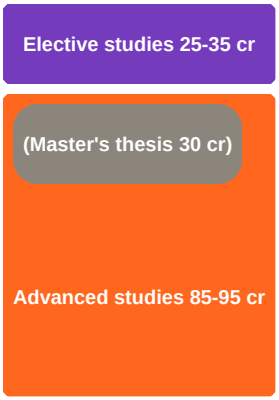
Curriculum 2017-2018

Master of Science (Technology) degree is 120 ECTS credits. The degree consists of major studies, Master's thesis and elective studies. Some majors offer both long and compact options. Students taking a compact major take also a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.

Long major:



Compact major:

CCIS programme offers eight majors. Some majors have also several tracks.

Learning Outcomes

Master's Programme in Computer, Communication and Information Sciences (CCIS) is jointly organized by the School of Electrical Engineering and the School of Science. The CCIS programme's core courses provide strong foundation in computer science, communication engineering, and information science. In addition, students can immerse themselves deep into one of the specialization tracks or focused majors.

In CCIS, education is based both on scientific research and industrial state-of-the-art. Students gain in-depth knowledge in one major. They learn how to apply scientific knowledge and scientific methods independently. Students interested in pursuing doctoral studies after their M.Sc. degree can easily transfer to the Helsinki Doctoral Education Network in Information and Communications Technology (HICT). Students acquire professional language and communication skills. All students are encouraged to include international, multidisciplinary, and entrepreneurial components as part of their studies.

Majors 2017-2018

You will find more information on the majors of the programme in the navigation bar on the left.

This study guide presents the curricula of CCIS programme. CCIS programme offers eight majors. Some majors have also several tracks.

Note that there are some restrictions regarding the selection of major (see How to apply).

The majors and tracks are the following:

- Acoustics and Audio Technology
- Communications Engineering
    - Internet Technologies
    - Wireless Communications
    - Communication Ecosystem
- Computer Science
    - Software Systems and Technologies
    - Secure Systems
    - Web Technologies, Applications, and Science
    - Interactive Technologies
    - Algorithms, Logic, and Computiation
    - Big Data and Large-Scale Computing
- Game Design and Production
- Machine Learning and Data Mining
- Mobile Computing, Services and Security
- Signal, Speech and Language Processing
    - Signal Processing and data science
    - Speech and Language Processing
- Software and Service Engineering
    - Software Engineering
    - Service Design and Engineering
    - User-Centered Design
    - Enterprise Systems

Some majors offer both long and compact options. Students taking a compact major take also a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.

You will find study tracks and recommended study schedules under Planning your studies.

Acoustics and Audio Technology (AAT) 2017-2018

Code: ELEC3030

Credits: Long (55-65 credits) or compact (40-45 credits) major

Professor in charge: Ville Pulkki (ELEC)

Professors: Tapio Lokki (SCI), Lauri Savioja (SCI), Vesa Välimäki (ELEC)

Abbreviation: AAT

School: Electrical Engineering (coordinator) and Science

Objectives

The major in Acoustics and Audio Technology gives fundamental knowledge about acoustical phenomena, human hearing and audio technologies, and also facilitates the students to apply the knowledge in practice.

The fields of electroacoustics, room and building acoustics, noise, musical acoustics, and audio signal processing are focused in the studies. A central field in the studies is technical psychoacoustics studying human hearing mechanisms, which is a cornerstone in the development of acoustical and audio technologies for human listeners. The fields together constitute the field of communication acoustics, where there exists always a human listener at the end of the acoustic communication channel. Digital signal processing is currently an important tool in acoustics and audio engineering, and the teaching also emphasizes the understanding of its general principles and of fundamental audio processing algorithms.

The target of the major is that the students could use their learning outcome flexibly in different tasks in industry and in academia. For example, the student should know why and how modern lossy audio codecs (mp3, AAC) work, or he/she should be able to measure, understand the perceptual aspects, and design the acoustics of a class room or a noise barrier. Some exemplar fields where the students are foreseen to be competent are sound recording and reproduction, audio coding, music technology, acoustic measurements, active noise cancellation, audio signal processing, room and building acoustics, and environmental noise. If the student wants to work as a certified acoustics consultant in Finland, at least 10 cr on building technology is required.

The research conducted in Aalto University in the fields of this major has focused on following topics: spatial sound reproduction, concert hall acoustics, synthesis of musical instruments and natural sounds, loudspeaker and headphone reproduction, spatial sound psychoacoustics, digital filtering of audio signals, and modeling of room acoustics. The University is facilitated with top-level acoustical laboratories: three anechoic chambers, a standardized multichannel listening room, sound-proof listening booths, and immersive audiovisual environments.

Content and structure

The major can be completed either as a long (55-65 cr) major or a compact (40-45 cr) major. Students taking the compact major take also a master level minor (20-25 cr). Students taking the long major may include an optional minor in their elective studies.

The major consists of 30 cr of compulsory courses and 10-35 cr of optional courses depending on the choice between long and compact major.

All the major courses are intended to be studied during the first year of master's studies. The course ELEC-E5600 Communication Acoustics is a recommended prerequisite to the other major courses.

Courses

Code	Name	Credits	Period/Year
Compulsory courses (30 credits):			
CS-E5500	Acoustical Measurements P	5	I / 1
CS-E5530	Virtual Acoustics	5	III-IV / 1
ELEC-E0100	Introduction to Master's Studies at Aalto ELEC	0	I-V / 1
ELEC-E5600	Communication Acoustics	5	I / 1
ELEC-E5610	Acoustics and the Physics of Sound	5	II / 1
ELEC-E5620	Audio Signal Processing P	5	III-IV / 1
ELEC-E5630	Acoustics and Audio Technology Seminar P (varying content)	5	IV-V / 1
Optional courses (10-35 credits):			

ELEC-E0200	Master's Thesis Process	0	I-V
CSE5520	Advanced Computer Graphics	5	III-V
CIV-E3010	Applied Building Physics and Design	5	IV
CIV-E1010	Building Materials Technology	5	I
CS-C3100	Computer Graphics	5	I-II
CSE4850	Computer Vision	5	I-II
ELEC-E5421	Convex Optimization for Engineers P	5	I-II
CIV-E3020	Design of Energy Efficient Buildings	5	II
ELEC-E5650	Electroacoustics P	5	IV-V
CSE4200	Emergent User interfaces	5	III-IV
CIV-E1050	Heat and Mass Transfer in Buildings	5	II
CS-C3120	Human-computer Interaction	5	I-II
CIV-E3030	Indoor Air Quality	5	V
CS-E3210	Machine Learning: Basic Principles	5	I
ELEC-E5640	Noise Control	5	II
ELEC-E5410	Signal Processing for Communications	5	I
ELEC-E5430	Signal Processing for Large Scale Data Analysis P	5	III-IV odd years
ELEC-E5660	Special Assignment in Acoustics and Audio Technology P	1-10	I-II, III-V
ELEC-E5500	Speech Processing	5	I
ELEC-E5510	Speech Recognition	5	II
ELEC-E5550	Statistical Natural Language Processing	5	III-IV
ELEC-E5440	Statistical Signal Processing	5	I-II
CIV-E1020	Mechanics of Beam and Frame Structures	5	I

You will find recommended study schedules under Planning your studies.

Departmental study advisors:

Antti Ojapelto, room 1143 (Maarintie 8), room B333 (Konemiehentie 2), tel. +358 50 560 9741, antti.ojapelto (a) aalto.fi

Janani Fernandez, studies-acoustics (at) aalto.fi

Timo Dönsberg, tel. +358 40 7532 046, timo.donsberg (a) aalto.fi

Communications Engineering (CE) 2017-2018

Code: ELEC3029

Credits: Long major (60 credits)

Professor in charge: Riku Jäntti

Professors: Riku Jäntti, Jukka Manner, Heikki Hämmäinen, Raimo Kantola, Stephan Sigg, Tarik Taleb, Patric Östergård, Risto Wichman, Olav Tirkkonen, Jyri Hämäläinen, Antti Oulasvirta

Abbreviation: CE

School: Electrical Engineering

Objectives

The major in Communications Engineering gives a solid understanding of Internet technologies, wireless communications and communications ecosystems - from concepts, technologies and methodologies perspective. Education includes both theoretical and practical aspects of Communications Engineering, preparing the students for a successful career in industry, research organizations or in postgraduate studies without forgetting the professional language and communications skills learned during the education. Students are encouraged to include international, multidisciplinary, and entrepreneurial components as part of their studies.

