Informatik
Schnittstelle Zukunft

JOHANNES KEPLER
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Curriculum Guide for the

BACHELOR STUDY COMPUTER SCIENCE

at the Johannes Kepler University Linz

valid from winter semester 2012/2013

Contents

§1 Qualification Profile

The bachelor study Computer Science at the Johannes Kepler University Linz is based on principles, methods and applications and offers a broad basic competence in computer science. On the one hand, it lays the foundations on which later master studies can build; on the other hand, it offers a professional education by enabling students to apply scientific knowledge to practical problems and to acquire new knowledge in a process of life-long learning.

A central feature of computer science in Linz is that theory and practice are tightly coupled. Hence, there is a necessity to drive this subject in its basics and also in its applications. Computer science has roots in mathematics, electrical engineering, and in a number of other areas. At the faculty of engineering and natural sciences at the Johannes Kepler University of Linz it is considered an engineering discipline, and therefore neither an offset of formal sciences nor a mere application of ready-to-use or off-the-shelf ideas. With its founding intention to be application-oriented, it emphasises the development of tools and methods. At the same time it gathers incentives and practical goal-orientation from its contact and cooperation with industry.

The bachelor study Computer Science aims at problem solving skills. Students should be empowered to solve non-trivial problems systematically using state-of-the-art computer science methods, i.e. to specify and to develop useful and reliable solutions as well as to validate, maintain and to further develop them.

In addition to technical skills students also acquire social skills. They learn to develop concepts, processes and results in a team and to communicate them to others. They are trained to understand and to use the terminology of clients and partners and to cooperate across multiple disciplines. By study exchange programmes and courses in English language students are prepared for collaboration with international partners. They gather basic skills in business, law and project management and are prepared to assess the impact of computer science to social, psychological and ethical aspects of society.

The courses of this study cover all major aspects of computer science and teach students how to apply this knowledge to practical problems. The study also promotes the cooperation with other areas of science and engineering. In general, graduates acquire knowledge and skills in the following areas:

- *Basics:* Basic formal skills that are essential for any engineering discipline. However, the contents of the formal classes are adapted to the special requirements of computer science.
- *Computer science*: Profound knowledge in the core areas of computer science (hardware, software, IT systems, applications) as well as a consolidation in selected current topics.
- *Problem solving skills*: Essential working methods in engineering and science, especially for problem analysis, for requirements specification, for the design of comprehensive solutions, and for their implementation in teams.
- *Application orientation*: Awareness of common computer science methods and tools in industry, basic familiarity with selected application areas, as well as the ability to put computer science solutions to work.
- *Continuing education*: Readiness and ability for life-long learning, especially the capability of autonomous training in new methods and tools of computer science.
- *Internationality*: Solid mastery of English (colloquial and technical) for communication with international partners.
- *Critical thinking*: Critical and responsible use of computer science methods with respect to ethics, gender problems and society.
- *Social competence*: Ability to work in teams, readiness to cooperate, management skills as well as the ability to present and moderate.

The bachelor study Computer Science offers a broad and balanced basic education. It prepares for a master study but allows also for a direct professional career in information and communication technology. Graduates of this bachelor study are all-purpose IT professionals.

§2 General Regulations and Terms

(1) Structure of the Study

The bachelor study Computer Science takes 6 semesters and comprises 180 ECTS points or 120 units per week (where 1 unit is 45 minutes). Its general structure is shown in Table 1.

Table 1: *Structure of the bachelor study Computer Science*

	ECTS	units
Compulsory subjects		
Propaedeutic	1.5	1
Theory	36.0	24
Hardware	22.5	15
Software	31.5	21
Systems	24.0	16
Applications	22.5	15
Complementary skills	15.0	10
Computer Science electives	10.5	7
Free electives	9.0	6
Bachelor thesis	7.5	5
Total	180.0	120

(2) 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. The project practical that has to be done as a bachelor thesis is a final project with a written part in which students should apply the knowledge that they acquired during their study.

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.

