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UNIVERSITÄT MÜNCHEN
INSTITUT FÜR INFORMATIK

Course Catalogue

Minor Subject: Computer Science for Bachelor Programmes

(60 ECTS-Points)

**According to the Examination Regulations
from 07.10.2010**

Version: 2012/11/08

About the Programme of Study

The 60-CP minor in Computer Science is basically designed as an independent study course, which can be combined with numerous majors. The following undergraduate majors can currently be combined with the 60-CP minor in Computer Science: History, Art History, Musicology, Philosophy, Prevention, Integration and Rehabilitation (PIR) for Hearing Impairment, Egyptology and Coptic Studies, Ancient Near East, Archaeology: Europe and Middle East, Buddhist and South Asian Studies, Anthropology, Japanese, Middle Eastern, Chinese Studies, Folklife Studies/European Ethnology, General and Comparative Literature, English, Book Science, Computational Linguistics, German Language, Finno-Ugrian Studies, German Studies, Greek Philology, Greek Studies, Italian Studies, Latin Studies, North American Studies, Phonetics and Speech Processing, Roman Studies, Scandinavian Studies, Slavic Studies.

The aim of the minor in Computer Sience is to qualify graduates from diverse major studies background for tasks that require better knowledge of the IT sector - this is, for example, in professional fields in which linguists work, often a key requirement. If the 60-CP minor is compared with the major Bachelors programme in Computer Science, then the minor comprises approximately half of the material offered in the Bachelors programme (of the 180 credits, 30 credits are for the minor and 30 credits for the mathematics component, so that about 120 credits for pure Computer Science content remains). Therefore the minor in Computer concentrates more on the practical aspects of Computer Science where a strong mathematical background is not so important.

The minor in Computer Science qualifies the students in particular with regard to two aspects:

- Many professional activities, which are chosen by graduates of different majors, nowadays often need an IT support. The minor in Computer Science should enable the graduates to form the bridge between the main subject and the IT department, or even to take over the IT operations for the major themselves.
- In the ideal case the gradutes should have acquired enough IT knowledge and skills to even start a career in the IT sector.

In addition to the ability to acquire a qualified employment, there is another key professional qualification goal: Together with the Computer Science students, in th third semester the students of the minor in CS take part in a large software development practical course. In small teams they develop a more extensive program. Here, in addition to the ability to program, in particular the teamwork and the ability to organization work efficiently, solid time management and careful documentation are trained. The trained competences contribute to the personal development of students empowering them in many ways to take responsibility for others and for themselves

The minor in Computer Science can be started in the winter semester or the summer semester. It is organized so that in the first five semesters 12 credits must be earned through one or two modules. This course catalog lists, however, only the modules that are part of the examination regulations. In addition students can earn 12 credits from further more specialised modules. Examples are: *Formal techniques in software development*, *Introduction to Grid Computing*, *IT management*, *Virtual Reality*, *Database Systems II*, *Multimedia programming*, *Knowledge Discovery in Databases I*, *Design and Implementation of Parallel Programs*, *Functional Programming*, *Security Protocols*, *Computational Biology I*, *Media Technology*, *Computer Graphics*, *Human-Machine Interaction.* In addition a number of practical courses are offered: *Mobile and Distributed Systems*, *Mobile Business Applications*, *Advanced Software Engineering.*

Contents

1 Explanations

CP	Credit Points
ECTS	European Credit Transfer and Accumulation System
h	hours
SS	summer semester
WS	winter semester
SWS	credit hours
GOP	Qualifying Examination (Grundlagen- und Ortientierungsprüfung)

1. Please note: The course catalogue serves as an orientation only for your course of study. For binding regulations please consult the official examination regulations. These can be found at www.lmu.de/studienangebot for the respective programmes of study.

2. In the description of the associated module components, ECTS points in brackets are for internal use only. ECTS points without backets are awarded for passing the corresponding examination.

3. Modules whose identifier starts with P are mandatory modules.
   Modules whose identifier starts with WP are elective modules.

4. One of the GOP-marked (Grundlagen- und Ortientierungsprüfung) examinations must be passed by the 3rd semester.

2 Module P 1: Introduction to Programming (INF-EiP-NF)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	P 1.1 Lecture: Introduction to Programming	WS	60 h (4 SWS)	120 h	(6) CP
exercise	P 1.2 Exercises: Introduction to Programming	WS	30 h (2 SWS)	60 h	(3) CP
tutorial	P 1.3 Tutorial for Introduction to Programming	WS	30 h (2 SWS)	60 h	(3) CP

12 ECTS points are awarded for this module. The attendance time is 8 hours a week. Including self-study, there are about 360 hours to be spended.

