, in which theory and practice are equally important. In addition to technical contents the educational goals of the curriculum are: proficiency in scientific methods, creativity, multidisciplinarity, team spirit, social skills, leadership and readiness for life-long learning.

The master studies of this curriculum emphasize internationality. This is achieved by many courses and project work being done in English (the master study Pervasive Computing is completely in English), as well as by promoting exchange students and English-speaking guest lecturers.

Master study Computer Science

The master study Computer Science offers a broad specialisation in major fields of computer science. In analogy to the bachelor study of Computer Science these areas are: formal methods of computer science, hardware design, software development, IT systems as well as application-oriented areas such as knowledge-based systems and parallel computing. The goal of this master study is to deepen and broaden the general computer science background of the students. This gives graduates particularly good chances on the job market.

Master study Pervasive Computing

The design of miniaturised systems, which are invisibly integrated in their environment and are connected in a spontaneous and wireless way require special computer science methods. The master study Pervasive Computing therefore deals with a combination of technologies (e.g., sensors, actuators, wireless communication, miniaturized memories and processors), paradigms (e.g., context-aware and adaptive systems, autonomous and self-organizing systems, organic and bio-inspired systems) and methods (e.g., for interaction, coordination, computational perception, reasoning and learning, artificial intelligence, virtual reality, semantic interoperability, system reliability, security and user friendliness). The educational goals are decision and evaluation skills as well as skills for designing and developing pervasive computing systems such as "information appliances", "wearable systems" or "ambient intelligence systems".

Master study Networks and Security

The protection of IT systems against internal or external attacks is a strategically important task in the planning and operation of such systems. Industry and economy need more security experts with a profound knowledge in computer science and networks. Important aspects in the application of security measures are the systematic configuration and monitoring of IT infrastructures. Graduates of this master study have broad job opportunities ranging from the design and implementation of security strategies, the administration of systems, networks and security policies, the application of cryptographic techniques as well as legal consulting in security areas. The profound technical education of this study also allows a career in research and development.

Master study Software Engineering

Economy and Industry have a great demand for well-trained software engineers who are able to manage large software projects, to apply cutting-edge software development techniques as well as to understand and to direct all phases of the software development process. The master study Software Engineering aims at producing such experts. It covers formal foundations as well as methods and tools for all project phases, such as requirements engineering, system modelling, architectural design, implementation, testing, deployment and maintenance of software systems. The focus is on scientific methods and their application to build high-quality software in an economic way. Most computer science graduates go into software development, therefore this master study offers an ideal preparation for their professional career.

§2 Overview

(1) Structure of the Curriculum

The master studies of this curriculum have the same modular and regular structure. Each of them takes 4 semesters and comprises 120 ECTS credits. Table 1 shows the structure of the master studies, their portion of compulsory and optional courses as well as their required amounts of ECTS credits and units per week (1 unit is 45 minutes).

Table 1: *Structure of the master studies in the area of computer science*

	ECTS	units
Major subject	37.5	25
Minor subject	18.0	12
Computer Science electives	9.0	6
Free electives	12.0	8
Master thesis seminars	9.0	6
Master thesis	30.0	
Master examination	4.5	
Total	120.0	57

The *major subject* is the core of each master study and consists of those courses that are characteristic for this study.

The *minor subject* gives students a second area of competence. It consists of courses that must be selected from the major subject of a particular other master study of this curriculum.

The courses of the *computer science electives* must be selected from a catalogue that is common to all master studies of this curriculum. They give students a chance to extend their computer science knowledge beyond the major and minor subjects. The *free elective courses* can be chosen from all studies at any university. They give students the opportunity to educate their personality and to acquire skills beyond computer science.

The *master thesis seminars* serve to prepare and guide the composition of the master thesis. These seminars are compulsory courses.

The *master thesis* is the final project in every master study. It is a scientific work, in which the knowledge and skills obtained during the study should be applied.

(2) Admission

Admission to any of the master studies of this curriculum requires a bachelor degree in Computer Science from the Johannes Kepler University Linz or an equivalent degree from some other university.

