



Programme syllabus

[An accessible version of the syllabus can be found in the Course and programme directory.](#)

Master's Programme, Computer Science 120 credits

Masterprogram, datalogi

Valid for students admitted to the education from autumn 21 (HT - Autumn term; VT - Spring term).

This is a translation of the Swedish, legally binding, programme syllabus.

Programme objectives

The aim of the Master's programme is to provide a broad education in Computer Science with the possibility of deepening and specializing within the area of computer science, the method science for construction of computer programmes including theoretical foundations as well as the practical ability to develop products and systems which include computers and software.

The programme will provide the students with the requisites and abilities to participate and lead work within evaluation, development and implementation of new technology within the field of computer science.

Knowledge and understanding

For the master's degree from the programme Computer Science, the student shall

- show knowledge and understanding in the main area of the education, including both broad knowledge in the field as well as substantial in-depth knowledge in certain areas of the field, and in-depth insight into current research and development work
- show in-depth methodological knowledge in the main area of education.

Skills and abilities

For the master's degree from the programme Computer Science, the student shall

- show a good analytical problem solving ability
- show the ability to independently define and solve construction problems within computer science
- show the requisites and abilities to participate in and develop practices implemented in industry, maintenance and academic research
- show the requisites for successful work in international and interdisciplinary project groups which include engineers and non-engineers. This goal includes abilities in oral and written presentation and argumentation in Swedish and English.

Ability to make judgements and adopt a standpoint

For the master's degree from the programme Computer Science, the student shall

- be able to evaluate the quality of scientific studies and show a reflective and critical approach to scientific and non-scientific texts
- through self-development, retain his/her own professional ability during a professional career
- follow the discussion about technology in society and contribute to it.

Extent and content of the programme

The Master's programme in Computer Science is in the second cycle and comprises 120 ECTS credits, which, at normal study rate, corresponds to two years. The programme is given in English, but some elective courses are given in Swedish.

One of the following tracks must be taken

- Data Science
- Interaction Design
- Cognitive Systems
- Software Technology
- Theoretical Computer Science

- Scientific Computing
- Visualization and Interactive Graphics
- Security and Privacy

In some tracks, one of several subtracks must be selected. Under special circumstances an individual track can be approved by the programme director.

Eligibility and selection

General admission requirements, and the following special eligibility requirements:

- Mathematics: three different subjects of a total of 22,5 credits. Among those subjects there must be a course in one-variabel calculus, a course in linear algebra and a course in discrete structures.
- Computer Science/Information technology: three different subjects of a total of 22.5 credits. Among those subjects there must be a course in object oriented programming, a course in algorithms and data structures and a course in computational complexity.
- A course in Calculus in Several Variable is required to some of the tracks.

If the number of applicants exceeds the number of available places a selection will be done from the following criterias: evaluation of university, grades from previous study, and motivation to study. The evaluation scale is 1-75.

Implementation of the education

Structure of the education

Each academic year consists of two semesters which are 20 weeks each, and each semester is further divided into two study periods.

During the first study year, mandatory courses are taken on a total of 30 ECTS credits.

In addition to the compulsory courses, it is required to follow a track within the master programme computer science. The compulsory courses in each track vary between 7.5 credits and 22.5 credits. In addition, each track has conditionally elective courses between 7.5 credits and 22.5 credits. Regardless of which track you follow, the program has 28 credits of elective courses.

A Programme Integrating Course, 2 ECTS credits, spread over two years is also compulsory for the programme.

The programme is concluded by a degree project, 30 ECTS credits.

Others 28 credits are elective courses.

Courses

The programme is course-based. Lists of courses are included in appendix 1.

Grading system

Courses in the first and the second cycle are graded on a scale from A to F. A-E are passing grades, A is the highest grade. The grades pass (P) and fail (F) are used for courses under certain circumstances.

The grading scale is found in the course syllabus.

Conditions for participation in the programme

Participation requires admission to courses within the programme, and course registration.

For further studies, special admission requirements for the course are to be fulfilled. Special admission requirements are listed in the respective course syllabus.

Degree project

The degree project is the final part of the education. The project work may begin when special admission requirements for the course are fulfilled.

Degree

This degree is entitled “Teknologie masterexamen” - Master of Science (120 credits). The text on the degree certificate states the educational programme completed by the student.