Type	compulsory module with compulsory module components
Usability	**Courses:**: Minor Subject: Computer Science for Bachelor Programmes (60 CP)
Entry Requ.	none
Level	1st semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: once, next chance Entry Requirement: none Qualifying Examination (Grundlagen und Orientierungsprüfung)

Contents

This module provides an introduction to the imperative, object-oriented and concurrent programming using a high level language. In addition to the knowledge of general programming principles, concepts, methods and techniques for displaying, structuring and processing of data and the development of algorithms are discussed. Particular emphasis is set on conceptual clarity and precise mathematical foundation with formal methods.
The main topics of the course are as follows:

- basic concepts about programs and their implementation;
- syntax of programming languages and their description;
- basic data types and imperative control structures;
- complexity and correctness of imperative programs;
- induction and recursion;
- simple sorting methods;
- introduction to the object-oriented program design;
- classes, interfaces and packages;
- inheritance, and exception handling;
- object-oriented implementation of lists and tree structures;
- basic concepts of concurrent programming: threads, synchronization and deadlock.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

The students will be able to implement solutions for small and manageable problems algorithmically and to realize them with a high level programming language as executable programs. Furthermore, students develop an understanding of the general principles of programming and programming languages. This lays the foundation to ensure that the students (after further experiences in the course of study) may become familiar quickly and accurately with any programming language.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Core Computer Science
Martin Wirsing

Teaching Lang.

German

3 Module P 2: Practical Course in Software Development (INF-SEP)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
tutorial	P 2.1 Aspects of Software Development	WS	30 h (2 SWS)	60 h	(3) CP
practical training	P 2.2 Software Development Projekt	WS	135 h (9 SWS)	135 h	(9) CP

12 ECTS points are awarded for this module. The attendance time is 11 hours a week. Including self-study, there are about 360 hours to be spended.

Type	compulsory module with compulsory module components
Usability	**Courses::** Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Media Informatics as Minor for Bachelor and Master Programmes. (60 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) Teaching Gymnasium (72 CP) Teaching Realschule (72 CP)
Entry Requ.	none
Level	3rd semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	oral exam: 15-45 min Repeatability: arbitrary Entry Requirement: none

Contents

The module consists of an introductory phase where the basic programming techniques that are needed for the later work, are introduced. In the second phase a complex software development project will be implemented in teams of three to six students. The main focus of the module is to get experience in team-oriented software development using generally available tools and methods.

The practical work is accompanied by a plenary session, in which the software development techniques necessary for the project are discussed. This typically includes programming with programming libraries, graphics programming, aspects of object-oriented analysis, introduction to client-server programming and the use of software management tools. In addition actual problems which showed up in the current phase of the project are discussed. The students work independently in small teams. Each team is assigned an advisor who helps the team in the upcoming tasks.

Qualifikation Aims

The software development internship provides practical experience in team-based development of a larger and complex software system using commonly available tools and methods. The goal is to develop the ability to develop in a small team a major software project. Upon successfully completing the software development internship, the participants should dare to take a student job in the IT industry.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Core Computer Science
Studiengangskoordinator

Teaching Lang.

German

4 Module WP 1: Programming and Modeling (INF-ProMo)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	WP 1.1 Lecture: Programming and Modeling	SS	30 h (2 SWS)	30 h	(2) CP
exercise	WP 1.2 Exercises: Programming and Modeling	SS	45 h (3 SWS)	75 h	(4) CP

6 ECTS points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) Teaching Gymnasium (72 CP) **Selection Rule**: You may choose two modules from WP 1 - WP 4.
Entry Requ.	none
Level	2nd semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: once, next chance Entry Requirement: none Qualifying Examination (Grundlagen und Orientierungsprüfung)

Contents

This module provides an introduction to programming concepts, particularly in the Functional Programmierung paradigm.
The main topics of the course are as follows:

- Evaluation of functional programs: substitution model, evaluation order and the practical realisation in programming languages;
- Functions as a means for abstraction;
- Higher-order functions and currying;
- Types and type checking;
- Pattern Matching;
- Modules;
- Input and output and imperative aspects of programming;
- Functional and imperative programming in comparison.