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

(3) Study Entrance and Orientation Phase

1. The study entrance and orientation phase consists of two exams from the list of courses in Table 3 that are marked with an "E".
2. Students have passed the study entrance and orientation phase if they have passed any two courses from the list of courses described in § 2(3)1. Exams for these courses can be repeated at most once by every student.
3. If the courses of the study entrance and orientation phase are offered only in the winter semester the vice rector for studies (on recommendation of the curriculum committee) can extend the study entrance and orientation phase by additional courses that are offered in the summer semester. Students being admitted in the summer semester can chose from this extended list.

(4) ECTS Points

According to the *European Credit Transfer System* (ECTS) the effort of the studies has to be specified in ECTS points, where 1 ECTS points 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 bachelor study is 180 ECTS points (approximately 30 ECTS points per semester). In this curriculum 1 unit generally corresponds to 1.5 ECTS points.

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

Table 2: *Correspondence between units, ECTS points 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

(5) Number of Students per Course and Course Admission

In compulsory courses 35 students are admitted to practicals, exercises and to the exercise part of combined courses, 20 students are admitted to seminars. The vice rector of studies and the curriculum committee have to make sure that enough parallel courses are offered.

In courses with a limit on the number of students the admission is done according to the direct assignment policy (*Direktzuteilungsverfahren*). The admission prerequisites listed in Table 4 must be obeyed.

§3 Compulsory Subjects

(1) Subjects and Courses

Students have to take all courses listed in Table 3. The column "E" denotes those courses that belong to the study entrance phase. The column "Sem" denotes the semester in which the course should be taken.

Table 3: *Courses of the compulsory subjects*

subject/course	VO	UE	PR	KV	ECTS	E	Sem
Propaedeutic							
Propaedeutic	.	.	.	1	1.5	E	1
Theory							
Mathematical Foundations	2	2	.	.	6.0	E	1
Discrete Structures	1	.	.	.	1.5	E	1
Algebra	3	2	.	.	7.5	.	2
Analysis	2	2	.	.	6.0	.	3
Computability and Complexity	2	1	.	.	4.5	.	3
Formal Models	2	1	.	.	4.5	.	4
Statistics	2	2	.	.	6.0	.	4
Hardware							
Digital Circuits	2	1	.	.	4.5	E	1
Electronics	2	1	.	.	4.5	.	2
Computer Architecture 1	3	1	.	.	6.0	.	3
Computer Architecture 2	2	1	.	.	4.5	.	4
Practical: Digital Circuits Design	.	.	2	.	3.0	.	4
Software							
Software Development 1	2	2	.	.	6.0	E	1
Software Development 2	2	2	.	.	6.0	.	2
Practical: Software Development 2	.	.	2	.	3.0	.	4
Algorithms and Data Structures 1	2	1	.	.	4.5	.	2
Algorithms and Data Structures 2	2	1	.	.	4.5	.	3
Systems Programming	.	.	2	.	3.0	.	3
Software Engineering	2	1	.	.	4.5	.	5
Systems							
Operating Systems	2	.	.	.	3.0	.	2
Practical: Operating Systems	.	.	1	.	1.5	.	2
Networks and Distributed Systems	2	1	.	.	4.5	.	3
Multimedia Systems	2	1	.	.	4.5	.	4
Compiler Construction	2	2	.	.	6.0	.	5
Embedded and Pervasive Systems	2	1	.	.	4.5	.	6
Applications							
Information Systems 1	2	2	.	.	6.0	E	1
Information Systems 2	2	1	.	.	4.5	.	5
Artificial Intelligence	2	1	.	.	4.5	.	5
Bioinformatics	2	.	.	.	3.0	.	5
Computer Graphics	2	1	.	.	4.5	.	6
Complementary Skills							
Ethics and Gender Studies	.	.	.	2	3.0	.	4
Techniques of Presentation and Team Work	.	.	.	2	3.0	.	1
Economy for Computer Science	2	.	.	.	3.0	E	2
Law for Computer Science	2	.	.	.	3.0	.	3
Project Management	.	.	.	2	3.0	.	5

(2) Contents of the Compulsory Subjects

Propaedeutic: General overview of the topics in computer science and of the bachelor study. The propaedeutic also serves as special study entry phase and as an orientation for first-year students.