Appendix 1 - Course list

Appendix 2 - Programme syllabus descriptions



Appendix 1: Course list

Master's Programme, Computer Science (TCSCM)

General courses

Year 1

Mandatory courses (32.0 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DA2210 | Introduction to the Philosophy of Science and Research Methodology for Computer Scientists | 6.0 hp | Second cycle |
| DD2300 | Program Integrating Course in Computer Science <i>One credit each academic year</i> | 2.0 hp | Second cycle |
| DD2380 | Artificial Intelligence | 6.0 hp | Second cycle |
| DD2395 | Computer Security | 6.0 hp | Second cycle |
| DD2440 | Advanced Algorithms | 6.0 hp | Second cycle |
| IK2218 | Protocols and Principles of the Internet | 6.0 hp | Second cycle |

Supplementary information

Students who in a previous degree have read a course corresponding to DD2380, DD2395, IK2218 or DD2440 may apply to read a replacement course instead. The application is submitted to the master coordinator who, after reviewing the previously read course, helps the student to choose an appropriate replacement course. The course should be at least 6 credits, advanced level and broad in computer science. It must not be included in the student's track and the subject matter may not be close to any of the other compulsory courses.

The choice of replacement course must be approved by the programme director.

Students at KTH:

- from **CTFYS** or **CINTE**, who miss the equivalent courses in previous degree are also required to take:

- DD2350 Algorithms, Data Structures and Complexity 9,5 credits *or* DD2352 Algorithms and Complexity 7,5 credits.

- SF1662 Discrete Mathematics 7,5 credits/SF1610 Discrete Mathematics, 7,5 credits /SF1679 Discrete Mathematics 7,5 credits.

- from **CINTE** who have read any of the following courses can apply to read a replacement course: IK1203 Network and Communication, ID1214 Artificial Intelligence and Applications, IV1013 Introduction to Computer Security. Contact the master coordinator according to the instructions above.

- from **CDATE**, who started 2011 or earlier, have to take the compulsory course ID2200 Operating System 6 credits in the master's programme.

Year 2

Mandatory courses (32.0 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DA231X | Degree Project in Computer Science and Engineering, Second Cycle | 30.0 hp | Second cycle |
| DD2300 | Program Integrating Course in Computer Science <i>One credit each academic year</i> | 2.0 hp | Second cycle |

Track, Cognitive Systems (CSCS)

Year 1

Mandatory courses (7.5 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|------------------|---------|--------------|
| DD2421 | Machine Learning | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2417 | Language Engineering <i>Conditionally elective for the subtrack Conversational systems</i> | 7.5 hp | Second cycle |
| DD2424 | Deep Learning in Data Science <i>Compulsory for the subtrack Vision and robotics, Conditionally elective for the subtrack Conversational systems</i> | 7.5 hp | Second cycle |
| DT2112 | Speech Technology <i>Conditionally elective for the subtrack Conversational systems</i> | 7.5 hp | Second cycle |
| DT2119 | Speech and Speaker Recognition <i>Conditionally elective for the subtrack Conversational systems</i> | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2438 | Artificial Intelligence and Multi Agent Systems | 15.0 hp | Second cycle |
| DD2477 | Search Engines and Information Retrieval Systems | 7.5 hp | Second cycle |

Supplementary information

Prerequisites:

SF1626 Calculus in Several Variable, 7,5 credits (or equivalent).

Information regarding conditionally elective courses

One of the subtracks must be taken:

Subtrack 1: Vision and Robotics

Mandatory courses (read in year 2):

- **DD2410** Introduction to Robotics
- **DD2423** Image Analysis and Computer Vision
- **DD2424** Deep Learning in Data Science

Subtrack 2: Conversational System

Mandatory course:

- **DT2151** Project in Conversational Systems

At least **one** must be taken:

- **DT2112** Speech Technology
- **DT2119** Speech and Speaker Recognition

At least **7,5 credits** must be taken from:

- **DD2424** Deep Learning in Data Science
- **DD2437** Artificial Neural Networks and Deep Architectures
- **DT2140** Multimodal Interaction and Interfaces
- **DD2417** Language Engineering.

Some courses may be given every two years.

Year 2

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2410 | Introduction to Robotics <i>Compulsory for the subtrack Vision and robotics</i> | 7.5 hp | Second cycle |
| DD2423 | Image Analysis and Computer Vision <i>Compulsory for the subtrack Vision and robotics</i> | 7.5 hp | Second cycle |
| DD2437 | Artificial Neural Networks and Deep Architectures <i>Conditionally elective for the subtrack Conversational systems</i> | 7.5 hp | Second cycle |
| DT2140 | Multimodal Interaction and Interfaces <i>Conditionally elective for the subtrack Conversational systems</i> | 7.5 hp | Second cycle |
| DT2151 | Project in Conversational Systems <i>Compulsory for the subtrack Conversational systems</i> | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2417 | Language Engineering | 7.5 hp | Second cycle |
| DD2429 | Computational Photography | 6.0 hp | Second cycle |
| DD2434 | Machine Learning, Advanced Course | 7.5 hp | Second cycle |
| DD2438 | Artificial Intelligence and Multi Agent Systems | 15.0 hp | Second cycle |
| DD2447 | Statistical Methods in Applied Computer Science | 6.0 hp | Second cycle |
| DD2477 | Search Engines and Information Retrieval Systems | 7.5 hp | Second cycle |
| DT2410 | Audio Technology | 7.5 hp | Second cycle |
| EL2320 | Applied Estimation | 7.5 hp | Second cycle |

| | | | |
|--------|--------------------|--------|--------------|
| SF1861 | Optimization | 6.0 hp | First cycle |
| SF2940 | Probability Theory | 7.5 hp | Second cycle |

Supplementary information

Prerequisites:

SF1626 Calculus in Several Variables, 7,5 credits (or equivalent).