The module consists of a lecture and exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

The module aims at providing the following:

- mastery of basic concepts of (general and declarative) programming;
- the ability to program small algorithms in functional imperative style and to evaluate and compare the two types;
- preparation for the future development of programming languages.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Core Computer Science
François Bry

Teaching Lang.

German

5 Module WP 2: Computer Architecture (INF-RA)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	WP 2.1 Lecture: Computer Architecture	SS	45 h (3 SWS)	45 h	(3) CP
exercise	WP 2.2 Exercises: Computer Architecture	SS	30 h (2 SWS)	60 h	(3) CP

6 ECTS points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) Teaching Gymnasium (72 CP) Teaching Realschule (72 CP) **Selection Rule**: You may choose two modules from WP 1 - WP 4.
Entry Requ.	none
Level	2nd semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: once, next chance Entry Requirement: none Qualifying Examination (Grundlagen und Orientierungsprüfung)

Contents

This module provides an overview of the binary representation of information on computers and on the architecture and operation of modern von Neumann computers. The traditional components of a computer are introduced. Their interaction is first theoretically and then practically illustrated with a machine language and ab assembly language. It is shown how to use the Boolean Algebra for designing simple circuits as well as more complex components of a processor and memory, and how to optimize them systematically.
The main topics of the course are as follows:

- the binary representation of information in the computer;
- the realisation of computer memory by electronic circuits and by optical and magnetic media;
- Boolean Algebra for the design of electronic circuits;
- design and optimisation of simple logic circuits in processors;
- components of the von Neumann architecture and its optimization;
- a machine-level assembly language;
- the interaction between the lower level components of a computer, as well as
- parallelization and multi-processor systems.

The module consists of a lecture and exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

The students will develop a basic understanding of the design and architecture of modern computers. They are introduced into the relationship between high-level languages and the processing of individual commands on the machine level. In particular, they should develop a sense of the consequences the machine architecture has for the execution of programs, written in high level languages.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Core Computer Science
Claudia Linnhof-Popien

Teaching Lang.

German

6 Module WP 3: Algorithms and Data Structures (INF-AlDs)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	WP 3.1 Lecture: Algorithms and Datastructures	SS	45 h (3 SWS)	45 h	(3) CP
exercise	WP 3.2 Exercises: Algorithms and Datastructures	SS	30 h (2 SWS)	60 h	(3) CP

6 ECTS points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Masters Programme Health Informatics (120 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) Teaching Gymnasium (72 CP) Teaching Realschule (72 CP) **Selection Rule**: You may choose two modules from WP 1 - WP 4.
Entry Requ.	none
Level	2nd semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: once, next chance Entry Requirement: none Qualifying Examination (Grundlagen und Orientierungsprüfung)

Contents

This module provides an introduction to the development of efficient algorithms as well as the interaction between algorithm and data structure. This is initially done for the important areas searching, sorting and graph algorithms. By the introduction of a modular system of algorithmic techniques, more general problems become algorithmically solvable.
The main topics of the course are as follows:

- basic concepts of algorithms and runtime analysis;
- basic data structures: arrays, linear lists, trees as well as the implementation of data structures;
- dynamic search methods: balanced binary trees, e.g. AVL-trees, B-trees, B*-trees, red-black trees, as well as dynamic hashing;
- sorting methods: a simple sorting algorithm, mergesort, quicksort, heapsort, complexity of the sorting problem;
- graph algorithms: different memory representations of graphs, graph runs. Building on these are algorithms for fundamental problems on graphs, in particular shortest paths and minimum spanning trees;
- algorithmic Methods and techniques: locally-optimized calculations ("greedy methods"), divide-and-conquer backtracking, branch-and-bound as well as dynamic programming.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

The students will be able to design efficient algorithms and data structures for searching, sorting and graph problems. These are to be realised in a high level language. Beyond the mentioned areas, the students are able to solve more general problems algorithmically using a basic kit of algorithmic techniques.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Core Computer Science
Hans-Peter Kriegel

Teaching Lang.

German

7 Module WP 4: Logic and Discrete Structures (INF-LDS)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	WP 4.1 Lecture: Logic and Discrete Structures	SS	45 h (3 SWS)	45 h	(3) CP
exercise	WP 4.2 Exercises: Logic and Discrete Structures	SS	30 h (2 SWS)	60 h	(3) CP

6 ECTS points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) **Selection Rule**: You may choose two modules from WP 1 - WP 4.
Entry Requ.	none
Level	2nd semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: once, next chance Entry Requirement: none Qualifying Examination (Grundlagen und Orientierungsprüfung)

Contents

The module provides basic knowledge of discrete mathematics and logic as far as it is relevant
for further informatics modules.
The main topics of the course are as follows:

- Discrete Mathematics: modular arithmetic, solving modular equations, recurrences, partial orders, lattices, finite groups and fields;
- Logic: propositional logic, predicate logic, syntax, semantics, proof calculi, correctness and completeness of logical systems, resolution, incompleteness of arithmetic.