Content and structure

The major offers three different study tracks: Wireless Communications, Internet Technologies and Communications Ecosystem. The tracks consist of compulsory part and optional part. Student must follow one of the study tracks. The courses for the optional part of the track must be chosen from the course list specified for that track. In the major there are three courses common to all tracks.

You will find study tracks and recommended study schedules under Planning your studies.

Study Coordinator: Mika Nupponen

Email: mika.nupponen(at)aalto.fi
Tel: +358 50 365 0542
Maarintie 8, room 2540

Computer Science (CS) 2017-2018

Code: SCI3042

Extent: Long or compact major (40-65 credits). Students taking a compact major take also a minor (20-25 cr). Students taking a long major may include an optional minor in their elective studies.

Responsible professor: Petri Vuorimaa

Abbreviation: CS

School: School of Science

Objectives

Computer Science major combines both theoretical and applied computer science. The faculty includes over 25 professors. The major has common core courses and five different tracks, which focus on algorithms, software systems, interaction, Web, and Big Data. In addition, the major offers a wide range of advanced courses. Students typically do their Master's thesis in industry. Students interested in postgraduate studies can also do their thesis in research projects of Aalto University.

Content and Structure

Available study tracks:

- Software Systems and Technologies
- Web Technologies, Applications, and Science
- Interactive Technologies
- Algorithms, Logic, and Computation
- Big Data and Large-Scale Computing

Major core courses

The major consists of core courses, track compulsory courses, and elective optional computer-science courses. The purpose of the core courses is to ensure that all students in the major have a solid basic knowledge of computer science and software technology topics. The track courses provide deeper understanding of a specific topic and sufficient background knowledge for the Master's thesis in the track's area. After the core and track compulsory courses, most students will be left with quite a few credits for other computer-science courses.

Students have to select at least five courses from the major core course list, including the compulsory core course(s) defined by the track. The core courses can also be done as part of the Bachelor studies, which reduces the number of core course required at the Master level. Students who have completed equivalent courses at another university can be excused from taking the core courses with agreement of the professor in charge of the study track.

CODE	NAME	CREDITS	PERIOD/YEAR
CS-C3140	Operating Systems	5	I/1st year
CS-C3170	Web Software Development	5	II-III/1st year
CS-C3130	Information Security	5	I/1st year
CS-C3100	Computer Graphics	5	I-II/1st year
CS-E3190	Principles of Algorithmic Techniques	5	I-II/1st year
CS-E3220	Declarative Programming	5	V/1st year
CS-E3210	Machine Learning: Basic Principles	5	I-II/1st year
ELEC-E7851	Computational User Interface Design	5	II/1st year

Study tracks

Professor in charge: Petteri Kaski
Other professors: Parinya Chalermsook, Tomi Janhunen, Pekka Orponen, Jukka Suomela, Jorma Tarhio, Stavros Tripakis
Extent: Long (55-65 credits) or compact (40-45 credits) major as CS track. Students taking a compact major take also a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.
Abbreviation: Algorithms

Objectives

The track on Algorithms, Logic, and Computation provides the students with a strong theoretical background that covers fundamental conceptual tools for the modelling, design, and analysis of advanced computing systems. Our students will receive a solid and versatile methodological education in preparation for a career as an expert in exploiting and advancing new computing technologies. The studies are organised by the Department of Computer Science (cs.aalto.fi) and strongly built on the themes of the research area of Algorithms, Logic, and Computation. The teaching and instruction of the students is conducted by the leading experts in this research area. Excellent students interested in pursuing doctoral studies after their M.Sc. degree can transfer to the Helsinki Doctoral Education Network in Information and Communications Technology (www.hict.fi).

Learning Outcomes

- Students can design, analyse, and implement novel, efficient algorithms for a wide range of computational problems and models of computing.
- Students can formalise computational problems, classify them according to their computational complexity, and use such classifications as a guidance in choosing the right methodology for tackling hard problems.
- Students master fundamental techniques in computational logic and are able to solve computational problems using state-of-the-art algorithms and tools for automated reasoning.
- Students can model and specify complex systems in a rigorous way, and use computational techniques to verify and synthesise such systems.

Content and Structure

The major consists of core courses, track compulsory courses, and optional computer-science courses. The purpose of the core courses is to ensure that all students in the major have a solid basic knowledge of computer science and software technology topics. The track courses provide deeper understanding of a specific topic and sufficient background knowledge for the Master's thesis in the track's area. After the core and track compulsory courses, most students will be left with quite a few credits for other computer-science courses.

Students have to select at least five courses from the major core course list, including the compulsory core course(s) defined by the track (bolded). The core courses can also be done as part of the Bachelor studies, which ieduces the number of core course required at the Master level. Students who have completed equivalent courses at another university can be excused from taking the core courses with agreement of the professor in charge of the study track.

In addition to the major core courses, the students have to take the track compulsory course(s).

The track optional courses listed below are recommended but not required. The rest of the credits for the major can consist of any Master-level computer science courses.

Major core courses, compulsory major core course bolded

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E3190	Principles of Algorithmic Techniques	5	I-II/1st year
CS-E3220	Declarative Programming	5	V/1st year
CS-C3170	Web Software Development	5	II-III/1st year
CS-C3130	Information Security	5	I/1st year
CS-C3140	Operating Systems	5	I/1st year
CS-C3100	Computer Graphics	5	I-II/1st year
CS-E3210	Machine Learning: Basic Principles	5	I-II/1st year
ELEC-E7851	Computational User Interface Design	5	II/1st year

Track compulsory courses (select at least three, 15 credits)

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E4500	Advanced Course in Algorithms	5	III-IV
CS-E4510	Distributed Algorithms	5	I-II
CS-E4520	Computer-Aided Verification and Synthesis	5	III-IV

CS-E4530	Computational Complexity Theory	5	III-IV

Track optional courses

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E4550	Advanced Combinatorics in Computer Science	5	V
CS-E4560	Parallel and Distributed Systems	5	I-II
CS-E4320	Cryptography and Data Security	5	I-II
CS-E4600	Algorithmic Methods of Data Mining	5	I-II
CS-E4580	Programming Parallel Computers	5	V
CS-E4800	Artificial Intelligence	5	III-IV
MS-C1080	Introduction to Abstract Algebra	5	III
MS-E1110	Number Theory	5	II
CS-E4003	Special Assignment in Computer Science	1-10	Agreed with the teacher
CS-E4004	Individual Studies in Computer Science	1-10	Agreed with the teacher
CS-E4590	Competitive Programming	2-5	I-II
Also other optional courses can be included per agreement with a professor in charge of the track.			

Professor in charge: Aristides Gionis
Other professors: Keijo Heljanko, Eero Hyvönen, Perttu Hämäläinen, Alex Jung, Kimmo Kaski, Samuel Kaski, Jaakko Lehtinen, Harri Lähdesmäki, Lauri Malmi, Ilkka Niemelä, Juho Rousu, Jari Saramäki, Jukka Suomela, Stavros Tripakis, Aki Vehtari
Extent: Long (55-65 credits) or compact (40-45 credits) major as CS track. Students taking a compact major take also a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.

Objectives

The track on big data and large-scale computing provides the students with a strong background to cope with the challenges arising from the growth of data and information in our society. The track covers a wide range of topics in data management, data processing, algorithmics, data science, and data analysis. The teaching and instruction of the students is conducted by the leading experts in the focus areas of this track. Excellent students interested in pursuing doctoral studies after their M.Sc. degree can transfer to the Helsinki Doctoral Education Network in Information and Communications Technology (HICT).

Learning Outcomes

The track aims to educate professionals who are capable of dealing with the different aspects of data management and data analysis. The graduates of the track will be able to cope with the main big data challenges: collecting and storing data, dealing with data complexity and heterogeneity, developing efficient algorithms to process large datasets, building scalable systems in cloud platforms, employing distributed and parallel computing, discovering patterns and hidden structure in the data, building models and making inferences, and learning to visualize large datasets.

Content and Structure

The major consists of core courses, track compulsory courses, and optional computer-science courses. The purpose of the core courses is to ensure that all students in the major have a solid basic knowledge of computer science and software technology topics. The track courses provide deeper understanding of a specific topic and sufficient background knowledge for the Master's thesis in the track's area. After the core and track compulsory courses, most students will be left with quite a few credits for other computer-science courses.

Students have to select at least five courses from the major core course list, including the compulsory core course(s) defined by the track (bolded). The core courses can also be done as part of the Bachelor studies, which reduces the number of core course required at the Master level. Students who have completed equivalent courses at another university can be excused from taking the core courses with agreement of the professor in charge of the study track.

In addition to the major core courses, the students have to take the track compulsory course(s).

