

# Computer Science, Master's Programme

120 credits

Computer Science, masterprogram

6MICS

Valid from: 2017 Spring semester

**Determined by**

Faculty Board of Institute of Technology

**Date determined**

2017-01-25

## Purpose

The Master's Programme in Computer Science aims to educate specialists who will be able to work at the forefront of modern software and computer systems technology in a variety of application areas. The programme also aims at ensuring that the students are well prepared for a career in research or continued studies towards a doctoral degree.

Computer science is one of the most dynamic and expansive fields of science. For the individual scholar or the professional in the field this means that, as well as having a good understanding of the theoretical and technical foundations of the field, one needs to be able to apply the technology to new challenging problems and integrate it with other technologies.

## Aim

The Master's Programme in Computer Science offers the opportunity for advanced study in computer science and engineering and allows for flexible planning of specialization areas. Having covered core computer science courses, the students will be able to focus their studies on areas such as artificial intelligence, databases and data-mining, internet computing, embedded systems, information security, design and programming computer games, language technology, human-computer interaction, theoretical computer science or design and implementation of computer languages.

The following learning outcomes will serve as measurable goals towards the implementation of the general aim of the program. These objectives are formulated in terms of capacities competences of the students who successfully complete the program.

- A Computer Science master will be able to understand and apply mathematical concepts which are necessary for modelling various kinds of computational problems. He/She will have an understanding of both software and hardware issues.
- A Computer Science master will be a competent programmer who is familiar with a variety of programming languages and tools and is able to creatively apply his/her knowledge and skills to modelling and developing software solutions which contribute towards applications in a wide variety of application domains.
- The Computer Science master will be able to work as a team member and effectively cooperate with other specialists and contribute towards the solution of complex technical problems.
- The Computer Science master will be qualified to take a leading role in a software design and development team, evaluate and compare solutions, and decision making. He/She will be able to further deepen his/her knowledge and contribute to the development of the area.
- The Computer Science master will be a good communicator who will be able to present coherent technical and scientific results both orally and in writing.
- Students who successfully complete the programme will have a good understanding of the impact of computers in society, ethical issues relevant to the field, as well as the responsibilities of the computer science professionals.
- Although computer science enjoys a relatively stable scientific foundation, the field is still dynamic and expansive. An important aspect of educational programs in the field is to prepare the students for a lifelong learning in the field.

## Content

The programme is based on fundamental mathematical, theoretical, and technical knowledge acquired by the student during his/her undergraduate education. This basic knowledge should cover programming in various languages and paradigms, algorithms, databases, system software, operating systems and mathematical knowledge which should include discrete mathematics, logic and statistics.

The Master's Programme in Computer Science is both theoretical and applied. A number of courses will provide the student with the broad view and understanding needed in order to master the general area. At the same time, a proper selection of courses allows for further specialisation.

Communication skills, presentation techniques (both oral and written), as well as team work, are emphasized during the whole program.

Each year the programme board decides what courses will be given and included in the programme. This is found in the curriculum. For each course there is a course syllabus, describing the learning outcomes, organisation, examination and the classification of the advancement level and to what subject area the course belongs. The course advancement level and subject area are important in fulfilling the requirements for the Master's degree.

## Education profiles

The specialisation areas are visible in the syllabus. If a specialisation requirement is fulfilled the specialisation will be included in the Degree Certificate.

Specialisation areas in the programme include:

- Artificial Intelligence and Data Mining
- Visualization and Computer Graphics
- Computer Networks, Distributed Systems and Security
- Embedded Systems
- Programming and Software Methods

In order to meet the specialization requirement, 42hp of the elective courses in the degree must be within the specialization.

## Entry requirements

- A bachelor's degree with a major in computer science, information technology, software engineering, computer engineering, alternatively, a bachelor's degree with a minor in computer science or related subject area, with a minimum of 60 ECTS credits in computer-related subjects (e.g. programming, data structures, databases, software engineering, computer hardware, computer networks).
- At least 24 ECTS credits in mathematics/applied mathematics and/or application of mathematics relevant for the programme including courses in discrete mathematics, linear algebra, calculus and mathematical statistics.
- English corresponding to the level of English in Swedish upper secondary education (English 6/B)

## Degree thesis

The thesis encompasses independent work corresponding to 30 ECTS credits. The students are encouraged to carry out their thesis work in their specialisation area. Thesis work should be supervised by a faculty member within computer science and engineering.

## Degree requirements

The programme is designed to give the Master's Degree "Teknologie masterexamen i datavetenskap" translated to "Master of Science (2 years) with a major in Computer Science".