Information regarding conditionally elective courses

One of the subtracks must be taken:

Subtrack 1: Vision and Robotics

Mandatory courses (read in year 2):

- **DD2410** Introduction to Robotics
- **DD2423** Image Analysis and Computer Vision
- **DD2424** Deep Learning in Data Science

Subtrack 2: Conversational System

Mandatory course:

- **DT2151** Project in Conversational Systems

At least **one** must be taken:

- **DT2112** Speech Technology
- **DT2119** Speech and Speaker Recognition

At least **7,5 credits** must be taken from:

- **DD2424** Deep Learning in Data Science
- **DD2437** Artificial Neural Networks and Deep Architectures
- **DT2140** Multimodal Interaction and Interfaces
- **DD2417** Language Engineering.

Some courses may be given every two years.

Track, Data Science (CSDA)

Year 1

Mandatory courses (7.5 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2421 | Machine Learning <i>One can be given credit for an equivalent earlier course</i> | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2417 | Language Engineering <i>Compulsory for the subtrack Natural Language Processing</i> | 7.5 hp | Second cycle |
| DD2420 | Probabilistic Graphical Models <i>Conditionally elective for the subtrack Machine learning</i> | 7.5 hp | Second cycle |
| DD2424 | Deep Learning in Data Science <i>Compulsory for the subtrack Machine Learning</i> | 7.5 hp | Second cycle |
| DD2477 | Search Engines and Information Retrieval Systems <i>Compulsory for the subtrack Natural Language Processing</i> | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2438 | Artificial Intelligence and Multi Agent Systems | 15.0 hp | Second cycle |
| DH2320 | Introduction to Visualization and Computer Graphics | 6.0 hp | Second cycle |
| DH2321 | Information Visualization | 6.0 hp | Second cycle |
| DT2112 | Speech Technology | 7.5 hp | Second cycle |
| DT2119 | Speech and Speaker Recognition | 7.5 hp | Second cycle |

Supplementary information

Prerequisites:

SF1626 Calculus in Several Variable, 7,5 credits (or equivalent).

Information regarding conditionally elective courses

One of the subtracks must be chosen:

Subtrack 1: Machine Learning

Mandatory course:

- **DD2421** Machine Learning
- **DD2424** Deep Learning in Data Science

One of these courses must be taken:

- **DD2434** Machine Learning Advanced Course
- **DD2437** Artificial Neural Networks and Deep Architectures
- **DD2420** Probabilistic Graphical Models.

Subtrack 2: Natural Language Processing

Mandatory courses:

- **DD2421** Machine Learning
- **DD2477** Search Engines and Information Retrieval Systems
- **DD2417** Language Engineering.

Some courses may be given every two years.

Year 2

Mandatory courses (7.5 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|--------------------------------|---------|--------------|
| DD2430 | Project Course in Data Science | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2434 | Machine Learning, Advanced Course <i>Conditionally elective for the subtrack Machine learning</i> | 7.5 hp | Second cycle |
| DD2437 | Artificial Neural Networks and Deep Architectures <i>Conditionally elective for the subtrack Machine learning</i> | 7.5 hp | Second cycle |
| SF2940 | Probability Theory | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2257 | Visualization | 7.5 hp | Second cycle |
| DD2412 | Deep Learning, Advanced Course | 6.0 hp | Second cycle |
| DD2413 | Social Robotics | 7.5 hp | Second cycle |
| DD2423 | Image Analysis and Computer Vision | 7.5 hp | Second cycle |
| DD2447 | Statistical Methods in Applied Computer Science | 6.0 hp | Second cycle |
| EL2320 | Applied Estimation | 7.5 hp | Second cycle |
| SF1811 | Optimization | 6.0 hp | First cycle |

Supplementary information

Prerequisites:

SF1626 Calculus in Several Variable, 7,5 credits (or equivalent).

Information regarding conditionally elective courses

One of the subtracks must be chosen:

Subtrack 1: Machine Learning

Mandatory course:

- **DD2424** Deep Learning in Data Science

One of these courses must be taken:

- **DD2434** Machine Learning Advanced Course
- **DD2437** Artificial Neural Networks and Deep Architectures
- **DD2420** Probabilistic Graphical Models.