The track optional courses listed below are recommended but not required. The rest of the credits for the major can consist of any Master-level computer science courses.

Major core courses, compulsory major core courses bolded

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E3190	Principles of Algorithmic Techniques	5	I-II/1st year
CS-E3210	Machine Learning: Basic Principles	5	I-II/1st year
CS-E3220	Declarative Programming	5	V/1st year
CS-C3170	Web Software Development	5	II-III/1st year
CS-C3130	Information Security	5	I/1st year
CS-C3140	Operating Systems	5	I/1st year
CS-C3100	Computer Graphics	5	I-II/1st year
ELEC-E7851	Computational User Interface Design	5	II/1st year

Track compulsory courses

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E4600	Algorithmic Methods of Data Mining	5	I-II
CS-E4120	Scalable Cloud Computing	5	I-II
CS-E4610	Modern Database Systems	5	III-IV

Track optional courses

Code	Name	Credits	Period/Year
CS-E4580	Programming Parallel Computers	5	V
CS-E4800	Artificial Intelligence	5	III-IV
CS-E4830	Kernel Methods in Machine Learning	5	I-II
CS-E4520	Computer-Aided Verification and Synthesis	5	III-IV
CS-E4890	Deep Learning	5	II
CS-E4820	Machine Learning: Advanced Probabilistic Methods	5	III-IV
CS-E4850	Computer Vision	5	I-II
CS-E4840	Information Visualization	5	IV
CS-E4100	Mobile Cloud Computing	5	I-II
ELEC-E5510	Speech Recognition	5	II
ELEC-E5421	Convex Optimization for Engineers P	7	I-II
CS-E4500	Advanced Course in Algorithms	5	III-IV
CS-E4110	Concurrent Programming	5	I-II

CS-E4870	Research Project in Machine Learning and Data Science	10	varies
CS-E4003	Special Assignment in Computer Science	1-10	Agreed with the teacher
CS-E4004	Individual Studies in Computer Science	1-10	Agreed with the teacher
CS-E4002	Special Course in Computer Science: Query Processing and Optimization for Big Data (2017-2018)	1-10	II
Also optional courses can be included per agreement with a professor in charge of the track.			

Professor in charge: Antti Oulasvirta
Other professors: David McGookin, Marko Nieminen, Tapio Takala
Extent: Long (55-65 credots) or compact (40-45 credits) major as CS track. Students taking a compact major take also a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.
Abbreviation: IxT

Objectives

There are great expectations toward emerging interactive technologies such as wearable computing, augmented reality, interactive machine learning, and context awareness, but also many failures. The goal the IxT track is to educate future leaders in interactive technologies and computation. The track introduces the interdisciplinary study of human–computer interaction (HCI) from computer science and engineering perspectives. The curriculum is unique in Finland and in Europe in its focus on computational and technical aspects of user interfaces and deep integration with state-of-the-art research.

Some highlights of the track include:

- Interdisciplinary orientation with focus on computational and engineering aspects of user interfaces
- Prototyping techniques for creative design of technically advanced user interfaces
- Exploiting computer science (e.g. machine learning and optimisation) to analyze user data and solve problems in design
- Interacting with diverse faculty across departments at Aalto as well as University of Helsinki
- An end-to-end project or internship on a state-of-the-art user interface with a company or a research group.

Learning Outcomes

The curriculum focuses on the computational, statistical, software and hardware aspects of interactive technologies, covering input devices, interactive media, interaction techniques, interface technologies, interactive applications, social media, and multimodal interactive systems. In the first courses, students learn the scientific basis in modeling, theories, and methods. As the curriculum progresses, they learn to apply them to increasingly more realistic design problems. They are introduced to basic aspects of human factors and social sciences relevant in human-computer interaction.

Studies on Interactive Technologies provides a basis for careers in the ICT industry, public sector, and research. At the end of the track, students can go on to careers where they lead design, research, or management, also as part of a data science team. They are well-equipped to approach modern, hard design problems including challenges in interface technologies, algorithms, data, modeling, and communications and networking.

However, they are also knowledgeable about the human and social factors affecting the success of interactive systems. They know how to address them in practical interdisciplinary development processes. They have the meta-cognitive skills to drive visions of interactive technology, critically evaluate different approaches to interaction, and to develop competences further by following advanced research literature.

Content and structure

The major consists of core courses, track compulsory courses, and optional computer-science courses. The purpose of the core courses is to ensure that all students in the major have a solid basic knowledge of computer science and software technology topics. The track courses provide deeper understanding of a specific topic and sufficient background knowledge for the Master's thesis in the track's area. After the core and track compulsory courses, most students will be left with quite a few credits for other computer-science courses.

Students have to select at least five courses from the major core course list, including the compulsory core course(s) defined by the track (bolded). The core courses can also be done as part of the Bachelor studies, which reduces the number of core course required at the Master level. Students who have completed equivalent courses at another university can be excused from taking the core courses with agreement of the professor in charge of the study track.

In addition to the major core courses, the students have to take the track compulsory course(s). They can also include courses from the optional courses list of the track and a list of technical background courses.

The track optional courses listed below are recommended but not required. The rest of the credits for the major can consist of any Master-level computer science courses.

Some of the courses are organized in collaboration with research groups at the Helsinki Institute for Information Technology HIIT and the University of Helsinki (Computer Science, Social Sciences).

Major core courses, compulsory major core course bolded

In addition to Computational User Interface Design, we recommend Computer Graphics, Machine Learning: Basic Principles, Principles of Algorithmic Techniques, and Web Software Development.

CODE	NAME	CREDITS	PERIOD/YEAR
ELEC-E7851	Computational User Interface Design	5	II/1st year
CS-C3170	Web Software Development	5	II-III/1st year
CS-C3130	Information Security	5	I/1st year
CS-C3140	Operating Systems	5	I/1st year
CS-C3100	Computer Graphics	5	I-II/1st year
CS-E3190	Principles of Algorithmic Techniques	5	I-II/1st year
CS-E3220	Declarative Programming	5	V/1st year
CS-E3210	Machine Learning: Basic Principles	5	I-II/1st year

Track compulsory courses: Choose minimum 15 credits

Students who have no previous introductory-level course in HCI must take **C3120 Introduction to Human-Computer Interaction** (5 cr).

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E4200	Emergent User Interfaces	5	III-IV/1
CS-E5220	User Interface Construction	5	II
ELEC-E7861	Research Project in Human-Computer Interaction	5-10	IV-V/1-2
ELEC-E7870	Advanced Topics in User Interfaces PV	3-5	V/1-2
ELEC-E7890	User Research	5	I/1-2
CS-E4840	Information Visualization	5	III/1
ELEC-E7880	Quality of Experience	3	I-V/2

Track optional courses

CODE	NAME	CREDITS	PERIOD/YEAR
MUO-E3005	User Inspired Design - Theory	5	I/1-2
CS-E5210	Usability Evaluation	5	IV/1
CS-E5610	Social Media	4	I-II
SP034i /029	Social Psychology of Information and Communication Technologies (University of Helsinki) NOT LECTURED 2017-2018.	TBT	TBD
CS-C2000	Ihminen havaitsijana	5	III-IV
CS-E4400	Design of WWW Services	5	I-II
CS-E4450	Explorative Information Visualization	5	I-II
CSM13402	Designing Interactive Systems (University of Helsinki, Computer Science)*	5	15.01.2018 -27.02.2018
DOM-E5088	Game Design Basics Workshop	3	V

CS-E4003	Special Assignment in Computer Science	1-10	Agreed with the teacher
CS-E4004	Individual Studies in Computer Science	1-10	Agreed with the teacher

* Students apply for this course through Flexible Study Right Agreement JOO.

Optional technical courses

CODE	NAME	CREDITS	PERIOD/YEAR
ELEC-E7260	Machine Learning for Mobile and Pervasive Systems	5	II-III/2
CS-E4850	Computer Vision	5	I-II
MS-E2416	Integer Programming	5	IV

Professor in charge: Keijo Heljanko
Other professors: Tuomas Aura, N. Asokan, Mario di Francesco, Lauri Malmi, Eljas Soisalon-Soininen, Jorma Tarhio, Antti Ylä-Jääski
Extent: Long (55-65 credits) or compact (40-45 credits) major as CS track. Students taking a compact major take also a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.
Abbreviation: SST

Objectives

The Software Systems and Technologies track covers a wide range of topics on software systems, including mobile and cloud computing, energy efficiency of computing, novel networking technologies, and pervasive applications built on top of this basic foundation. The focus of the program is on applied computer science building on a solid software systems technology background. In this track it is also possible to study advanced learning technologies for education.