The module consists of a lecture and exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

Students should understand and apply the presented concepts and methods of discrete mathematics as far as they are relevant to informatics. Through the example of predicate logic they should grasp the differences between syntax and semantics, and between truth and provability. They should become able to understand advanced logical formalisms presented in further modules, or acquire them later through self-study.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Core Computer Science
Martin Hofmann

Teaching Lang.

German

8 Module WP 5: Computer Networks and Distributed Systems (INF-RVS)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	**Component (compulsory)**	**Rota**	**Attendance**	**Self-study**	**ECTS**
lecture	WP 5.1 Lecture: Computer Networks and Distributed Systems	SS	30 h (2 SWS)	60 h	(3) CP
exercise	WP 5.2 Exercises: Computer Networks and Distributed Systems	SS	30-45 h (2-3 SWS)	45-60 h	(3) CP

6 ECTS points are awarded for this module. The attendance time is 8 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Masters Programme Health Informatics (120 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) **Selection Rule**: You may choose two modules from WP 5 - WP 7.
Entry Requ.	none
Level	4th semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: arbitrary Entry Requirement: none

Contents

The module provides classification, structure and function of networks with a focus on communication protocols and integrates basic components of distributed systems. For this it uses the popular layered models and architectures. Concepts and procedures independent of the layers are addressed separately, in order to specialise them by examples of communicaton protocols in all major layers of the model. These include the physical layer, the data link layer including multiple access, the network layer, the transport layer, and also the Internet Service Protocols. The presentation and the communication layers are introduced with concepts from the communication middleware for distributed systems. As an outlook for the operation of distributed systems, the module treats summarily the basics of Internet management.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

The qualification aims are:

- Understanding of the methods and techniques in computer networks and distributed systems;
- Ability of classification and evaluation of new protocols;
- Understanding of distributed applications and their relation to the properties of the underlying network.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Communication Systems and System Programming Group
Dieter Kranzlmüller

Teaching Lang.

German

9 Module WP 6: Formal Languages and Complexity Theory (INF-FSK)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	WP 6.1 Lecture: Formal Languages and Complexity Theory	SS	45 h (3 SWS)	45 h	(3) CP
exercise	WP 6.2 Exercises: Formal Languages and Complexity Theory	SS	30 h (2 SWS)	60 h	(3) CP

6 ECTS points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) Teaching Gymnasium (72 CP) Teaching Realschule (72 CP) **Selection Rule**: You may choose two modules from WP 5 - WP 7.
Entry Requ.	none
Level	4th semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: arbitrary Entry Requirement: none

Contents

The module provides basic knowledge in the areas of formal languages, computability and complexity theory.
The main topics of the course are as follows:

- automata and formal Languages: Chomsky hierarchy, regular languages and finite automata, context-free languages and pushdown automata, context-sensitive languages;
- computability: Turing machines and other models of computation, undecidability, recursively enumerable problems;
- complexity theory, especially the classes P and NP, definition and proof of NP completeness.

The module consists of a lecture and in addition exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

The students should learn the above mentioned recurring theoretical foundations of computer science and are able to apply them to practical problems. Examples are, to identify a problem as NP-complete, or to identify state-based specifications as finite automata, and to apply determinisation and minimisation methods.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Core Computer Science
Martin Hofmann

Teaching Lang.

German

10 Module WP 8: Software Engineering (INF-ST)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	WP 8.1 Lecture: Software Engineering	WS	45 h (3 SWS)	45 h	(3) CP
exercise	WP 8.2 Exercises: Software Engineering	WS	30 h (2 SWS)	60 h	(3) CP

6 ECTS points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) Teaching Gymnasium (72 CP) Teaching Realschule (72 CP) **Selection Rule**: You may choose two modules from WP 8 - WP 12.
Entry Requ.	none
Level	5th semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: arbitrary Entry Requirement: none

Contents

This module introduces the fundamental principles of software engineering. The entire software development process is presented, starting with requirements analysis, system design, to implementation and testing. As a graphical modeling language, the Unified Modeling Language (UML) is used in all phases of the development process. The implementation language is Java.
The main topics of the module are as follows:

- software development processes;
- requirements analysis with use cases;
- design of static system structures with class diagrams;
- modelling behavior with state machines, sequence, and activity diagrams
- architecture of complex software systems;
- design and architectural patterns;
- relationship between models and implementations in object-oriented languages;
- software testing.