Subtrack 2: Natural Language Processing

Mandatory courses:

- **DD2477** Search Engines and Information Retrieval Systems
- **DD2417** Language Engineering.

Some courses may be given every two years.

Track, Interaction Design (CSID)

Year 1

Mandatory courses (15.0 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DH2628 | Interaction Design Methods | 7.5 hp | Second cycle |
| DH2629 | Interaction Design as a Reflective Practice | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DH2321 | Information Visualization | 6.0 hp | Second cycle |
| DH2400 | Physical Interaction Design and Realization | 7.5 hp | Second cycle |
| DH2632 | Human-Computer Interaction, Research Seminars | 3.0 hp | Second cycle |

Information regarding conditionally elective courses

At least **15 credits** (ie either 7,5+7,5 credits, or 7,5+6+3 credits) must be taken:

- **DH2321** Information Visualization
- **DH2400** Physical Interaction Design and Realization
- **DH2632** Human-Computer Interaction Research Seminars
- **DH2408** Evaluation Methods in Human-Computer Interaction
- **DH2413** Advanced Graphics and Interaction
- **DM2630** User Experience Design and Evaluation
- **DT2140** Multimodal Interaction and Interfaces.

Some courses may be given every two years.

Year 2

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------|------|---------|------------|
| | | | |

| | | | |
|--------|--|--------|--------------|
| DH2408 | Evaluation Methods in Human-Computer Interaction | 6.0 hp | Second cycle |
| DH2413 | Advanced Graphics and Interaction | 9.0 hp | Second cycle |
| DM2630 | User Experience Design and Evaluation | 9.0 hp | Second cycle |
| DT2140 | Multimodal Interaction and Interfaces | 7.5 hp | Second cycle |

Information regarding conditionally elective courses

At least **15 credits** (ie either 7,5+7,5 credits, or 7,5+6+3 credits) must be taken:

- **DH2321** Information Visualization
- **DH2400** Physical Interaction Design and Realization
- **DH2632** Human-Computer Interaction Research Seminars
- **DH2408** Evaluation Methods in Human-Computer Interaction
- **DH2413** Advanced Graphics and Interaction
- **DM2630** User Experience Design and Evaluation
- **DT2140** Multimodal Interaction and Interfaces.

Some courses may be given every two years.

Track, Scientific Computing (CSSC)

Year 1

Mandatory courses (7.5 Credits)

| Code | Name | Credits | Edu. level |
|--------|---|---------|--------------|
| DD2356 | Methods in High Performance Computing <i>Mandatory in Subtrack 1 and 2</i> | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|--------|--|---------|--------------|
| DD2358 | Introduction to High Performance Computing <i>Mandatory in Subtrack 1</i> | 7.5 hp | Second cycle |
| DD2363 | Methods in Scientific Computing <i>Mandatory in Subtrack 2</i> | 7.5 hp | Second cycle |
| DD2365 | Advanced Computation in Fluid Mechanics | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2401 | Neuroscience | 7.5 hp | Second cycle |
| DD2421 | Machine Learning | 7.5 hp | Second cycle |
| DH2320 | Introduction to Visualization and Computer Graphics | 6.0 hp | Second cycle |
| DT2212 | Music Acoustics | 7.5 hp | Second cycle |
| HL2008 | Simulation Methods in Medical Engineering | 7.5 hp | Second cycle |

Supplementary information

Prerequisites:

SF1626 Calculus in Several Variable, 7,5 credits.

Information regarding conditionally elective courses

One of the subtracks must be taken:

Subtrack 1: High Performance Computing

Mandatory courses within the subtrack:

- **DD2358** Introduction to High Performance Computing
- **DD2356** Methods in High Performance Computing
- **DD2360** Applied GPU Programming

One of the courses should be taken:

- **DD2370** Computational Methods for Electromagnetics
- **DD2375** Project Course in High-Performance Computing

Subtrack 2: Computational Science

Mandatory courses within the subtrack:

- **DD2356** Methods in High Performance Computing
- **DD2363** Methods in Scientific Computing
- **DD2444** Project Course in Scientific Computing

One of the courses should be taken:

- **DD2437** Artificial Neural Networks and Deep Architectures
- **DD2257** Visualization
- **DD2365** Advanced Computation in Fluid Mechanics.

Some courses may be given every two years.