Theory: Formal foundations of computer science in mathematics (analysis, algebra, number theory, graph theory, combinatorics, statistics), logic (predicate logic, formal specification, reasoning and proofs) as well as in formal systems and models (automata theory, Turing machines, Petri nets, computability, decidability, algorithmic complexity).

Hardware: Digital circuits at gate level, electronics as far as relevant for computer science, architecture of sequential and parallel computers, memory and bus systems, cache hierarchies, superscalar architectures, VLIW architectures, assembler programming, and programming of parallel computers.

Software: Solid programming skills in an imperative programming language, object-oriented software development (class libraries, frameworks, design patterns), modern programming techniques (threading, RMI, reflection, JDBC, applets, servlets, web services), algorithms and data structures (searching, sorting, random numbers, exhaustion, lists, trees, graphs, sets, distributed, parallel and heuristic algorithms), as well as software engineering (software processes, requirements engineering, design, testing).

Systems: Applications of computer science at the systems level, e.g. foundations and case studies of operating systems (memory management, parallel processes and synchronisation, file systems, event processing), networks and distributed systems (ISO/OSI reference model, ethernet, TCP/IP, switching, routing), embedded and mobile architectures (ASICs, microcontrollers, Smartcards, wireless communication, sensors, actuators), multimedia systems (media formats, data compression techniques, animation, interactive television), as well as compiler construction methods.

Applications: Major application areas of computer science with respect to the strengths and focuses of computer science in Linz, e.g. databases, information systems, computer graphics, artificial intelligence, and bioinformatics.

Complementary skills: A special goal of this curriculum and its qualification profile is to develop the students' personality as scientists and engineers. This includes topics such as ethics, gender awareness, social and cultural competence, scientific working techniques, presentation skills, and project management skills. Furthermore, students are exposed to fundamental principles of economy and law.

(3) Prerequisites for Course Registration

Certain courses are based on others. Table 4 shows which courses have to be passed before students can register for certain other courses. Numbered courses (e.g., Software Development 1 and 2) are based on each other by definition and must be taken in this order.

It is recommended to take the courses in the semesters that are listed in Table 3. This maintains all the prerequisites and guarantees a smooth course of study.

§4 Computer Science Electives

These courses allow students to deepen and broaden their knowledge according to their individual preferences. Students have to select courses with a total of 7 units (10.5 ECTS points) from Sections 4.1 to 4.3. These courses must contain at least one seminar from Section 4.3. They should be attended during the last two semesters of the bachelor study and cannot be re-selected in a subsequent master study.

4.1 General Electives

This section contains courses which are regularly delivered at least every two years. They are listed in Table 4.