The students graduating from the track will have a strong technical background on many of the modern core technologies for mobile and cloud based applications. Students interested in pursuing doctoral studies after their M.Sc. degree can easily transfer to the Helsinki Doctoral Education Network in Information and Communications Technology (HICT).

Learning Outcomes

The graduates of the Software Systems and Technologies track will be able to create and analyze large software systems. The main areas of software systems covered are mobile and cloud computing, energy efficiency of computing, novel networking, and pervasive applications. The track focuses on applied computer science building on a solid software systems background. It is also possible to study advanced learning technologies for education through this track.

Content and structure

The major consists of core courses, track compulsory courses, and optional computer-science courses. The purpose of the core courses is to ensure that all students in the major have a solid basic knowledge of computer science and software technology topics. The track courses provide deeper understanding of a specific topic and sufficient background knowledge for the Master's thesis in the track's area. After the core and track compulsory courses, most students will be left with quite a few credits for other computer-science courses.

Students have to select at least five courses from the major core course list, including the compulsory core course(s) defined by the track (bolded). The core courses can also be done as part of the Bachelor studies, which reduces the number of core course required at the Master level. Students who have completed equivalent courses at another university can be excused from taking the core courses with agreement of the professor in charge of the study track.

In addition to the major core courses, the students have to take the track compulsory course(s).

The track optional courses listed below are recommended but not required. The rest of the credits for the major can consist of any Master-level computer science courses.

Major core courses, compulsory major core course bolded (min 25 credits)

CODE	NAME	CREDITS	PERIOD/YEAR
CS-C3140	Operating Systems	5	I/1st year
CS-C3170	Web Software Development	5	II-III/1st year
CS-C3130	Information Security	5	I/1st year

CS-C3100	Computer Graphics	5	I-II/1st year
CS-E3190	Principles of Algorithmic Techniques	5	I-II/1st year
CS-E3220	Declarative Programming	5	V/1st year
CS-E3210	Machine Learning: Basic Principles	5	I-II/1st year
ELEC-E7851	Computational User Interface Design	5	II/1st year

Track compulsory courses (15 credits)

Code	Name	ECTS	Period/year
CS-E4100	Mobile Cloud Computing	5	I-II/1st year
CS-E4000	Seminar on Computer Science	5	I-II or III-V/1st year
CS-E4110	Concurrent Programming	5	I-II/2nd year

Track optional courses

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E4120	Scalable Cloud Computing	5	I-II/2nd year
CS-E4140	Applications and Services in Internet	5	I-II
ELEC-E8408	Embedded Systems Development	5	III-IV
CS-E4160	Laboratory Works in Networking and Security	5-10	I-II
CS-E4170	Mobile Systems Programming	5	III-IV/1st year
CS-E4005	Methods and Tools for Network Systems	5	I
CS-E4210	Learning Technologies	5	I-II
CS-E4220	Research Methods (not lectured in the academic year 2017-2018)	5-8	III-IV
CS-E4520	Computer Aided Verification and Synthesis	5	III-IV
CS-E4580	Programming Parallel Computers	5	V
CS-E4002	Special Course in Computer Science: Query Processing and Optimization for Big Data (2017-2018)	1-10	II
CS-E4003	Special Assignment in Computer Science	1-10	Agreed with the teacher
CS-E4004	Individual Studies in Computer Science	1-10	Agreed with the teacher

Professor in charge: Petri Vuorimaa
Other professors: Eero Hyvönen
Extent: Long (55-65 credits) or compact (40-45 credits) major as CS track. Students taking a compact major take also a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.
Abbreviation: WEB

Objectives

Web may be the most important invention in the field of data processing since the invention of the computer itself, when the influence on society and business life is considered. The teaching in the Web Technologies, Applications, and Science track handles subject areas of web services and web content in a versatile way. The students learn to develop content to the web and control the technologies related to presenting and transferring that data.

One relevant learning goal is the ability to develop web services to the users. In the deeper level this entails intelligent services and applications. Also information retrieval systems and their evaluation are introduced. Other core content is related to developing web services to machines. On the higher levels than XML, the WWW is based on the semantic web technologies, where the core issues are presenting the knowledge, logics and inference. Human labor, structural data or different methods of automatic annotation (structural or statistical methods) are used to create these kinds of structures.

Content and structure

The major consists of core courses, track compulsory courses, and optional computer-science courses. The purpose of the core courses is to ensure that all students in the major have a solid basic knowledge of computer science and software technology topics. The track courses provide deeper understanding of a specific topic and sufficient background knowledge for the Master's thesis in the track's area. After the core and track compulsory courses, most students will be left with quite a few credits for other computer-science courses.

Students have to select at least five courses from the major core course list, including the compulsory core course(s) defined by the track (bolded). The core courses can also be done as part of the Bachelor studies, which reduces the number of core course required at the Master level. Students who have completed equivalent courses at another university can be excused from taking the core courses with agreement of the professor in charge of the study track.

In addition to the major core courses, the students have to take the track compulsory course(s).

The track optional courses listed below are recommended but not required. The rest of the credits for the major can consist of any Master-level computer science courses.

Major core courses, compulsory major core courses bolded

CODE	NAME	CREDITS	PERIOD/YEAR
CS-C3170	Web Software Development	5	II-III/1st year
CS-C3130	Information Security	5	I/1st year
CS-C3140	Operating Systems	5	I/1st year
CS-C3100	Computer Graphics	5	I-II/1st year
CS-E3190	Principles of Algorithmic Techniques	5	I-II/1st year
CS-E3220	Declarative Programming	5	V/1st year
CS-E3210	Machine Learning: Basic Principles	5	I-II/1st year
ELEC-E7851	Computational User Interface Design	5	II/1st year

Track compulsory courses

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E4400	Design of WWW Services	5	I-II/1st year
CS-E4410	Semantic Web	5	III-IV/1st year
CS-E4460	WWW-applications	5	I-II/2nd year

Track optional courses

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E5220	User Interface Construction	5	II/1st year
CS-E4430	Web Services	4	I-II/2nd year
CS-E4420	Information Retrieval	5	III-IV/2nd year

CS-E4003	Special Assignment in Computer Science	1-10	Agreed with the teacher
CS-E4004	Individual Studies in Computer Science	1-10	Agreed with the teacher
CS-E4000	Seminar in Computer Science	5	I-II, III-IV
CS-E4610	Modern Database Systems	5	III-IV/1st year
CS-E4450	Explorative Information Visualization	5	I-II
CS-E4800	Artificial Intelligence	5	III-IV/1st year
CS-E5610	Social Media	4	I-II
CS-E5740	Complex Networks	5	I-II

You will find recommended study schedules under Planning your studies.

Game Design and Production (Game) 2017-2018

Code: SCI3046

Extent: Long or compact major (40-65 credits). Students taking a compact major take also a minor (20-25 cr). Students taking a long major may include an optional minor in their elective studies.

Responsible Professor: Perttu Hämäläinen

School: School of Science

Objectives

The objective of the major is to educate programmer-designers* that understand both technology and the player's point of view, and can thus 1) participate in overall game design and 2) take responsibility of the myriad design decisions that are not necessarily communicated in a design document and only arise during implementation.

The students will learn about game design, production, and technology using a project-oriented, hands-on with minds-on approach. The project courses emphasize interdisciplinary and collaborative work. The teacher network includes both game industry professionals and game scholars.

* You may also substitute "engineer" or "computer scientist" for "programmer"

Learning Outcomes

- Deepening of technological expertise already built during Bachelor level studies (compulsory technical courses on computer graphics, machine learning, and artificial intelligence)
- Building a wide set of cross-disciplinary design, production, and teamworking skills (compulsory Deparment of Media courses, especially DOM-E5095 game project, during which multiple games are developed).
- Deeper understanding of each student's specific areas of interest (large selection of elective courses that can be included in the personal study plan).

Structure and content

The Game Design and Production major is organized in collaboration with Media Lab Helsinki of Aalto ARTS, which has an M.A. in New Media "sibling major" with the same name. Computer and video games is a multidisciplinary field, and the M.Sc. and M.A. majors share a large portion of the courses. The obligatory courses differ, however, and the CCIS students should expect to work in a more technical role, e.g., when creating a joint thesis game with ARTS students. Multidisciplinarity is also emphasized by the high flexibility of elective studies, where one can include, e.g., 3D animation, interactive storytelling and interaction design in addition to computer science.