Year 2

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2257 | Visualization | 7.5 hp | Second cycle |
| DD2360 | Applied GPU Programming <i>Mandatory in Subtrack 1</i> | 7.5 hp | Second cycle |
| DD2370 | Computational Methods for Electromagnetics | 7.5 hp | Second cycle |
| DD2437 | Artificial Neural Networks and Deep Architectures | 7.5 hp | Second cycle |
| DD2444 | Project Course in Scientific Computing <i>Mandatory in Subtrack 2</i> | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| BB2280 | Molecular Modeling | 7.5 hp | Second cycle |
| DD2402 | Advanced Individual Course in Computational Biology | 6.0 hp | Second cycle |
| DD2421 | Machine Learning | 7.5 hp | Second cycle |
| DD2435 | Mathematical Modelling of Biological Systems | 9.0 hp | Second cycle |
| DD2443 | Parallel and Distributed Computing | 7.5 hp | Second cycle |
| EL2820 | Modelling of Dynamical Systems | 7.5 hp | Second cycle |
| SF2561 | The Finite Element Method | 7.5 hp | Second cycle |
| SF2565 | Program Construction in C++ for Scientific Computing | 7.5 hp | Second cycle |

Supplementary information

Prerequisites:

SF1626 Calculus in Several Variable, 7,5 credits.

Information regarding conditionally elective courses

One of the subtracks must be taken:

Subtrack 1: High Performance Computing

Mandatory courses within the subtrack:

- **DD2358** Introduction to High Performance Computing
- **DD2356** Methods in High Performance Computing
- **DD2360** Applied GPU Programming

One of the courses should be taken:

- **DD2370** Computational Methods for Electromagnetics
- **DD2375** Project Course in High-Performance Computing

Subtrack 2: Computational Science

Mandatory courses within the subtrack:

- **DD2356** Methods in High Performance Computing
- **DD2363** Methods in Scientific Computing
- **DD2444** Project Course in Scientific Computing

One of the courses should be taken:

- **DD2437** Artificial Neural Networks and Deep Architectures
- **DD2257** Visualization
- **DD2365** Advanced Computation in Fluid Mechanics.

Some courses may be given every two years.

Track, Security and Privacy (CSSP)

Year 1

Mandatory courses (7.5 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|----------------------|---------|--------------|
| DD2520 | Applied Cryptography | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|-----------------------------|---------|--------------|
| DD2448 | Foundations of Cryptography | 7.5 hp | Second cycle |
| DD2525 | Language-Based Security | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|-------------------------------------|---------|--------------|
| DD2460 | Software Safety and Security | 7.5 hp | Second cycle |
| EP2520 | Building Networked Systems Security | 7.5 hp | Second cycle |
| ID2218 | Design of Fault-tolerant Systems | 7.5 hp | Second cycle |
| IL1333 | Hardware Security | 7.5 hp | First cycle |

Information regarding conditionally elective courses

At least **two** of the courses must be taken:

- **DD2448** Foundations of Cryptography
- **DD2525** Language-Based Security
- **DD2496** Privacy Enhancing Technologies
- **DD2443** Parallel and Distributed Computing

At least **one** course must be taken:

- **DD2497** Project course in System Security
- **EP2510** Advanced Networked Systems Security.

Some courses may be given every two years.

Year 2

Mandatory courses (7.5 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|----------------------|---------|--------------|
| DD2520 | Applied Cryptography | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|-------------------------------------|---------|--------------|
| DD2443 | Parallel and Distributed Computing | 7.5 hp | Second cycle |
| DD2496 | Privacy Enhancing Technologies | 7.5 hp | Second cycle |
| DD2497 | Project course in System Security | 7.5 hp | Second cycle |
| DD2525 | Language-Based Security | 7.5 hp | Second cycle |
| EP2510 | Advanced Networked Systems Security | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2528 | Dependable Autonomous Systems | 7.5 hp | Second cycle |
| EN2720 | Ethical Hacking | 7.5 hp | Second cycle |
| EP2790 | Security Analysis of Large-Scale Computer Systems | 7.5 hp | Second cycle |

Information regarding conditionally elective courses

At least **two** of the courses must be taken:

- **DD2448** Foundations of Cryptography
- **DD2525** Language-Based Security
- **DD2496** Privacy Enhancing Technologies
- **DD2443** Parallel and Distributed Computing

At least **one** course must be taken:

- **DD2497** Project course in System Security
- **EP2510** Advanced Networked Systems Security.

Some courses may be given every two years.