The requirements are the following:

- a Bachelor's degree as specified in the entrance requirements.
- course requirements for a total of 120 ECTS credits from courses from the curriculum of the programme, or after special decision from the programme board, and thesis work.
- passed the requirements for all compulsory courses.
- courses on advancement level A (advanced) 90 ECTS credits including:
  - at least 30 ECTS credits courses from the major subject of Computer Science.
  - a 30 ECTS credits Master's Thesis in the major subject of Computer Science.
- at least 45 ECTS credits from courses in mathematics or applications of mathematics from the Bachelor level (basic) or Master level (advanced), see list of specific courses.
- a Master's thesis presented and passed as per Linköping Institute of Technology degree regulations.

Courses overlapping each other regarding contents are not allowed to be included in the degree. Courses used for the Bachelor's degree can never be included in the Master's degree.

Entrance requirements

See general rules and regulations for master programmes at LiTH.

About the Degree

Students who have studied advanced courses in computer science prior to the Master's programme can either transfer some of their credits to the programme or be allowed to substitute compulsory courses in the programme with other courses. Transferring credits is only applicable to earlier courses that have not been included in other degrees.

## Degree in Swedish

Master of Science (120 credits) with a major in Computer Science.

## Degree in English

Master of Science (two years) with a major in Computer Science

## Specific information

Graduate Level Courses

Certain PhD courses can be taken by master students. These course selections are subject to formal decision by the executive committee of the Programme Board.

## Common rules

See also common rules

# Curriculum

## Semester 1 (Autumn 2017)

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TDDD65	Introduction to the Theory of Computation	6*	G2X	2	C
TDDE18	Programming C++	6*	G2X	4	C
TDDC17	Artificial Intelligence	6	G2X	3	E
TDTS06	Computer Networks	6	G2X	1	E
<b>Period 2</b>					
TDDD65	Introduction to the Theory of Computation	6*	G2X	1	C
TDDE18	Programming C++	6*	G2X	3	C
TDDD07	Real Time Systems	6	A1X	4	E
TDDD37	Database Technology	6	G2X	1	E
TDDE01	Machine Learning	6	A1X	1	E
TDTS08	Advanced Computer Architecture	6	A1X	2	E
TSIT02	Computer Security	6	G2X	2	E

### *Specialisation: AI and Data Mining*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TDDC17	Artificial Intelligence	6	G2X	3	E
<b>Period 2</b>					
TDDD37	Database Technology	6	G2X	1	E
TSIT02	Computer Security	6	G2X	2	E

### *Specialisation: Computer Networks, Distributed Systems and Security*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TDTS06	Computer Networks	6	G2X	1	E
<b>Period 2</b>					
TSIT02	Computer Security	6	G2X	2	E



*Specialisation: Embedded Systems*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 2</b>					
TDDD07	Real Time Systems	6	A1X	4	E
TDTS08	Advanced Computer Architecture	6	A1X	2	E

*Specialisation: Visualization and Computer Graphics*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TDDC17	Artificial Intelligence	6	G2X	3	E

**Semester 2 (Spring 2018)**

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TATA54	Number Theory	6*	G2X	-	E
TATA64	Graph Theory	6*	A1X	2	E
TBMI26	Neural Networks and Learning Systems	6	A1X	2	E
Tddb68	Concurrent Programming and Operating Systems	6	G2X	3	E
TDDD17	Information Security, Second Course	6*	A1X	4	E
TDDD25	Distributed Systems	6	A1X	2	E
TDDD38	Advanced Programming in C++	6*	A1X	2	E
TDDD41	Data Mining - Clustering and Association Analysis	6	A1X	3	E
TDDD97	Web Programming	6	G2X	3	E
TDDE05	AI Robotics	6*	A1X	4	E
TDDE09	Natural Language Processing	6	A1X	2	E
TDTS07	System Design and Methodology	6	A1X	1	E
TDTS21	Advanced Networking	6*	A1X	1	E
TNM048	Information Visualisation	6	A1X	3	E
TNM061	3-D Computer Graphics	6*	G2X	1	E
TSBK35	Audio and Image Compression	6	A1X	4	E
<b>Period 2</b>					

Course code	Course name	Credits	Level	Timetable module	ECV
TAOP24	Optimization, Advanced Course	6	G2X	1	E
TATA54	Number Theory	6*	G2X	-	E
TATA64	Graph Theory	6*	A1X	2	E
TDDC78	Programming of Parallel Computers - Methods and Tools	6	A1X	3	E
TDDD05	Component Based Software	6	A1X	1	E
TDDD17	Information Security, Second Course	6*	A1X	4	E
TDDD27	Advanced Web Programming	6	A1X	3	E
TDDD29	IT-Project Management	6	A1X	3	E
TDDD38	Advanced Programming in C++	6*	A1X	-	E
TDDD48	Automated Planning	6	A1X	1	E
TDDE05	AI Robotics	6*	A1X	4	E
TDDE31	Big Data Analytics	6	A1X	1	E
TDTS21	Advanced Networking	6*	A1X	1	E
TNM061	3-D Computer Graphics	6*	G2X	4	E
TNM079	Modelling and Animation	6	A1X	2	E
TNM096	Artificial Intelligence - Principles and Techniques	6	G2X	1	E
TNM098	Advanced Visual Data Analysis	6	A1X	4	E