Students take the Major compulsory courses. In addition, they take Major optional courses. Listing of optional courses is not exhaustive. Additionally, students may choose courses from all Aalto schools according to the personal study plan. It is strongly suggested that students venture outside their comfort zone and do not, for example, take a course in web software development if they already possess the equivalent skills and knowledge.

Courses

Major compulsory courses

CODE	NAME	CREDITS	PERIOD/YEAR
CS-C3100	Computer Graphics	5	I-II
CS-E3210	Machine Learning: Basic Principles	5	I-II
CS-E4800	Artificial Intelligence	5	III-IV
DOM-E0000	Understanding Media, Art and Design	4	I/1st year
DOM-E5080	Game Design	5	I
DOM-E5083	Game Analysis	5	III-V
DOM-E5095	Game Project	5-15	I-V/1st year
DOM-E5093	Game Design Exam	1	III,V
DOM-E5001	Personal study plan	1	I/1st year

Recommended optional courses (students may also suggest others as game design is a multidisciplinary field).

CODE	NAME	CREDITS	PERIOD/YEAR
DOM-E5094	Advanced Topics in Game Design	3-5	I
DOM-E5082	Playability Evaluation	3	III
DOM-E5087	Action Games	3-5	V
CS-E5100	Introduction to IT Business and Venturing	2	I-II
DOM-E5038	Generative and Interactive Narratives	3	III-V
DOM-E5066	Introduction to Sound Design and Music	1-5	I
DOM-E5029	Introduction to 3D Animation	4	I
DOM-E5058	Information Visualization and Design	3-6	III
CS-E4840	Information Visualization	5	IV
ELEC-E7851	Computational User Interface Design		II
CS-E4200	Emergent User Interfaces	5	III-IV
CS-C3120	Human-Computer Interaction	5	I-II
CS-E5520	Advanced Computer Graphics	5	III-V
CS-C3170	Web Software Development	5	II-III/1st year
CS-C3130	Information Security	5	I/1st year
CS-E3190	Principles of Algorithmic Techniques	5	I-II/1st year
CS-E4580	Programming Parallel Computers	5	V
CS-E4830	Kernel Methods in Machine Learning	5	I-II
CS-E4890	Deep Learning	5	II
CS-E4820	Machine Learning: Advanced Probabilistic Methods	5	III-IV
CS-E4850	Computer Vision	5	III-IV
CS-E4100	Mobile Cloud Computing	5	I-II

You will find study tracks and recommended study schedules under Planning your studies.

Machine Learning and Data Mining (Macadamia) 2017-2018

Code: SCI3044

Extent: Long major (55-65 credits). Compact major is not offered. Students who want to take a minor are encouraged to include it in elective studies.

Responsible Professor: Samuel Kaski

Other professors: Aristides Gionis, Alex Jung, Juha Karhunen, Jouko Lampinen, Harri Lähdesmäki, Heikki Mannila, Juho Rousu, Aki Vehtari

Abbreviation: Macadamia

School: School of Science

Objectives

The major in Machine Learning and Data Mining (Macadamia) gives a strong basic understanding of modern computational data analysis and modelling methodologies. It builds on the strong research at the Department of Computer Science. The methods of machine learning and data mining are applicable and needed in a wide variety of fields ranging from process industry to mobile communications, social networks and artificial intelligence. Recent spearhead application areas include bioinformatics, computational linguistics, multimodal interfaces, and intelligent information access.

The major provides an excellent basis for doctoral studies as well as industrial research and development work. Teaching and supervision for Macadamia students is given by an enthusiastic and experienced group headed by world leaders in this research field. Excellent Macadamia students can continue their studies in the Helsinki Doctoral Education Network in Information and Communication Technology (HICT).

Learning Outcomes

1) The student is able to formalize data analysis problems in terms of the underlying statistical and computational principles

2) The student is able to assess suitability of different machine learning methods for solving a particular new problem encountered in industry or academia, and apply the methods to the problem.

3) The student can interpret the results of a machine learning algorithm, assess their credibility, and communicate the results with experts of other fields.

4) The student can implement common machine learning methods, and design and implement novel algorithms by modifying the existing approaches.

5) The student understands the theoretical foundations of the machine learning field to the extent required for being able to follow research in the field

Content and Structure

The students have to take the eight compulsory courses. In addition, they include courses from the major optional courses list. Also other optional courses may be included per agreement with a professor in charge of the major.

Major compulsory courses 40 credits

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E3210	Machine Learning: Basic Principles	5	I-II/1st year
CS-E5710	Bayesian Data Analysis	5	I-II/1st year
CS-E4890	Deep Learning	5	II/1st year
CS-E4820	Machine Learning: Advanced Probabilistic Methods	5	III-IV/1st year
CS-E4600	Algorithmic Methods of Data Mining	5	I/1st year
CS-E4830	Kernel Methods in Machine Learning	5	I-II/2nd year
CS-E4840	Information Visualization	5	IV/1st year
CS-E4870	Research Project in Machine Learning and Data Science	5-10	varies/2nd year

Major optional courses (choose 15-25 credits)

CODE	NAME	CREDITS	PERIOD/YEAR

CS-E5790	Computational Science	5	I-II/1st year
CS-E4850	Computer Vision	5	I-II/2nd year
ELEC-E5510	Speech Recognition	5	II/2nd year
ELEC-E5550	Statistical Natural Language Processing	5	III-IV/1st year
CS-E5870	High-Throughput Bioinformatics	5	II/2nd year
CS-E4800	Artificial Intelligence	5	III-IV/1st year
CS-E4004	Individual Studies in Computer Science	1-10	Agreed with the teacher
CS-E4070	Special Course in Machine Learning and Data Science	3-10	varies
CS-E4880	Machine Learning in Bioinformatics	3-10	I-II
CS-E5890	Statistical Genetics and Personalized Medicine	5	IV-V

Also other optional courses may be included per agreement with a professor in charge of the major.

You will find study tracks and recommended study schedules under Planning your studies.

Security and Cloud Computing (SECCLO) 2017-2018

Code: SCI3084

Extent: Long (55-65 credits) or compact major (40-45 credits). Students taking a compact major take also a minor (20-25 cr). Students taking a long major may include an optional minor in their elective studies.

Responsible professor: Tuomas Aura

Other professors: N. Asokan, Mario Di Francesco, Keijo Heljanko, Antti Ylä-Jääski

Abbreviation: SECCLO

School: School of Science

Study programme

Studies in the Security and Cloud Computing major give students a broad understanding of the latest and future technologies for secure mobile and cloud computing systems. Students will gain both practical engineering knowledge and theoretical insights into secure systems engineering, distributed application development, network and service architectures, and cloud and mobile platforms. We believe in combining theoretical knowledge and security expertise with product development skills. The studies are also closely linked with research at Aalto University. The graduates are well prepared for international industrial R&D jobs, security engineering and consulting, various expert roles, and doctoral studies at Aalto University and internationally.

The major combines three previous study modules: the Security and Mobile Computing (NordSecMob) Master's program, the Mobile Computing - Services and Security major, as well as the Secure Systems track.

Learning outcomes

- Students have the theoretical understanding of information security and practical skills for designing and analyzing secure computing systems.
- Students understand the architectural principles of distributed services and applications. They are able to design, analyze andimplement distributed, cloud and mobile computing systems.
- Students have in-depth knowledge of their chosen thesis topic.
- Students have strong software development skills and other technical and professional skills that enable them to take key roles inan industrial research and development environment, and they are qualified to continue to doctoral studies in academia.

Structure and content

The major covers fundamental concepts, methods and the latest technologies on secure systems engineering, distributed application development, ubiquitous computing, network and service architectures, ubiquitous computing, and cloud and mobile computing platforms. The studies are closely bound to the research done by the teachers, for example, on the Internet of Things, pervasive and ubiquitous computing, cloud platforms and services, mobile platform security, and network security. Special attention is paid to security and privacy issues as they are critical requirements in developing and deploying services in open networks and distributed systems. The teaching methods combine theory with hands-on exercises and software development on mobile devices and cloud platforms. Students also practice writing and presentation skills and learn to follow the latest research.

Courses

Major compulsory courses

These courses are compulsory, unless already included in the student's previous studies. Students who have studied similar content at another university or have specific personal learning goals should contact the responsible professor of the major to discuss their personal study plan.

CODE	NAME	CREDITS	PERIOD
CS-C3130	Information Security	5	I/1st year
CS-E4100	Mobile Cloud Computing	5	I-II/1st year
CS-E4120	Scalable Cloud Computing	5	I-II/1st year
CS-C3170	Web Software Development	5	II-III/1st year
CS-E4000	Seminar on Computer Science	5	III-V/1st year or I-II/2nd year

Major optional courses

Students should choose enough other master-level courses to meet the required number of credits for the major. The courses listed below are especially recommended. Please follow announcements about special courses with annually changing topics and teaching periods. Other master-level courses on relevant topics, including computer science, mathematics, communications technology and entrepreneurship may be included with prior agreement of the responsible professor of the major.