Track, Software Technology (CSST)

Year 1

Mandatory courses (7.5 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|-----------------------------------|---------|--------------|
| DD2480 | Software Engineering Fundamentals | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2372 | Automata and Languages <i>Conditionally elective for the subtrack Programming Languages</i> | 6.0 hp | Second cycle |
| DD2459 | Software Reliability <i>Conditionally elective for the subtrack Software Engineering</i> | 7.5 hp | Second cycle |
| DD2460 | Software Safety and Security <i>Conditionally elective for the subtrack Software Engineering</i> | 7.5 hp | Second cycle |
| DD2481 | Principles of Programming Languages <i>Mandatory for the subtrack Programming Languages and conditionally elective for the subtrack Software Engineering</i> | 7.5 hp | Second cycle |
| DD2482 | Automated Software Testing and DevOps <i>Conditionally elective for the subtrack Software Engineering</i> | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2421 | Machine Learning | 7.5 hp | Second cycle |
| DD2477 | Search Engines and Information Retrieval Systems | 7.5 hp | Second cycle |
| ID1217 | Concurrent Programming | 7.5 hp | First cycle |

Information regarding conditionally elective courses

One of the subtracks must be chosen:

Subtrack 1: Programming Languages

Mandatory courses:

- **DD2481** Principles of Programming Languages
- **DD2488** Compiler Construction

One course must be taken (given alternately every two years):

- **DD2372** Automata and Languages (not given Spring 2021)
- **DD2457** Program Semantics and Analysis (not given Spring 2022)

Subtrack 2: Software Engineering

Mandatory course:

- **DD2487** Large-Scale Software Development

At least **two** courses must be taken:

- **DD2443** Parallel and Distributed Computing
- **DD2459** Software Reliability
- **DD2460** Software Safety and Security
- **DD2481** Principles of Programming Languages
- **DD2482** Automated Software Testing and DevOps
- **DD2528** Dependable Autonomous Systems (given every two years, not in Autumn 2022).

Some courses may be given every two years.

Year 2

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2372 | Automata and Languages <i>Conditionally elective for the subtrack Programming Languages</i> | 6.0 hp | Second cycle |
| DD2443 | Parallel and Distributed Computing <i>Conditionally elective for the subtrack Software Engineering</i> | 7.5 hp | Second cycle |
| DD2487 | Large-Scale Software Development <i>Compulsory for the subtrack Software Engineering</i> | 7.5 hp | Second cycle |
| DD2488 | Compiler Construction <i>Compulsory for the subtrack Programming languages</i> | 9.0 hp | Second cycle |
| DD2528 | Dependable Autonomous Systems | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2421 | Machine Learning | 7.5 hp | Second cycle |
| DD2458 | Problem Solving and Programming under Pressure | 9.0 hp | Second cycle |
| DD2477 | Search Engines and Information Retrieval Systems | 7.5 hp | Second cycle |
| ID1217 | Concurrent Programming | 7.5 hp | First cycle |

Information regarding conditionally elective courses

One of the subtracks must be chosen:

Subtrack 1: Programming Languages

Mandatory courses:

- **DD2481** Principles of Programming Languages
- **DD2488** Compiler Construction

One course must be taken (given alternately every two years):

- **DD2372** Automata and Languages (not given Spring 2021)
- **DD2457** Program Semantics and Analysis (not given Spring 2022)

Subtrack 2: Software Engineering

Mandatory course:

- **DD2487** Large-Scale Software Development

At least **two** courses must be taken:

- **DD2443** Parallel and Distributed Computing
- **DD2459** Software Reliability
- **DD2460** Software Safety and Security
- **DD2481** Principles of Programming Languages
- **DD2482** Automated Software Testing and DevOps
- **DD2528** Dependable Autonomous Systems (given every two years, not in Autumn 2022).

Some courses may be given every two years.

Track, Theoretical Computer Science (CSTC)

Year 1

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2372 | Automata and Languages <i>Conditionally elective for the subtrack Formal Methods and Semantics</i> | 6.0 hp | Second cycle |
| DD2445 | Complexity Theory <i>Conditionally elective for the subtrack Algorithms, Complexity and Cryptography</i> | 7.5 hp | Second cycle |
| DD2448 | Foundations of Cryptography <i>Mandatory for the subtrack Algorithms, Complexity and Cryptography</i> | 7.5 hp | Second cycle |
| DD2459 | Software Reliability <i>Conditionally elective for the subtrack Formal Methods and Semantics</i> | 7.5 hp | Second cycle |
| DD2460 | Software Safety and Security <i>Conditionally elective for the subtrack Formal Methods and Semantics</i> | 7.5 hp | Second cycle |
| SF2972 | Game Theory | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|------------------------|---------|-------------|
| ID1217 | Concurrent Programming | 7.5 hp | First cycle |

Supplementary information

Mandatory course for all:

DD2467 Individual Project in Theoretical Computer Science 7,5 credits

Information regarding conditionally elective courses

All should take **at least one** of these courses:

- **SF2740** Graph Theory (will be given every two years, given in Fall 2021)
- **SF2972** Game Theory (will be given every two years, given in Spring 2022)
- **SF2940** Probability Theory
- **SF2741** Enumerative Combinatorics (will be given every two years, given in Fall 2022).