The module consists of a lecture and of additional exercises in groups. The concepts introduced in the lecture are practiced in the exercise section with concrete application examples.

Qualifikation Aims

The students will acquire a general understanding of the major aspects of modern software engineering using notions and tools that are currently researched in academia and employed in industry.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Programming and Software Technology
Rolf Hennicker

Teaching Lang.

German English

11 Module WP 9: Operating Systems (INF-BS)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	WP 9.1 Lecture: Operating Systems	WS	45 h (3 SWS)	45 h	(3) CP
exercise	WP 9.2 Exercises: Operating Systems	WS	30 h (2 SWS)	60 h	(3) CP

6 ECTS points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) Teaching Realschule (72 CP) **Selection Rule**: You may choose two modules from WP 8 - WP 12.
Entry Requ.	none
Level	5th semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: arbitrary Entry Requirement: none

Contents

This module provides an introduction to the relevant components of modern operating systems. It begins by outlining methods for process management and process control, especially concurrent processes. In particular, methods for detection and avoidance of conflicts (deadlocks and race conditions) are treated with concurrent access to shared resources.
The main topics of the course are as follows:

- the history of operating systems;
- strategies for process management in operating systems;
- the support of the operating system for parallelizing programs;
- strategies for Resource Management and coordination of processes;
- techniques for memory management and control of input and output channels;
- local and distributed interprocess communication.

The module consists of a lecture and exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples. In addition, the students do exercises, which deepen the application of theoretical concepts in high-level languages.

Qualifikation Aims

This module provides students with the necessary basic knowledge for the specific use of the special structure and properties of modern operating systems. It lays the foundations for the development of optimized and scalable computer programs for modern operating systems.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Core Computer Science
Claudia Linnhof-Popien

Teaching Lang.

German

12 Module WP 10: Database Systems I (INF-DBSI)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	WP 10.1 Lecture: Database Systems I	WS	30 h (2 SWS)	60 h	(3) CP
exercise	WP 10.2 Exercises: Database Systems I	WS	30-45 h (2-3 SWS)	45-60 h	(3) CP

6 ECTS points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Masters Programme Health Informatics (120 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) Teaching Gymnasium (72 CP) Teaching Realschule (72 CP) **Selection Rule**: You may choose two modules from WP 8 - WP 12.
Entry Requ.	none
Level	5th semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: arbitrary Entry Requirement: none

Contents

The course provides an introduction to the field of database systems from a user perspective. It focuses on the theoretical aspects of the relational database design using the relational data model, relational algebra and the relational calculus. There is a detailed treatment of the SQL query language, which is implemented in most relational systems. Further topics are formalisms, algorithms and a theory of relational design theory, as well as newer applications in the area of databases.
The main topics of the course are as follows:

- relational and object-relational data as well as other models;
- Relational Algebra;
- tuple calculus and domain calculus;
- SQL;
- database design for the E/R model;
- normalforms;
- transactions including synchronization and recovery techniques;
- physical database design (index structures and query optimization);
- integration of database operations in application programs.

The module consists of a lecture and exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

The students are able to apply database systems professionally as user, as application programmer and as system designer. They are taught the skills to do focussed research in large databases using complex queries, to develop database schemas avoiding redundancy problems and taking into account efficiency aspects, and to implement efficient database applications.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Database Systems Group
Christian Böhm

Teaching Lang.

German

13 Module WP 11: Web Information Systems (INF-WebInfo)

Part of Minor Subject: Computer Science for Bachelor Programmes (60 CP)

Associated Module Components

Teaching	Component (compulsory)	Rota	Attendance	Self-study	ECTS
lecture	WP 11.1 Lecture: Web Information Systems	WS	30 h (2 SWS)	60 h	(3) CP
exercise	WP 11.2 Exercises: Web Information Systems	WS	30-45 h (2-3 SWS)	45-60 h	(3) CP

6 ECTS points are awarded for this module. The attendance time is 5 hours a week. Including self-study, there are about 180 hours to be spended.