*Specialisation: AI and Data Mining*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TBMI26	Neural Networks and Learning Systems	6	A1X	2	E
TDDD41	Data Mining - Clustering and Association Analysis	6	A1X	3	E
TDDE05	AI Robotics	6*	A1X	4	E
TDDE09	Natural Language Processing	6	A1X	2	E
<b>Period 2</b>					
TDDD48	Automated Planning	6	A1X	1	E
TDDE05	AI Robotics	6*	A1X	4	E
TDDE31	Big Data Analytics	6	A1X	1	E
TNM096	Artificial Intelligence - Principles and Techniques	6	G2X	1	E

*Specialisation: Computer Networks, Distributed Systems and Security*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TDDD17	Information Security, Second Course	6*	A1X	4	E
TDDD25	Distributed Systems	6	A1X	2	E
TDTS21	Advanced Networking	6*	A1X	1	E
<b>Period 2</b>					
TDDD17	Information Security, Second Course	6*	A1X	4	E
TDTS21	Advanced Networking	6*	A1X	1	E

*Specialisation: Embedded Systems*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
Tddb68	Concurrent Programming and Operating Systems	6	G2X	3	E
TDDD25	Distributed Systems	6	A1X	2	E
TDTS07	System Design and Methodology	6	A1X	1	E
<b>Period 2</b>					
TDDC78	Programming of Parallel Computers - Methods and Tools	6	A1X	3	E

*Specialisation: Programming and Software Methods*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
Tddb68	Concurrent Programming and Operating Systems	6	G2X	3	E
TDDD25	Distributed Systems	6	A1X	2	E
TDDD38	Advanced Programming in C++	6*	A1X	2	E
TDDD97	Web Programming	6	G2X	3	E
<b>Period 2</b>					
TDDC78	Programming of Parallel Computers - Methods and Tools	6	A1X	3	E
TDDD05	Component Based Software	6	A1X	1	E
TDDD27	Advanced Web Programming	6	A1X	3	E
TDDD38	Advanced Programming in C++	6*	A1X	-	E

*Specialisation: Visualization and Computer Graphics*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TNM048	Information Visualisation	6	A1X	3	E
TNM061	3-D Computer Graphics	6*	G2X	1	E
TSBK35	Audio and Image Compression	6	A1X	4	E
<b>Period 2</b>					
TDDD27	Advanced Web Programming	6	A1X	3	E
TNM061	3-D Computer Graphics	6*	G2X	4	E
TNM079	Modelling and Animation	6	A1X	2	E
TNM096	Artificial Intelligence - Principles and Techniques	6	G2X	1	E
TNM098	Advanced Visual Data Analysis	6	A1X	4	E

**Semester 3 (Autumn 2018)**

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TATA55	Abstract Algebra	6*	G2X	3	E
TBMI19	Medical Information Systems	6*	A1X	2	E

Course code	Course name	Credits	Level	Timetable module	ECV
Tddb84	Design Patterns	6	A1X	4	E
TDDC34	Technical, Economic and Societal Evaluation of IT-products	6	A1X	3	E
TDDC88	Software Engineering	12*	A1X	1	E
TDDD04	Software Testing	6	A1X	2	E
TDDD08	Logic Programming	6	A1X	4	E
TDDD23	Design and Programming of Computer Games	6	A1X	2	E
TDDD38	Advanced Programming in C++	6*	A1X	2	E
TDDD43	Advanced Data Models and Databases	6*	A1X	2	E
TDDE19	Advanced Project Course - AI and Machine Learning	6*	A1F	4	E
TDDE21	Advanced Project Course: Secure Distributed and Embedded Systems	6*	A1X	4	E
TDS06	Computer Networks	6	G2X	1	E
TNCG15	Advanced Global Illumination and Rendering	6	A1X	4	E
TNM067	Scientific Visualization	6	A1X	3	E
TNM095	Artificial Intelligence for Interactive Media	6	A1X	2	E
TSEA26	Design of Embedded DSP Processor	6	A1X	1	E
TSIN01	Information Networks	6	A1X	3	E
TSIT03	Cryptology	6	A1X	2	E
TSKS02	Telecommunication	6*	G2X	1	E
TSKS12	Modern Channel Coding, Inference and Learning	6	A1X	1	E
TSTE86	Digital Integrated Circuits	6	A1X	2	E
<b>Period 2</b>					
TDDD89	Scientific Method	6	A1X	3	C
TAMS22	Probability Theory and Bayesian Networks	6	A1X	1	E
TATA55	Abstract Algebra	6*	G2X	3	E
TBMI19	Medical Information Systems	6*	A1X	3	E
Tddb44	Compiler Construction	6	A1X	1	E
TDDC88	Software Engineering	12*	A1X	1	E
TDDC90	Software Security	6	A1X	1	E