CODE	NAME	CREDITS	PERIOD/YEAR
CS-E4005	Methods and Tools for Network Systems	5	I-II/1st year
CS-E4140	Applications and Services in Internet	5	I-II/1st year
CS-E4300	Network Security	5	II/1st or 2nd year
CS-E4160	Laboratory Works in Networking and Security	5	III-IV/1st year
CS-E4170	Mobile Systems Programming	5	III-IV/1st year
CS-E4310	Mobile Systems Security	5	III-IV/1st year
ELEC-E7320	Internet Protocols	5	III-IV/1st year
CS-E4330	Special Course in Information Security	2-10	varies
CS-E4520	Computer Aided Verification and Synthesis	5	III-IV/1st year
CS-E3210	Machine Learning: Basic Principles	5	I-II/2nd year
CS-E4600	Algorithmic Methods of Data Mining	5	I-II/2nd year
CS-E4002	Special Course in Computer Science	1-10	varies
CS-E4003	Special Assignment on Computer Science	1-10	Agreed with the teacher

You will find study tracks and recommended study schedules under Planning your studies.

Signal, Speech and Language Processing (SSLP) 2017-2018

Code: ELEC3031

Extent: long major (60 cr) or compact major (40 cr)

Responsible professor: Mikko Kurimo

Professors: Paavo Alku, Visa Koivunen, Jorma Skyttä, Sergiy Vorobyov, Risto Wichman, Esa Ollila, Tom Bäckström

Abbreviation: SSLP

School: Electrical Engineering

Objectives

The purpose of the major is to provide the students with basics of either signal processing or speech and language processing and the ability to apply those in various fields of science and technology.

Students focusing in signal processing are given a strong theoretical background of modern signal processing. This means a toolbox of knowledge on signals and systems modelling, representation through transforms, systems optimization and implementation. Some emphasis is on the most recent research priorities in the field of signal processing in domains of data analysis, compression and storage, communications as well as in representation of signals. In addition, students can obtain even deeper understanding of signal processing and adjacent sciences, or apply signal processing in other fields. Interesting applications include radar systems and networks, data transmission, sensing and tracking of objects and spaces, as well as analysis of technical (machine based) and social (human based) networks. The cyber level of the smart power grid is increasingly important for efficient energy distribution and utilization, offering a platform for applying signal processing methodology for solving essential problems of great societal impact.

Students focusing in speech and language processing are provided basics of that field and the ability to apply those in various fields of science and technology. Speech and language processing utilizes signal processing, mathematical modeling and machine learning for statistical language modeling, information retrieval and speech analysis, synthesis, recognition and coding. Applications and research priorities have recently been, for example, speech recognition and synthesis, dictation, subtitling, machine translation, language learning, large-scale video data indexing and retrieval, speech coding and quality improvement in mobile phones and networks as well as in medical research of the human voice.

This major offers excellent opportunities also for postgraduate studies.

Content and structure

The major offers two different study tracks: signal processing and data science, and speech and language processing. The tracks consist of compulsory part and optional part. Student must follow one of the study tracks. In the major there are two courses common to both tracks.

The major can be completed either as a long (60 cr) or compact (40 cr) major. Students taking a compact major take also a master level minor (20-25 cr). Students taking a long major may include an optional minor in their elective studies.

See study tracks & recommended study orders under Planning your studies.

Software and Service Engineering (SSE) 2017-2018

Code: SCI3043

Extent: Long (55-65 credits) or compact major (40-45 credits). Students taking a compact major take also a minor (20-25 cr). Students taking a long major may include an optional minor in their elective studies.

Responsible professors: Casper Lassenius

Abbreviation: SSE

School: School of Science

Objectives

Digital products and services are crucial to economies, societies and human well-being. For companies and other organizations, they offer exponentially expanding opportunities for new functionality and capabilities beyond traditional product boundaries. Students of Software and Service Engineering learn how to design, develop, and manage digital products and services that create business value and satisfy user needs within modern organizations. Students learn how to tackle wicked, real-world problems taking human, societal and organizational factors into account.

The major has four tracks making it possible to specialize in software engineering, service design and engineering, user-centered design, or enterprise systems.

Structure and Content

SSE offers both long and compact majors. The following tracks are available:

1. Software Engineering
2. Service Design and Engineering (SDE)
3. Enterprise Systems

All the students majoring software and service engineering take the major common courses (10 credits). In addition, they take courses according to their study track. It is strongly recommended that students also participate in the Portfolio course in Software and Service Engineering (CSE-E5695)

Major common courses 10 credits

CODE	NAME	CREDITS	PERIOD/YEAR
CS-C3150	Software Engineering *	5	I-II, III-IV
CS-E4900	User-centred Methods for Product and Service Design	5	I-II

* If the course have been taken as part of the B.Sc. studies, it can be substituted with any optional courses of the track the student is studying. In the case the student has taken similar course at another institution, the professor should be contacted for discussing possible substitution.

Study tracks

Professor in charge: Martti Mäntylä
Other professors: Kary Främling, Jari Collin
Extent: Long or compact major (40-65 credits). Students taking a compact major take also a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.

Objectives

For most companies and organizations, developing and managing information systems has become increasingly critical for how the companies create and capture value, how they work with partners and users, and how they secure competitive advantage. The Enterprise Systems track provides its students the knowledge, competences, and skills they will need to act successfully in the industry and society to tackle these challenges and opportunities.

Learning outcomes

After completing the track, the students should be able to understand the opportunities of digitalization in industrial applications and related domains and to turn these opportunities to actual business value by defining, creating, deploying, and managing relevant information systems. They will will have the skills needed to work effectively in multidisciplinary teams including business and technology experts.

Structure

Students are expected to take the major common courses and track compulsory courses. In addition, they take courses from the track optional course list. It is strongly recommended that students also participate in the Portfolio course in Software and Service Engineering (CS-E4920).

Framtidens industriföretag, FIF, 60 credits
FIF is a Nordic interdisciplinary programme for engineering students. Students who have chosen the Enterprise Systems track as their long major can apply to take part in FIF. The application round is organised annually in March/April.

In addition to the the major common courses and track compulsory courses, FIF students include FIF courses in their Track optional courses and in the Elective Studies. Course choices are confirmed in the student´s personal study plan (HOPS) after consultation with the professor. For more information on FIF please see http://fif.aalto.fi/sv/.

Major common courses (10 credits)

CODE	NAME	CREDITS	PERIOD
CS-C3150	Software Engineering *	5	I-II, III-IV
CS-E4900	User-centred Methods for Product and Service Design	5	I-II

Track compulsory courses (15 credits)

CODE	NAME	CREDITS	PERIOD
CS-E5300	Enterprise Systems Architecture *	5	I
CS-E5310	ICT Enabled Service Business and Innovation	5	I-II
CS-E5320	Seminar on Enterprise Information Systems	5	IV

Track optional courses

CODE	NAME	CREDITS	PERIOD
SELECT 15-30 CREDITS FROM THE FOLLOWING			
CS-E4920	Portfolio in Software and Service Engineering	1-5	I-V
CS-E5380	Special Assignment on Enterprise Information Systems	3-10	I-V
CS-E5000	Seminar in Software and Service Engineering	5	I-II, III-V
CS-E5001	Research Seminar in Software and Service Engineering	5	I-II, III-V
CS-E5330	IT Governance	5	II
CS-E5340	Introduction to Industrial Internet	5	IV
CS-E5360	Systems of Systems	5	V
CS-E5370	Law in Digital Society	5-6	IV
CS-E5390	Seminar on Law and Technology	3-6	IV-V
CS-E4950	Software Architectures *	5	III-V
CS-E4940	Requirements Engineering *	5	III-V
CS-E4930	Software Processes and Projects	5	IV-V
37E00550	Business Intelligence	6	IV

IN ADDITION, SELECT 15-30 CREDITS FROM THE FOLLOWING (LONG MAJOR)			
CS-E5005	Research Methods in Software and Service Engineering	3-5	I-II
CS-E5100	Introduction to IT Business and Venturing	2	I-II
CS-E5110	Management of a Technology Venture	6	II
CS-E5410	Technology Entrepreneurship Seminar	4	IV
TU-E1021	Strategies for Growth and Renewal	5	III-IV
TU-E1120	Strategic Management of Technology and Innovation	5	III-V

* If any of these courses have been taken as part of the B.Sc. studies, they can be substituted with any elective courses of the track. In the case the student has taken similar courses at another institution, the professor should be contacted for discussing possible substitutions.

