

Master's Programme in Computer, Communication and Information Sciences Study Guide 2015-2016

For the reader

This study guide explains the degree requirements of the programmes, and gives students the necessary information about completing the degree and its contents.

In addition to study guides, Aalto University uses various online services for planning and monitoring one's studies, and for keeping up with what is going on at the university. In planning one's studies, this study guide and the online tools complement each other and should be used side by side.

Below is an introduction to students' most important online tools:

WebOodi

Course descriptions,
registering for courses and exams,
planning your studies
(personal study plan)

Study guide

Degree structure and the courses
it consists of

MyCourses

Course home pages, timetables,
materials, course spaces,
course news

Into

is a student portal, with information about studies,
Aalto services and Aalto university in general.

The Into pages give you general information about studies: timetables, instructions on registration, advice on how to plan your studies and draw up a personal study plan, forms, information about studies abroad or in other Aalto schools or other Finnish universities, common practices in courses, academic rules and regulations etc. Into pages of the programme: into.aalto.fi/display/enccis/.

Degree structure

Directors of degree programme: Professor Petri Vuorimaa (SCI), Professor Jyri Hämäläinen (ELEC)

Degree: Master of Science (Technology), 120 ECTS

Abbreviation: CCIS

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.

Objectives

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.

Long major:

**MAJOR
55-65 ECTS**

**MASTER'S THESIS
30 ECTS**

**ELECTIVE STUDIES
25-35 ECTS**

Compact major:

**MAJOR
40-45 ECTS**

**MASTER'S THESIS
30 ECTS**

**MINOR
20-25 ECTS**

**ELECTIVE STUDIES
25-35 ECTS**

Minors

Students taking a compact major must have a minor (20-25 credits). Students taking a long major are encouraged to include minor in elective studies. Bachelor level minors may be accepted. The minor is confirmed in the Personal Study Plan (HOPS).

More information on Aalto University's minor subjects:
[Aalto University Minors Guide 2015-2016](#)

Elective studies

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. 5 credits. ELEC students: see the internships credit application instructions of the School of Electrical Engineering.)

Language studies

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

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 instructor(s) can be from a company or from another university. Thesis instructor(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 related to the master's thesis.

The master's thesis is a public document and cannot be concealed.

Majors

This study guide presents the curricula of **CCIS** programme as well as the related international joint programmes [ICT Innovation](#) and [NordSecMob](#).

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

Note, that there are some restrictions regarding the selection of major (students studying bachelor's degree in the School of Science or the School of Electrical Engineering, please check the [available study paths](#)).

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 Complexity
 - 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
 - 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.

ICT Innovation programme offers the following majors:

- Cloud Computing and Services
- Digital Media Technology
- Embedded Systems
- Human Computer Interaction and Design

- Service Design and Engineering

NordSecMob programme has only one major, Security and Mobile Computing.

Acoustics and Audio Technology

Professor in charge: Ville Pulkki (ELEC)

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

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

Abbreviation: AAT

Code: ELEC3030

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.

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 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 1. year of master's studies. The course ELEC-E5600 Communication Acoustics is a recommended prerequisite to the other major courses.

Code	Name	Credits	Period/Year
Compulsory courses (30 credits):			
ELEC-E0100	Introduction to Master's Studies at Aalto ELEC	0	I-II / 1
ELEC-E5600	Communication Acoustics	5	I / 1
ELEC-E5610	Acoustics and the Physics of Sound	5	II / 1
ME-E2430	Acoustical Measurements L	5	II / 1
ELEC-E5620	Audio Signal Processing L	5	III-IV / 1
ME-E2420	Room Acoustics L	5	III-IV / 1
ELEC-E5630	Acoustics and Audio Technology Seminar L (varying content)	5	IV-V / 1
Optional courses (10-35 credits):			
ELEC-E5640	Meluntorjunta (Bullerbekämpning, Noise control) L	5	I
ELEC-E5650	Electroacoustics L	5	IV-V
ELEC-E5660	Special assignment in Acoustics and Audio Technology L	1-10	I-II, III-V
ELEC-E5410	Signal Processing for Communications	5	I
ELEC-E5420	Convex Optimization for Engineers	5	I-II
ELEC-E5430	Signal Processing for Large Scale Data Analysis L	5	III-IV
ELEC-E5440	Statistical Signal Processing	5	I-II
ELEC-E5500	Speech Processing	5	I
ELEC-E5510	Speech Recognition	5	II
CSE-C3800	Usability and User Interfaces	5	I-II
ME-C3100	Computer Graphics	5	I-II
ME-E4100	Advanced Computer Graphics	5	III-V
ME-E4200	Experimental User Interfaces	5	III-IV
T-61.3025	Principles of Pattern Recognition	5	III
T-61.3040	Statistical Signal Modeling	5	
T-61.3050	Machine Learning: Basic Principles	5	I-II
T-61.5020	Statistical Natural Language Processing	5	III-IV
T-61.5070	Computer Vision	5	III-IV
T-61.5100	Digital Image Processing	5	I-II

Communications Engineering

Professor in charge: Jyri Hämäläinen
Professors: Riku Jäntti, Jukka Manner, Heikki Hämmäinen
Extent: Long major (60 credits)
Abbreviation: CE
Code: ELEC3029
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.