In addition to that, the following rules apply:

1. Graduates of the bachelor study "Wirtschaftsinformatik" at the Johannes Kepler University Linz are admitted to the master study Software Engineering.
2. Graduates of the bachelor studies "Mechatronik" and "Informationselektronik" at the Johannes Kepler University Linz are admitted to the master study Pervasive Computing.
3. Graduates of the bachelor studies "Mechatronik", "Informationselektronik", "Technische Mathematik" and "Wirtschaftsinformatik" at the Johannes Kepler University Linz as well as graduates of Computer-Science-related studies at other universities are admitted to any of the master studies of this curriculum. However, in this case the minor subject must be replaced by bridge courses.

The equivalence as well as the Computer-Science-relatedness of foreign degrees is decided by the vice rector of studies at the Johannes Kepler University Linz.

(3) Combination of Master Studies

Students may obtain degrees in multiple master studies of this curriculum, but the major subject of a completed master study must not be selected as the minor subject of another master study. Courses of the computer science electives (§6), which have been selected in one master study must not be re-selected for another master study.

§3 General Regulations and Terms

(1) Course Types

Lectures ("Vorlesungen", VO) are courses that introduce students to certain areas and methods of their study.

Exercises ("Übungen", UE) are courses which reinforce topics from the corresponding lecture by carrying out practical and concrete exercises. Marking is based on continuous assessment of the students' work.

Combined courses ("Kombinierte Veranstaltungen", KV) are courses consisting of lectures and exercises, which are intertwined according to didactic aspects.

Practicals (PR) have similar goals as exercises and are continuously assessed. In contrast to exercises they can be independent from lectures and usually promote project-oriented work in a team.

Seminars (SE) are courses involving collaboration between students. Marking of seminars is based on continuous assessment of the students' work, on their preparation of talks (including seminar papers) and on their participation in discussions.

Master thesis seminars (SE) are seminars which prepare students for writing their master thesis.

The courses of this curriculum can be taught in English and can make use of e-learning techniques.

(2) ECTS Credits

According to the *European Credit Transfer System* (ECTS) the effort of the studies has to be specified in ECTS credits, where 1 ECTS credit corresponds to 25 full hours of work (§51(2)26 UG). This includes the attendance time in courses as well as the time for preparation, exercises and practical work at home. The total effort of every master study is 120 ECTS credits (approximately 30 ECTS credits per semester).

In this curriculum 1 unit generally corresponds to 1.5 ECTS credits with the exception of the two master thesis seminars, which have 6 ECTS credits each. The master thesis is worth 30 ECTS credits and the master examination 4.5 ECTS credits.

Lecturers have to adjust the effort of every course in such a way that it matches the ECTS credits of the course. Table 2 shows the expected work load (in full hours) for different amounts of units and ECTS credits.

Table 2: *Correspondence between units, ECTS credits and full hours*

units	ECTS	full hours
1	1.5	37.5
2	3.0	75.0
3	4.5	112.5
4	6.0	150.0
5	7.5	187.5

(3) Number of Students per Course and Course Admission

In the courses of the major subjects 35 students are admitted to exercises and to the exercise part of combined courses, 15 students are admitted to practicals, and 20 students to seminars. The vice rector of studies and the curriculum committee have to make sure that enough parallel courses are offered. Electives do not have parallel courses.

In courses with a limit on the number of students the admission is done according to the direct assignment policy (*Direktzuteilungsverfahren*).

§4 Major Subject

In the major subject of every master study students have to take the compulsory courses described in Table 3 corresponding to 37.5 ECTS credits (25 units).

Table 3: *Compulsory courses of every master study (WS = winter semester, SS = summer semester)*