The student may propose a change to other courses in mathematics at advanced level and a total of at least 7,5 credits. The proposal is submitted to the Master Coordinator well in advance of the course start. The course change must be approved by the Programme Director.

Subtrack 1: Algorithms, Complexity and Cryptography

Mandatory course:

- **DD2448** Foundations of Cryptography

At least **one** of the courses must be taken:

- **DD2542** Seminars on Theoretical Computer Science, Algorithms and Complexity (will be given every two years, given in Fall 2022)
- **DD2445** Complexity Theory (will be given every two years, given in Fall 2021).

Subtrack 2: Formal Methods and Semantics

One mandatory course:

- **DD2452** Formal Methods (will be given every two years, given in Fall 2022), **or**
- **DD2552** Seminars on Theoretical Computer Science, Programming Languages and Formal Methods (will be given every two years, given in Fall 2021).

At least **7,5 credits** must be taken:

- **DD2459** Software Reliability
- **DD2457** Program Semantics and Analysis (will be given every two years, given in Spring 2023)
- **DD2460** Software Safety and Security
- **DD2372** Automata and Languages (will be given every two years, given in Spring 2022)
- **DD2443** Parallel and Distributed Computing.

Some courses may be given every two years.

Year 2

Mandatory courses (7.5 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2467 | Individual Project in Theoretical Computer Science | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2372 | Automata and Languages <i>Conditionally elective for the subtrack Formal Methods and Semantics</i> | 6.0 hp | Second cycle |
| DD2443 | Parallel and Distributed Computing <i>Conditionally elective for the subtrack Formal Methods and Semantics</i> | 7.5 hp | Second cycle |
| DD2452 | Formal Methods <i>Compulsory for the subtrack Formal Methods and Semantics</i> | 7.5 hp | Second cycle |
| DD2457 | Program Semantics and Analysis <i>Conditionally elective for the subtrack Formal Methods and Semantics</i> | 6.0 hp | Second cycle |
| DD2542 | Seminars on Theoretical Computer Science, Algorithms and Complexity <i>Conditionally elective for the subtrack Algorithms, Complexity and Cryptography</i> | 7.5 hp | Second cycle |
| DD2552 | Seminars on Theoretical Computer Science, Programming Languages and Formal Methods <i>Mandatory for the subtrack Formal Methods and Semantics</i> | 7.5 hp | Second cycle |
| SF2740 | Graph Theory | 7.5 hp | Second cycle |
| SF2741 | Enumerative Combinatorics | 7.5 hp | Second cycle |
| SF2940 | Probability Theory | 7.5 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2447 | Statistical Methods in Applied Computer Science | 6.0 hp | Second cycle |
| DD2458 | Problem Solving and Programming under Pressure | 9.0 hp | Second cycle |
| ID1217 | Concurrent Programming | 7.5 hp | First cycle |

Supplementary information

Mandatory course for all:

DD2467 Individual Project in Theoretical Computer Science, 7,5 credits

Information regarding conditionally elective courses

All should take **at least one** of these courses:

- **SF2740** Graph Theory (will be given every two years, given in Fall 2021)
- **SF2972** Game Theory (will be given every two years, given in Spring 2022)
- **SF2940** Probability Theory
- **SF2741** Enumerative Combinatorics (will be given every two years, given in Fall 2022).

The student may propose a change to other courses in mathematics at advanced level and a total of at least 7,5 credits. The proposal is submitted to the Master Coordinator well in advance of the course start. The course change must be approved by the Programme Director.

Subtrack 1: Algorithms, Complexity and Cryptography

Mandatory course:

- **DD2448** Foundations of Cryptography

At least **one** of the courses must be taken:

- **DD2542** Seminars on Theoretical Computer Science, Algorithms and Complexity (will be given every two years, given in Fall 2022).
- **DD2445** Complexity Theory (will be given every two years, given in Fall 2021).

Subtrack 2: Formal Methods and Semantics

Mandatory course:

- **DD2452** Formal Methods (will be given every two years, given in Fall 2022),
- **DD2552** Seminars on Theoretical Computer Science, Programming Languages and Formal Methods (will be given every two years, given in Fall 2021).

At least 7,5 credits must be taken:

- **DD2459** Software Reliability
- **DD2457** Program Semantics and Analysis (will be given every two years, given in Spring 2023)
- **DD2460** Software Safety and Security
- **DD2372** Automata and Languages (will be given every two years, given in Spring 2022)
- **DD2443** Parallel and Distributed Computing.

Some courses may be given every two years.