Table 4: *General electives*

course	*kind*	*lang*	*WS*	*SS*	*institute*
Advanced Model Checking	2VO	E	.	*	FMV
Agile Methoden der Softwareentwicklung	2KV	D	.	*	SEA
Anwendungsorientierte Wissensverarbeitung	2VO	D	.	*	FAW
Barrierefreie Systementwicklung	2KV	D	*	.	IIS
Biometrische Identifikation	2VO	D	*	.	CP
Datenmodellierung und Applikationsentwicklung	2KV	D	.	*	FAW
Debugging	2VO	E	*	.	FMV
Digitale Bildverarbeitung	2KV	D	*	.	CP
Digitale Sprachverarbeitung	2KV	D	*	.	CP
Embedded Systems	2KV	D	.	.	PC
Engineering of Software-intensive Systems	2KV	E	.	*	SEA
Entwurf integrierter Schaltungen	2PR	D	*	.	RIIC
Gender Studies TNF-Einführung	2KV	D	.	*	FGF
Geschlecht und Wirtschaftsinformatik	2VO	D	*	.	FGF
Hardwareentwicklung mit programmierbarer Logik	2KV	D	*	.	RIIC
Hardwareorientiertes Arbeiten an PCs	2PR	D	*	.	FIM
Information Displays	2VO	E	.	*	CG
Interactive Rendering and Visualization	2VO	E	*	.	CG
Kapazitätsplanung	2KV	D	.	*	TK
Konzeptionelle Datenmodellierung	2KV	D	.	*	FAW
Logic Programming	2KV	E	*	.	RISC
Mensch-Maschine-Kommunikation	2VO	D	*	.	SSW
Mobile Computing	2KV	E	*	.	TK
Model Engineering	2VO+1UE	D	*	.	TK
Modeling Internet Applications	2KV	D	.	*	TK
Product Line Engineering	2KV	D	.	.	SEA
Real-Time Systems	2KV	D	.	.	PC
Rewriting in Logic and Computer Science	2VO	E	.	.	RISC
Secure Code	1KV	D	.	*	FIM
Sensor Networks	2KV	D	.	.	PC
Sicherheit in Applikationsprotokollen	1KV	D	*	.	FIM
Statistik 2	2KV	D	*	.	CA
System Software	2KV	E	.	*	SSW
Theoretical Concepts of Machine Learning	2VO+1UE	D	*	.	BIO
Übersetzerbau 2	2KV	D	.	*	SSW
VLSI-Entwurf	2KV	D	.	*	RIIC
Web Engineering	2KV	D	.	*	FAW
Web Information Retrieval	2KV	D	.	*	FAW
Wireless LANs	1KV	D	.	*	FIM

4.2 Special Topics

These courses allow institutes to react to new trends in computing and to embed courses from external lecturers. The names of these courses consist of a main title according to Table 5 and a subtitle describing the actual topic of the course. The kind of these courses (VO, UE, KV, PR) as well as their number of units are defined by the lecturers. Students can attend multiple courses with the same main title but different subtitles. The Special Topics offered in a particular semester can be seen in the current course catalogue.

Table 5: *Special topics*

Lehrveranstaltung	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

4.3 Seminars

The name of a seminar consists of a main title according to Table 6 as well as a subtitle describing the actual topic of the seminar. Students can attend multiple seminars with the same main title but different subtitles. The seminars offered in a particular semester can be seen in the current course catalogue.

Table 6: *Seminars*

Lehrveranstaltung	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

§5 Free Electives

Students have to take free elective courses with a total of 9 ECTS points (6 units). These courses can be selected from any study at any university and can be taken throughout the whole bachelor 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).

In the context of the Free Elective students can also select courses from the master studies in the area of computer science. These courses, however, cannot be credited again in the corresponding master study.

§6 Bachelor Thesis

At the end of the bachelor study students have to write a bachelor thesis, which has to be done in the context of a project practical. The thesis should have the structure of a scientific publication, i.e.:

- The thesis should be positioned in its computer science context (problem specification, definition of terms, comparison with related work, etc.).
- Students should show their mastery of common methods and notations of computer science.
- The results should be critically evaluated and compared with existing solutions.

The bachelor thesis is a practical (PR) with 7.5 ECTS points (5 units).

§7 Examinations

(1) Every course has to be finished by an examination. The examination mode (written or oral) of lectures (VO) and 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) The subject examinations in the Compulsory Subjects (§3) and in the Computer Science Elective (§4(1)) have to be taken in the form of course examinations.

(3) The bachelor study Computer Science finishes with a bachelor examination, which is a summary examination collected from the subject examinations of the Compulsory Subjects (§3) and the Computer Science Elective (§4(1)). Finishing the bachelor study requires also the successful submission of the Bachelor Theses (§5) as well as passing the Free Elective (§4(2)).

§8 Academic Degree

Graduates of the bachelor study Computer Science are awarded the academic degree "Bachelor of Science" (BSc).

§9 Commencement

(1) This curriculum comes into effect on October 1, 2012.

(2) The modifications in §2(3) and §3 are only valid until September 30, 2014.

(3) The modifications in §6 come into effect on October 1, 2011.