Compulsory courses	VO	UE	KV	PR	SE	ECTS	WS/SS
Master study Computer Science							
Model Checking	2	1	.	.	.	4.5	WS
Software Architectures	.	.	3	.	.	4.5	WS
Parallel Computing	.	.	3	.	.	4.5	WS
Hardware Design	2	1	.	.	.	4.5	SS
Cooperative Systems	2	1	.	.	.	4.5	SS
Knowledge-centered Systems	.	.	3	.	.	4.5	SS
Practical in Computer Science	.	.	.	5	.	7.5	SS
Seminar in Computer Science: ...	.	.	.	.	2	3.0	WS
Master Study Networks and Security							
Introduction to IT Security	2	.	.	.	.	3.0	WS
Information Security Management	1	.	.	.	.	1.5	WS
IT Law and Computer Forensics	2	.	.	.	.	3.0	WS
System Administration	.	.	2	.	.	3.0	WS
Parallel Computing	.	.	3	.	.	4.5	WS
Network Management	.	.	3	.	.	4.5	SS
Cryptography	.	.	3	.	.	4.5	SS
Security Models in Information Systems	.	.	2	.	.	3.0	SS
Practical in Networks and Security	.	.	.	5	.	7.5	SS
Seminar in Networks and Security: ...	.	.	.	.	2	3.0	WS
Master study Pervasive Computing							
Pervasive Computing Infrastructure	2	1	.	.	.	4.5	WS
Pervasive Computing Systems Development	2	1	.	.	.	4.5	WS
Unconventional User Interaction	2	1	.	.	.	4.5	WS
Machine Learning and Pattern Classification	.	.	3	.	.	4.5	SS
Cooperative Systems	2	1	.	.	.	4.5	SS
Mixed Reality Systems	.	.	3	.	.	4.5	SS
Practical in Pervasive Computing	.	.	.	5	.	7.5	SS
Seminar in Pervasive Computing: ...	.	.	.	.	2	3.0	WS
Master study Software Engineering							
Formal Methods in Software Development	.	.	3	.	.	4.5	WS
Requirements Engineering	.	.	2	.	.	3.0	WS
Software Architectures	.	.	3	.	.	4.5	WS
Principles of Programming Languages	.	.	3	.	.	4.5	WS
Testing of Software Systems	.	.	2	.	.	3.0	SS
Knowledge-centered Systems	.	.	3	.	.	4.5	SS
Software Processes and Tools	.	.	2	.	.	3.0	SS
Practical in Software Engineering	.	.	.	5	.	7.5	SS
Seminar in Software Engineering: ...	.	.	.	.	2	3.0	WS

Contents of the Major Subjects

Master study Computer Science: Profound specialisation in major topics of computer science, including formal foundations (software verification and model checking), hardware design (development of digital hardware), software development (object-oriented and component-based architectures, layered and distributed architectures), distributed and cooperating IT systems (middleware technologies, coordination models, protocols, techniques and applications of wireless communication) as well as a selection of modern IT technologies and applications (parallel computing, information systems, knowledge-based systems).

Master study Pervasive Computing: A system-oriented part teaches the basic infrastructure for pervasive computing (identification, localisation, context-awareness, activity recognition, spontaneous interaction, mobile ad-hoc networks, sensor/actuator systems) as well as fundamental paradigms and implementation techniques in combination with artificial intelligence methods. The course on cooperative systems teaches methods for interaction, communication and coordination. The courses on unconventional user interaction and mixed reality systems convey techniques of human-machine interaction (embedded interaction, tangible user interfaces, augmented and virtual reality) as well as forms of explicit and implicit interactions between physical reality and digital computer systems.

Master study Networks and Security: Mathematical and technical topics (e.g. cryptography), architecture and components of secure network infrastructures (e.g., servers, routers, switches, firewalls, intrusion detection systems) as well as techniques for planning, configuration and operation of such systems. Further topics are the detection and defence of malware, vulnerability tests as well as redundancy in the organisation of network services. Finally, the courses of this study also deal with legal aspects of networks as well as with computer forensics and security-related topics in databases.

Master study Software Engineering: Application of scientific methods for the specification, development and maintenance of large software systems. In addition to formal aspects (specification, analysis and verification of software) this master study deals with requirements engineering techniques, with architectural design (object-oriented and component-based architectures, layered and distributed architectures), with software testing as well as with the application of information systems and knowledge-based techniques in software engineering. Further topics are programming paradigms (imperative, functional, declarative), software process models (waterfall model, spiral model, prototyping, agile methods) as well as software engineering tools.