Track, Visualization and Interactive Graphics (CSVG)

Year 1

Mandatory courses (7.5 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2258 | Introduction to Visualization, Computer Graphics and Image /Video Processing | 7.5 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|-----------------------------------|---------|--------------|
| DD2257 | Visualization | 7.5 hp | Second cycle |
| DH2321 | Information Visualization | 6.0 hp | Second cycle |
| DH2323 | Computer Graphics and Interaction | 6.0 hp | Second cycle |
| DH2413 | Advanced Graphics and Interaction | 9.0 hp | Second cycle |
| DH2650 | Computer Game Design | 6.0 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|---------------------------------------|---------|--------------|
| DD2356 | Methods in High Performance Computing | 7.5 hp | Second cycle |
| DD2424 | Deep Learning in Data Science | 7.5 hp | Second cycle |

Information regarding conditionally elective courses

At least **18 credits** must be taken:

- **DD2257** Visualization
- **DH2321** Information Visualization
- **DH2323** Computer Graphics and Interaction
- **DH2413** Advanced Graphics and Interaction
- **DH2650** Computer Game Design.

Some courses may be given every two years.

Year 2

Mandatory courses (6.0 Credits)

| Code | Name | Credits | Edu. level |
|------------------------|--|---------|--------------|
| DD2470 | Advanced Topics in Visualization and Computer Graphics | 6.0 hp | Second cycle |

Conditionally elective courses

| Code | Name | Credits | Edu. level |
|------------------------|-----------------------------------|---------|--------------|
| DD2257 | Visualization | 7.5 hp | Second cycle |
| DH2321 | Information Visualization | 6.0 hp | Second cycle |
| DH2323 | Computer Graphics and Interaction | 6.0 hp | Second cycle |
| DH2413 | Advanced Graphics and Interaction | 9.0 hp | Second cycle |
| DH2650 | Computer Game Design | 6.0 hp | Second cycle |

Recommended courses

| Code | Name | Credits | Edu. level |
|------------------------|---|---------|--------------|
| DD2356 | Methods in High Performance Computing | 7.5 hp | Second cycle |
| DD2423 | Image Analysis and Computer Vision | 7.5 hp | Second cycle |
| DD2424 | Deep Learning in Data Science | 7.5 hp | Second cycle |
| DM2350 | Human Perception for Information Technology | 7.5 hp | Second cycle |

Information regarding conditionally elective courses

At least **18 credits** must be taken:

- **DD2257** Visualization
- **DH2321** Information Visualization
- **DH2323** Computer Graphics and Interaction
- **DH2413** Advanced Graphics and Interaction
- **DH2650** Computer Game Design.

Some courses may be given every two years.



Appendix 2: Specialisations

Master's Programme, Computer Science (TCSCM)

Track, Cognitive Systems (CSCS)

The track of Cognitive Systems is about the development of programs with artificial intelligence, ie abilities traditionally associated with people. Within the track you can choose to go deeper into robotics or conversational systems (systems that interact through human language, such as voice assistants, social robots and chat bots).

Track, Data Science (CSDA)

In our society, huge amounts of data are produced. This track Data Science is about methods for managing and analyzing data from various sources, e.g. images, video, text. Within the track one of two sub-tracks can be selected; Machine Learning or Natural Language Processing.

Track, Interaction Design (CSID)

The Interaction Design track deals with the development of interactive systems from a user-centered perspective in theory and practice. The track deals with concepts and models, methods for data collection and analysis, design and development and evaluation.

Track, Scientific Computing (CSSC)

The track Scientific Computing focuses on the techniques of mathematical modeling and numerical simulation of physical, chemical and biological systems. This can be the basis for virtual experiments that simulated crash tests, but also to build interactive virtual environments, i.e. for computer games. Within the track there are two sub-tracks, one of them must be selected, either High Performance Calculations or Scientific Calculations.

Track, Security and Privacy (CSSP)

This track, Security and Privacy, is about the theory and practice of security, ranging from concepts to implementation, at different layers (hardware, network, system, application) and foundations (cryptography, formal methods, systems).

Track, Software Technology (CSST)

The track Software Technology is about methods for designing, developing and maintaining software. After a common course in Program Development Technology's basics, one of two sub-tracks is chosen: either Program Language specializing in Program Language basics, Compilers and Program Semantics or Software Engineering specializing in Large-scale Software Development, Automated Testing and Design of Reliable and Secure Software (distributed and/or autonomous).

Track, Theoretical Computer Science (CSTC)

The track Theoretical Computer Science is about the abstract and mathematical methods to study algorithms. Students learn to use formal methods and focus on verifiable properties of software and software systems. Within the track there are two sub-tracks, of which one must be selected, either Algorithms, Complexity and Cryptography or Formal Methods and Semantics.

Track, Visualization and Interactive Graphics (CSVG)

The Visualization and Graphics track stretches from basic visualization and graphics to modern research in the field. Visualization is mainly about making large and complex data understandable with the help of graphics, but has applications in computer games and other virtual environments.