Type	elective module with compulsory module components
Usability	**Courses:**: Bachelor Programme in Computer Science (150 CP) Bachelor Programme in Computer Science plus Computer Linguistics (180 CP) Bachelor Programme in Computer Science plus Mathematics (180 CP) Bachelor Programme in Computer Science plus Statistics (180 CP) Bachelor Programme in Media Informatics (180 CP) Minor Subject: Computer Science for Bachelor Programmes (30 CP) Minor Subject: Computer Science for Bachelor Programmes (60 CP) Teaching Gymnasium (72 CP) Teaching Realschule (72 CP) **Selection Rule**: You may choose two modules from WP 8 - WP 12.
Entry Requ.	none
Level	5th semester (recommended)
Duration	The module comprises one semester.
Grading	The module is marked.
Assessment	written exam: 90-180 min or oral exam: 15-45 min Repeatability: arbitrary Entry Requirement: none

Contents

This module introduces the techniques of web-based information systems. The main topics of the course are as follows:

- Unstructured data or Document-Web: HTML and basics of information retrieval, search and the basics of network analysis, keyword query languages, data structures for the web and data parallelism.
- Semi-structured data, or the Data-Web: XML, data models, schemas, the Web query languages XPath and XQuery, basics of evaluating web requests
- Semantic data or the Metadata-Web: RDF/S, social semantic web systems, SPARQL.

The module consists of a lecture and exercises in small groups. The concepts introduced in the lecture are practiced in the exercise section with concrete examples.

Qualifikation Aims

The module aims at providing the following:

- appropriate use of basic web standards such as HTML, XML and RDF/S and prepare for the future development of the imported web standards;
- mastery of basic web applications such as search engines, Semantic Web systems and social media;
- use of Web query languages;
- introduction to basic techniques of information retrieval, data storage and data parallelism.

Responsible

Ludwig-Maximilians University
Institute for Computer Science
Programming and Modelling Languages Group
François Bry

Teaching Lang.

German

14 Curricula

The course can be started in the winter semester and in the summer semester. For both start semesters curricula are proposed. The plans are only suggestions. Every student is free to follow another curriculum which is compatible with the examination regulations.

14.1 Curriculum for Start in the Winter Semester

1. Semester (WS)

Shortname	Title	CP
INF-EiP-NF	Introduction to Programming	12
		12

2. Semester (SS)

Shortname	Title	CP
Choices: You can choose 2 modules among the following list:		
INF-ProMo	Programming and Modeling	6
INF-RA	Computer Architecture	6
INF-AlDs	Algorithms and Data Structures	6
INF-LDS	Logic and Discrete Structures	6
		12

3. Semester (WS)

Shortname	Title	CP
INF-SEP	Practical Course in Software Development	12
		12

4. Semester (SS)

Shortname	Title	CP
Choices: You can choose 2 modules among the following list:		
INF-RVS	Computer Networks and Distributed Systems	6
INF-FSK	Formal Languages and Complexity Theory	6
	1 advanced module	6
		12

5. Semester (WS)

Shortname	Title	CP
Choices: You can choose 2 modules among the following list:		
INF-ST	Software Engineering	6
INF-BS	Operating Systems	6
INF-DBSI	Database Systems I	6
INF-WebInfo	Web Information Systems	6
	1 advanced module	6
		12

14.2 Curriculum for Start in the Summer Semester

1. Semester (SS)

Shortname	Title	CP
Choices: You can choose 2 modules among the following list:		
INF-ProMo	Programming and Modeling	6
INF-RA	Computer Architecture	6
INF-AlDs	Algorithms and Data Structures	6
INF-LDS	Logic and Discrete Structures	6
		12

2. Semester (WS)

Shortname	Title	CP
INF-EiP-NF	Introduction to Programming	12
		12

3. Semester (SS)

Shortname	Title	CP
Choices: You can choose 2 modules among the following list:		
INF-ProMo	Programming and Modeling	6
INF-RA	Computer Architecture	6
INF-AlDs	Algorithms and Data Structures	6
INF-LDS	Logic and Discrete Structures	6
INF-RVS	Computer Networks and Distributed Systems	6
INF-FSK	Formal Languages and Complexity Theory	6
	1 advanced module	6
		12

4. Semester (WS)

Shortname	Title	CP
INF-SEP	Practical Course in Software Development	12
		12

5. Semester (SS)

Shortname	Title	CP
Choices: You can choose 2 modules among the following list:		
INF-RVS	Computer Networks and Distributed Systems	6
INF-FSK	Formal Languages and Complexity Theory	6
	1 advanced module	6
		12