Practical and Seminar

The major subject of every master study contains a practical with 7.5 ECTS credits (5 units) and a seminar with 3 ECTS credits (2 units). The practical serves as a consolidation and a practical application of the knowledge conveyed in the other courses of the major subject. It should be organised as a team work. The seminar should rehearse scientific working principles. Its name is "Seminar in *M*" (where *M* is the name of the master study) with an appropriate subtitle denoting the topic of the seminar. The seminar is part of the seminar catalogue in Table 6.

§5 Minor Subject

The minor subject gives students a second area of competence (beside the major subject) offering a specialisation in one of the main areas of computer science.

In the minor subject students have to select courses from the major subject of a specific other master study of this curriculum with a total of 18 ECTS credits (12 units). The selected courses must not include the practical. If a major subject does not contain enough choices (e.g., because some courses of this subject are also part of the own major subject or have already been selected as a free elective in the bachelor study) students have to take courses of the kind "Special Topics in *M*" (Table 5) or "Seminar in *M*" (Table 6), where *M* denotes the master study of the selected minor subject.

§6 Computer Science Electives

The Computer Science electives allow students to deepen and broaden their knowledge according to their individual preferences. Courses that were already taken in the bachelor study cannot be re-selected in the electives of the master studies. Students have to select courses with a total of 9 ECTS credits (6 units) from Table 4, 5 or 6.

(1) General Electives

These courses (see Table 4) have a fixed name and a fixed amount of ECTS credits and units.

Table 4: *General elective courses*

Courses	VO	UE	KV	PR	SE	ECTS	Institute
Accessible System Design	.	.	2	.	.	3.0	IIS
Advanced Model Checking	2	.	.	.	.	3.0	FMV
Agile Methods in Software Development	.	.	2	.	.	3.0	SEA
Applied Knowledge Processing	2	.	.	.	.	3.0	FAW
Biometric Identification	2	.	.	.	.	3.0	CP
Capacity Planning	.	.	2	.	.	3.0	TK
Compiler Construction 2	.	.	2	.	.	3.0	SSW
Computer Vision	2	.	.	.	.	3.0	CG
Conceptual Data Modelling	.	.	2	.	.	3.0	FAW
Data Modelling and Application Development	.	.	2	.	.	3.0	FAW
Debugging	2	.	.	.	.	3.0	FMV
Digital Image Processing	.	.	2	.	.	3.0	CP
Digital Speech Processing	.	.	2	.	.	3.0	CP
E-Government	.	.	2	.	.	3.0	IWV
Embedded Systems	.	.	2	.	.	3.0	PC
Engineering of Software-intensive Systems	.	.	2	.	.	3.0	SEA
Gender and Business Computing	2	.	.	.	.	3.0	FGF
Gender Studies Introduction for TNF	.	.	2	.	.	3.0	FGF
Hardware-oriented Work on PCs	.	.	.	2	.	3.0	FIM
Human-Computer Interaction	2	.	.	.	.	3.0	PC
HW Development w. Programmable Logic Devices	.	.	2	.	.	3.0	RIIC
Information Displays	2	.	.	.	.	3.0	CG
Integrated Circuits Design	.	.	.	2	.	3.0	RIIC
Interactive Rendering and Visualization	2	.	.	.	.	3.0	CG
Logic Programming	.	.	2	.	.	3.0	RISC
Mobile Computing	.	.	2	.	.	3.0	TK
Model Engineering	2	1	.	.	.	4.5	BIO
Modelling Internet Applications	.	.	2	.	.	3.0	TK
Product Line Engineering	.	.	2	.	.	3.0	SEA
Real-Time Systems	.	.	2	.	.	3.0	PC
Rewriting in Logic and Computer Science	2	.	.	.	.	3.0	RISC
Secure Code	.	.	1	.	.	1.5	FIM
Security in Application Protocols	.	.	1	.	.	1.5	FIM
Sensor Networks	.	.	2	.	.	3.0	PC
Statistics 2	.	.	2	.	.	3.0	CA
System Software	.	.	2	.	.	3.0	SSW
Theoretical Concepts of Machine Learning	2	1	.	.	.	4.5	BIO
VLSI Design	.	.	2	.	.	3.0	RIIC
Web Engineering	.	.	2	.	.	3.0	FAW
Web Information Retrieval	.	.	2	.	.	3.0	FAW
Wireless LANs	.	.	1	.	.	1.5	FIM

(2) Special Topics

Special topics courses allow the institutes to take up current trends in their fields and to use the teaching offer of incoming lecturers. The name of such courses consists of a main title as shown in Table 5 and a subtitle denoting the actual contents of the course. The type of such courses (VO, UE, KV, PR) as well as their length in units can be freely chosen by the lecturers. The ECTS credits are calculated as units × 1.5.