Course code	Course name	Credits	Level	Timetable module	ECV
TDDD38	Advanced Programming in C++	6*	A1X	-	E
TDDD43	Advanced Data Models and Databases	6*	A1X	2	E
TDDD56	Multicore and GPU Programming	6	A1X	2	E
TDDE13	Multi Agent Systems	6	A1X	1	E
TDDE16	Text Mining	6	A1X	2	E
TDDE19	Advanced Project Course - AI and Machine Learning	6*	A1F	4	E
TDDE21	Advanced Project Course: Secure Distributed and Embedded Systems	6*	A1X	4	E
TNM084	Procedural Methods for Images	6	A1X	4	E
TNM086	Virtual Reality Techniques	6	A1X	2	E
TSIN02	Internetworking	6	A1X	1	E
TSKS02	Telecommunication	6*	G2X	2	E

*Specialisation: AI and Data Mining*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TDDD08	Logic Programming	6	A1X	4	E
TDDD23	Design and Programming of Computer Games	6	A1X	2	E
TDDD43	Advanced Data Models and Databases	6*	A1X	2	E
TDDE19	Advanced Project Course - AI and Machine Learning	6*	A1F	4	E
<b>Period 2</b>					
TDDD43	Advanced Data Models and Databases	6*	A1X	2	E
TDDE13	Multi Agent Systems	6	A1X	1	E
TDDE16	Text Mining	6	A1X	2	E
TDDE19	Advanced Project Course - AI and Machine Learning	6*	A1F	4	E

*Specialisation: Computer Networks, Distributed Systems and Security*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TDDE21	Advanced Project Course: Secure Distributed and Embedded Systems	6*	A1X	4	E
TDS06	Computer Networks	6	G2X	1	E
TSIN01	Information Networks	6	A1X	3	E
TSIT03	Cryptology	6	A1X	2	E
TSKS02	Telecommunication	6*	G2X	1	E
<b>Period 2</b>					
TDDC90	Software Security	6	A1X	1	E
TDDE21	Advanced Project Course: Secure Distributed and Embedded Systems	6*	A1X	4	E
TSIN02	Internetworking	6	A1X	1	E
TSKS02	Telecommunication	6*	G2X	2	E

*Specialisation: Embedded Systems*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TDDE21	Advanced Project Course: Secure Distributed and Embedded Systems	6*	A1X	4	E
TSEA26	Design of Embedded DSP Processor	6	A1X	1	E
TSKS02	Telecommunication	6*	G2X	1	E
TSTE86	Digital Integrated Circuits	6	A1X	2	E
<b>Period 2</b>					
TDDD56	Multicore and GPU Programming	6	A1X	2	E
TDDE21	Advanced Project Course: Secure Distributed and Embedded Systems	6*	A1X	4	E
TSKS02	Telecommunication	6*	G2X	2	E

*Specialisation: Programming and Software Methods*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
Tddb84	Design Patterns	6	A1X	4	E
TDDC88	Software Engineering	12*	A1X	1	E
TDDD04	Software Testing	6	A1X	2	E
TDDD08	Logic Programming	6	A1X	4	E
<b>Period 2</b>					
Tddb44	Compiler Construction	6	A1X	1	E
TDDC88	Software Engineering	12*	A1X	1	E
TDDC90	Software Security	6	A1X	1	E
TDDD56	Multicore and GPU Programming	6	A1X	2	E

*Specialisation: Visualization and Computer Graphics*

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TNCG15	Advanced Global Illumination and Rendering	6	A1X	4	E
TNM067	Scientific Visualization	6	A1X	3	E
TNM095	Artificial Intelligence for Interactive Media	6	A1X	2	E
<b>Period 2</b>					
TNM084	Procedural Methods for Images	6	A1X	4	E
TNM086	Virtual Reality Techniques	6	A1X	2	E

**Semester 4 (Spring 2019)**

Course code	Course name	Credits	Level	Timetable module	ECV
<b>Period 1</b>					
TQXX30	Degree project - Master's Thesis	30*	A1X	-	C
<b>Period 2</b>					
TQXX30	Degree project - Master's Thesis	30*	A1X	-	C

ECV = Elective / Compulsory / Voluntary

\*The course is divided into several semesters and/or periods