Professor in charge: Marjo Kauppinen and Marko Nieminen
Extent: Compact (40-45 credits) or long major (55-65 credits). Students taking a compact major also take a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.
Abbreviation: SDE

Objectives

Digital services, software, and applications form an integral part of modern everyday life both in working surroundings and in leisure time contexts. Software in large organisations is being used by employees who perform a multitude of tasks. Tiny mobile games are developed for entertaining people. Understanding customer and user needs are essential in digital service design.

A typical characteristic of contemporary software and service design is its multi-disciplinarity. Core contents of the track include the conceptual and methodological basis for working with customers, users, and other stakeholders throughout digital service development. Teams with varying backgrounds create novel, innovative, and commercially viable concepts and realisations in a collaborative manner. The user-centred and software-engineering methods support these joint design and evaluation activities.

After completing their studies, students can work in industry, design and engineering companies, public organisations as well as in startups as product managers, software developers, user interface and interaction designers, user experience managers, service designers, business analysts, and project managers.

Learning outcomes

In the “service design and engineering” track, students learn to

1. discover and analyse customer and user needs
2. combine design techniques from software engineering, service design and user-centred design, and apply them in practice
3. tailor an efficient design process for the needs of a company and projects
4. design and implement digital services that create customer and business value
5. create novel and innovative service concepts in multidisciplinary teams
6. critically evaluate strengths and weaknesses of service concepts and digital services
7. build up strong conceptual foundation and well-structured knowledge base for continuous learning

Content and structure

Service Design and Engineering Compact Major 40-45 credits

The compact major of the SDE track consists of two major common courses. In addition to these courses, the Design Project is the only compulsory course. Students can also select courses from the track optional course list. It is strongly recommended that students also participate in the Portfolio course in Software and Service Engineering (CS-E4920). Combined with personal discussions with responsible professors of the track, this course supports students in finding their individual study and career profile.

It is also strongly recommended that students also select Aalto Service Minor. Aalto Service Minor provides a broad and multidisciplinary basis for digital service development. Students taking the SDE track and wanting to focus on entrepreneurship are recommended to take the Aalto Ventures Program as part of their elective studies.

Major common courses (10 credits)

CODE	NAME	CREDITS	PERIOD
CS-C3150	Software Engineering *	5	I-II, III-IV
CS-E4900	User-centred Methods for Product and Service Design	5	I-II

Track compulsory course (10 credits)

CODE	NAME	CREDITS	PERIOD
CS-E5200	Design Project	10	III-IV

Track optional courses (20-25 credits)

CODE	NAME	CREDITS	PERIOD
CS-E4920	Portfolio in Software and Service Engineering	1-5	I-V
CS-E5000	Seminar in Software and Service Engineering	5	I-II, III-V
CS-E5001	Research Seminar in Software and Service Engineering	5	I-II, III-V
CS-E5210	Usability Evaluation	5	IV-V
CS-E5220	User Interface Construction	5	II
CS-C3180	Software Design and Modeling*	5	I-II
CS-E4930	Software Processes and Projects	5	IV-V
CS-E4940	Requirements Engineering	5	III-V
CS-E4950	Software Architectures	5	III-IV
CS-E4960	Software Testing and Quality Assurance	5	I-II
CS-E5005	Research Methods in Software and Service Engineering	5	I-II
	In addition to the above, courses from the other tracks of the SSE major can be included as optional courses. Also other optional courses can be included per agreement with a professor in charge of the track.		

* If any of these courses have been taken as part of the B.Sc. studies, they can be substituted with any elective courses of the track. In the case the student has taken similar courses at another institution, the professor should be contacted for discussing possible substitutions.

Aalto Service Minor (20-25 credits)

Aalto Service Minor is offered to all Aalto master's students who want to get a broad, multidisciplinary general knowledge on services. After completing the minor, the student has a general knowledge of how to manage, operate, design, and develop services and service business successfully. The student has acquired a service-oriented mindset and experience of working in an interdisciplinary manner with students from different disciplines.

CODE	NAME	CREDITS	PERIOD
Compulsory			
TU-E2000	Aalto Introduction to Services P	3-6	I
Optional courses Pick and choose enough to fulfill minor requirements. Choose at leat two courses from the following core courses:			
TU-E2012	Service operations Management	5	III-IV
MUO-E3008	Designing for Services	5 or 10	III
CS-E4900	User-Centered Methods for Product and Service Design	5	I-II
CS-E5310	ICT Enabled Service Business and Innovation	5	I-II
37E00100	Information Economy	6	IV

37E08000	Service Business Models	6	IV
37E00600	Hackathon Project	6	II
If necessary, choose from the courses listed below to reach total credit requirement. The courses listed below can be included in the minor without separate approval (NOTE: acceptance to Aalto Service Minor does not guarantee that you will be accepted to these courses):			
37E01500	Project Management and Consulting Practice (Not lectured 2017-2018)	6	
37E4400	Critical Issues in Information Systems Research (varying content)	6	V
TU-E2110	Innovation in Operations and Services	3-5	III-IV
TU-E3121	People in Service Operations	5	II
23C550	Services Marketing	6	III

Service Design and Engineering Long Major 55-65 credits

The long major of the SDE track consists of two major common courses. In addition to these courses, the Design Project is the only compulsory course. Students can also select courses from the track optional course list. It is strongly recommended that students also participate in the Portfolio course in Software and Service Engineering (CS-E4920). Combined with personal discussions with responsible professors of the track, this course supports students in finding their individual study and career profile.

Students selecting the long major focus on various aspects of digital service design including user-centred design, business and customer analysis combined with software engineering. Students of the long major have the possibility to tailor the major personally in collaboration with their supervising professor. Additionally, the long major lays a proper foundation for doctoral studies in the field.

Students taking the SDE track and wanting to focus on entrepreneurship are recommended to take the Aalto Ventures Program as part of their elective studies.

Major common courses (10 credits)

CODE	NAME	CREDITS	PERIOD
CS-C3150	Software Engineering *	5	I-II, III-IV
CS-E4900	User-centred Methods for Product and Service Design	5	I-II

Track compulsory course (10 credits)

CODE	NAME	CREDITS	PERIOD
CS-E5200	Design Project	10	III-IV

Track optional courses (Select 35-45 credits from the following:)

CODE	NAME	CREDITS	PERIOD
CS-E4920	Portfolio in Software and Service Engineering	1-5	I-V
CS-E5000	Seminar in Software and Service Engineering	5	I-II, III-V
CS-E5001	Research Seminar in Software and Service Engineering	5	I-II, III-V
CS-E5210	Usability Evaluation	5	IV-V
CS-E5220	User Interface Construction	5	II
CS-C3180	Software Design and Modeling*	5	I-II

CS-E4930	Software Processes and Projects	5	IV-V
CS-E4940	Requirements Engineering	5	III-V
CS-E4950	Software Architectures	5	III-IV
CS-E4960	Software Testing and Quality Assurance	5	I-II
CS-E5005	Research Methods in Software and Service Engineering	5	I-II
CS-E5004	Individual Studies in Software and Service Engineering	1-10	Agreed with the teacher
CS-E5002	Special Course in Software and Service Engineering	1-10	varies
CS-E5100	Introduction to IT Business and Venturing	2	I-II
CS-E5110	Management of a Technology Venture	6	II
CS-E5300	Enterprise Systems Architecture	5	I
CS-E5310	ICT Enabled Service Business and Innovation	5	I-II
CS-E5370	Law in Digital Society	5-6	IV
CS-E5340	Introduction to Industrial Internet	5	IV

In addition to the above, courses from the other tracks of the SSE major can be included as optional courses. Also other optional courses can be included per agreement with a professor in charge of the track.

Professor in charge: Casper Lassenius
Other professors: Marjo Kauppinen, Kari Smolander
Extent: Long (55-65 credits) or compact major (40-45 credits). Students taking a compact major also take a minor (20-25 credits). Students taking a long major may include an optional minor in their elective studies.

Objectives

Software is at the core of most developed economies and organizations. The software engineering track is intended for students who want to become proficient in developing and managing development of software systems and services in real-world organizations, big and small.

The track combines theoretical studies with a large number of practical assignments done both in groups and as individuals, providing opportunities not only to understand but to apply the various methods and tools taught. Many of the assignments are either done for industrial customers representing real-life organizations or based on cases from industry. Many courses use lecturers from industry to provide practical viewpoints to the subjects studied.