Table 5: *Special topics*

Courses	VO	UE	KV	PR	ECTS
Special Topics in Computer Science: ...	*	*	*	*	* × 1.5
Special Topics in Networks and Security: ...	*	*	*	*	* × 1.5
Special Topics in Pervasive Computing: ...	*	*	*	*	* × 1.5
Special Topics in Software Engineering: ...	*	*	*	*	* × 1.5

(3) Seminars

The name of a seminar consists of a main title as shown in Table 6 and a subtitle denoting the topic of the seminar.

Table 6: *Seminars*

Courses	SE	ECTS
Seminar in Computer Science: ...	2	3.0
Seminar in Networks and Security: ...	2	3.0
Seminar in Pervasive Computing: ...	2	3.0
Seminar in Software Engineering: ...	2	3.0

§7 Free Electives

Students have to take free elective courses with a total of 12 ECTS credits (8 units). These courses can be selected from any study at any university and can be taken throughout the whole master study. Their goal is to provide students with additional skills beyond the area of computer science.

In view of the qualification profile the following areas are especially recommended as free elective courses:

- Courses in the area of gender studies (e.g. from the "Institut für Frauen- und Geschlechterforschung" at the Johannes Kepler University Linz).
- Courses about social skills (e.g. from the "Interdisziplinäres Zentrum für Soziale Kompetenz" at the Johannes Kepler University).
- Courses in the area of economy and law (e.g. from the Faculty of Social Sciences and Economy and the Faculty of Law at the Johannes Kepler University Linz).
- Foreign language courses (e.g. from the department "Fachsprachen" of the "Institut für Internationales Management" at the Johannes Kepler University Linz).

§8 Master Thesis

(1) Goals and Effort

As a final project master students have to write a master thesis. The topic of the master thesis must be chosen from the major subject of their master study. The goal of the master thesis is to demonstrate that students are able to solve a non-trivial problem in the area of their master study using scientific methods and latest technology. Institutes have to adjust the effort of a master thesis so that it corresponds to 30 ECTS credits.

(2) Master Thesis Seminars

As a preparation and a guidance for the master thesis students have to take the two master seminars from Table 9.

Table 9: *Master thesis seminars*

Courses	Type	units	ECTS
Master Thesis Seminar WS	SE	3	4.5
Master Thesis Seminar SS	SE	3	4.5

§9 Examinations

A master study of this curriculum is completed if all examinations for the courses described in §4 to §8, the master thesis and the master examination have been passed successfully.

(1) Course Examinations

The examination mode (written or oral) for lectures (VO) and for the exercise part of combined courses (KV) can be defined by the lecturer. Exercises (UE) and practicals (PR) are assessed by continuous and final evaluations. Seminars (SE) are assessed on the basis of the seminar paper, the seminar presentation and the cooperation of the student in the seminar.

(2) Master Examination

The master examination is assessed by a committee of three professors. It is the final examination of the master study and consists of the following three parts:

- *Master thesis defence*, assessed by the head of the examination committee.
- *Examination about the major subject*, assessed by an examiner representing the major subject.
- *Examination about the minor subject*, assessed by an examiner representing the minor subject.

The contents of the examination about the major and the minor subject are the contents of the courses in these areas including the attended elective courses that are related to them. If a student took bridge courses instead of the minor subject the examination about the minor subject is replaced with an examination about the bridge courses. The effort of the master examination is calculated with 4.5 ECTS credits.

§10 Academic Degree

Graduates of a master study of this curriculum are awarded the academic degree "Diplom-Ingenieurin" or "Diplom-Ingenieur" (abbreviated Dipl.-Ing. or DI)[1].

[1] This corresponds to the international academic degree "Master of Science" (MSc).

§11 Commencement

This curriculum comes into effect on October 1, 2012.