Software engineering majors typically work in industry in roles such as Scrum Master, team lead, software architect, project manager, test lead, process engineer, or product owner. Students of software engineering are recommended to take a technical minor in computer science, but the major can also be fruitfully combined with e.g. strategic management, organizational development, or occupational psychology and leadership. The long major gives students the possibility to study software engineering more in-depth, giving the possibility to focus on a specific area of interest. This lays a good foundation for expert roles in industry, or for PhD studies in software engineering.

Learning outcomes

In the software engineering track, students learn the processes, methods and techniques used in professional software development in organizations and projects of various sizes. Core subjects include various software development activities, such as requirements engineering, design, implementation, testing and deployment, as well as supporting activities including project management, organizational development, and configuration management.

Software Engineering Long Major (55-65 credits)

The long major in software engineering gives students the opportunity to specialize in software engineering to help become software engineering experts in industry, as well as lays a good foundation for graduate studies. Students of the long major have the possibility to tailor the major personally in collaboration with their supervising professor.

The students take the major common courses and track compulsory courses. In addition, they take courses from the track optional course list. It is recommended to take most of the software engineering specific courses (Software Engineering, Software Design and Modelling, Software Processes and Projects, Requirements Engineering, Software Architectures, and Software Testing and Quality Assurance) during the first year of studies. Their content is to be applied in practice on the Software Project 3 course during the second year. It is strongly recommended that students also participate in the Portfolio course in Software and Service Engineering (CS-E4920).

Major common courses (10 credits)

CODE	NAME	CREDITS	PERIOD
CS-C3150	Software Engineering *	5	I-II, III-IV
CS-E4900	User-centred Methods for Product and Service Design	5	I-II

Track compulsory courses (15-18 credits)

CODE	NAME	CREDITS	PERIOD
CS-C3180	Software Design and Modelling*	5	I-II
CS-E4910	Software Project 3	5-8	I-V
CS-E5000 or CS-E5001	Seminar in Software and Service Engineering or Research Seminar in Software and Service Engineering	5	I-II, III-V

Track optional courses

SELECT 20-40 CREDITS FROM THE FOLLOWING

CODE	NAME	CREDITS	PERIOD
CS-E4920	Portfolio in Software and Service Engineering	1-5	I-V
CS-E5005	Research Methods in Software and Service Engineering	5	I-II
CS-E4930	Software Processes and Projects	5	IV-V
CS-E4940	Requirements Engineering	5	III-V
CS-E4950	Software Architectures	5	III-IV
CS-E4960	Software Testing and Quality Assurance	5	I-II
CS-E5004	Individual Studies in Software and Service Engineering	1-10	I-V
CS-E5002	Special Course in Software and Service Engineering	1-10	I-V

IN ADDITION, SELECT 0-30 CREDITS FROM THE FOLLOWING

CODE	NAME	CREDITS	PERIOD
TU-E5000	Innovation and project management	5	II
CS-E5100	Introduction to IT Business and Venturing	2	I-II
CS-E5110	Management of a Technology Ventures	5	I-II
TU-C3030	Basics in Research and Development Management	3-5	III-IV
CS-E4970	Individual Study in Software Business	2-16	I-V

TU-E3010	Leading as Practice	5	III-V
	In addition to the above, courses from the other tracks of the SSE major can be included as optional courses. Also other optional courses can be included per agreement with a professor in charge of the track.		

* If the course has been taken as part of the B.Sc. studies, it can be substituted with any optional courses of the track. In the case the student has taken similar courses at another institution, the professor should be contacted for discussing possible substitutions.

It is recommended to take most of the software engineering specific courses (Software Engineering, Software Design and Modelling, Software Processes and Projects, Requirements Engineering, Software Architectures, and Software Testing and Quality Assurance) during the first year of studies. Their content is to be applied in practice on the Software Project 3 course during the second year.

Software Engineering Compact Major 40-45 credits

The compact major aims at teaching students the main elements of software engineering to give them a sound foundation for future careers in industry.

The students take the major common courses (10 credits) and track compulsory courses (10-13 credits). In addition, they take courses from the track optional courses list and other optional studies. Students taking a compact major must have a minor (20-25 credits). It is strongly recommended that students also participate in the Portfolio course in Software and Service Engineering (CS-E4920).

Major common courses (10 credits)

CODE	NAME	CREDITS	PERIOD
CS-C3150	Software Engineering *	5	I-II, III-IV
CS-E4900	User-centred Methods for Product and Service Design	5	I-II

Track compulsory courses (10-13 credits)

CODE	NAME	CREDITS	CODE
CS-C3180	Software Design and Modelling*	5	I-II
CS-E4910	Software Project 3	5-8	I-V

Track optional courses

SELECT 20-40 CREDITS FROM THE FOLLOWING

CODE	NAME	CREDITS	PERIOD
CS-E4920	Portfolio in Software and Service Engineering	1-5	I-V
CS-E5000 or CS-E5001	Seminar in Software and Service Engineering or Research Seminar in Software and Service Engineering	5	I-II, III-V
CS-E5005	Research Methods in Software and Service Engineering	5	I-II
CS-E4930	Software Processes and Projects	5	IV-V
CS-E4940	Requirements Engineering	5	III-V
CS-E4950	Software Architectures	5	III-IV
CS-E4960	Software Testing and Quality Assurance	5	I-II

IN ADDITION, SELECT 0-30 CREDITS FROM THE FOLLOWING

CODE	NAME	CREDITS	PERIOD
TU-E5000	Innovation and Project Management	5	I-II

CS-E5100	Introduction to IT Business and Venturing	2	I-II
TU-E3010	Leading as Practice	5	III-IV
TU-C3030	Basics in Research and Development Management	5	III-IV
	In addition to the above, courses from the other tracks of the SSE major can be included as optional courses. Also other optional courses can be included per agreement with a professor in charge of the track.		

* If the course has been taken as part of the B.Sc. studies, it can be substituted with any optional courses of the track. In the case the student has taken similar courses at another institution, the professor should be contacted for discussing possible substitutions.

It is recommended to take most of the software engineering specific courses (Software Engineering, Software Design and Modelling, Software Processes and Projects, Requirements Engineering, Software Architectures, and Software Testing and Quality Assurance) during the first year of studies. Their content is to be applied in practice on the Software Project 3 course during the second year.

You will find recommended study schedules under Planning your studies.

Elective studies 2017-2018

Students choose 25-35 credits of elective studies. As elective studies, students can complete a minor and/or take individual courses. Individual elective courses can also be taken from other programmes at Aalto University or other Finnish universities through Flexible Study Right (JOO).

Entrepreneurial and multidisciplinary Aalto studies are recommended. Foreign students are encouraged to take Finnish courses.

Also studies completed abroad during student exchange can be included in the elective studies (exchange studies can also form an international minor or be included in the major). Work experience completed in Finland or abroad can also be included in Elective Studies. (SCI students: max. 10 credits. ELEC students: see the internships credit application instructions of the School of Electrical Engineering.)

Compulsory language studies 2017-2018

Compulsory language studies are included as part of the Finnish bachelor's degree for students who have studied in Finland and whose language of education is Finnish or Swedish. If the language studies have not been completed in the student's bachelor's degree, the student must take 2 ECTS in the second national language and 3 ECTS in one foreign language, including both oral and written proficiency.

Students who have received their education in a language other than Finnish or Swedish, or received their education abroad, are required to complete only 3 ECTS in one foreign language, including both oral and written proficiency. Relevant courses (marked with 'o' and 'w') are offered by the Aalto University Language Center.

Students who have received their education abroad and who already have excellent command of English (e.g. English as their first language) may choose 3 credits of Finnish courses instead, hence not covering the requirement of oral/written proficiency but meeting the language requirement of the degree. If this applies to you, please contact your school's Learning Services for further advice, as different schools have different procedures for validating this exemption.

Master's thesis 2017-2018

Students are required to complete a Master's Thesis, which is a research assignment with a workload corresponding to 30 credits. The thesis is written on a topic usually related to the student's major and agreed upon between the student and a professor who specializes in the topic of the thesis. The supervisor of the thesis must be a professor in the Aalto University. The thesis advisor(s) can be from a company or from another university. Thesis advisor (s) must have at least a Master’s degree.

Master’s Thesis work includes a seminar presentation or equivalent presentation. The student is also required to write a maturity essay (ELEC students) or a press release (SCI students) related to the Master’s Thesis.

The Master’s Thesis is a public document and cannot be concealed.

Read more about writing a Master's thesis under Planning your studies.