Communications Engineering - Internet Technologies

The Internet technologies track provides a solid basis for understanding the theory, design principles and practicalities of the core technologies and protocols in the Internet, both in wireless and fixed network communication. In addition to providing theoretical background, many courses involve practical implementation projects that touch the current state-of-the-art Internet protocols and applications.

A graduate from the Internet technologies track understands the fundamentals on Internet architecture and protocols, can perform modeling and analysis on the protocols, and understands security issues in Internet communication. A graduate can also apply this knowledge in practical implementations in real-world use cases, and understand the key factors in providing commercial Internet service. Through a wide selection of optional courses, a graduate is expected to have a deeper understanding on selected topics, such as wireless communication, different networked services, network economics, or cybersecurity.

The track consists of 35 cr of compulsory courses and 25 cr of optional courses

Code	Name	Credits	Period/Year
compulsory courses (35 credits)			
ELEC-E0100	Introduction to Master's Studies at Aalto ELEC	0	I-II / 1
ELEC-E7110	Trends in Communications Engineering Research	5	I-II / 1
ELEC-E7120	Wireless Systems	5	I / 1
ELEC-E7130	Internet Traffic Measurements and Analysis	5	I / 1
CSE-C3400	Information Security	5	I / 2

ELEC-E7310	Routing and SDN	5	II / 1
ELEC-E7320	Internet Protocols	5	III-IV / 1
ELEC-E7330	Laboratory Course in Internet Technologies	5	I-II / 2
optional courses (choose 25 credits):			
ELEC-A7900	Telecommunications Forum L V *	5	I-II / 1
ELEC-E7420	Network service provisioning	5	I-II / 2
ELEC-E7230	Mobile Communication Systems	5	I / 2
ELEC-E7220	Radio Resource and Spectrum Management	5	IV / 1
ELEC-E7450	Performance Analysis P	5	V / 1
ELEC-E7460	Modelling and Simulation P	5	II / 2
ELEC-E7210	Communications theory	5	II / 1
ELEC-E7820	Operator Business P	5	I / 2
ELEC-E7810	Patterns in Communications Ecosystems	5	IV-V / 1
T-110.5241	Networked Security	5	II / 2
CSE-E5470	Mobile Systems Security	5	III-IV / 1
ELEC-E7470	Cybersecurity P	5	V / 1
ELEC-E7850	User Interfaces	5	II / 1
ELEC-E7910	Special Project in Communications Engineering	2-10	I, II, III, IV, V
ELEC-E7490	Challenged Networks P V	5-10	III

*Can be included only once in MSc studies and only as a 5 cr (or more) version

Communications Engineering - Wireless Communications

The Wireless Communications track focuses on various physical layer, link layer and network layer techniques utilized in modern wireless communication systems as well as the methods that are utilized to design, evaluate and deploy them. The optional courses of the track allows the student to focus either on physical layer characteristics and related signal processing methods, wireless communication system level aspects or networking related aspects.

A graduate from the Wireless Communications track understands main operation principles, characteristics, limitations, and evolution paths of the most common radio systems; understands the principles of radio network planning and optimization; is able to evaluate the system performance and develop new system concepts and algorithms. A graduate can also apply this knowledge in practical implementations in real-world use cases.

The track consists of 45 cr of compulsory courses and 15 cr of optional courses

Code	Name	Credits	Period/Year
compulsory courses (45 credits):			
ELEC-E0100	Introduction to Master's Studies at Aalto ELEC	0	I-II / 1
ELEC-E7110	Trends in Communications Engineering Research	5	I-II / 1

ELEC-E7120	Wireless Systems	5	I / 1
ELEC-E7130	Internet Traffic Measurements and Analysis	5	I / 1
ELEC-E7210	Communication Theory	5	II / 1
ELEC-E7220	Radio Resource and Spectrum Management	5	IV / 1
ELEC-E5410	Signal Processing for Communications	5	I-II / 2
ELEC-E7230	Mobile Communication Systems	5	I / 2
ELEC-E7250	Laboratory Course in Communications Engineering	5	III-V / 1
ELEC-E7240	Coding Methods P	5	III / 1
optional courses (choose 15 credits):			
ELEC-A7900	Telecommunications Forum L V*	5	I-II / 1
ELEC-E7910	Special Project in Communications Engineering	2-10	I-V
ELEC-E7410	Communication Transmission lines	5	V / 1
ELEC-E4420	Microwave Engineering I	5	III-IV / 1
ELEC-E7310	Routing and SDN	5	II / 1
ELEC-E7320	Internet Protocols	5	III-IV / 1
ELEC-E7330	Laboratory course in Internet Technologies	5	I-II / 2
ELEC-E7450	Performance Analysis P	5	V / 1
ELEC-E7460	Modelling and Simulation P	5	II / 2
CSE-C3400	Information Security	5	I / 2
CSE-E5470	Mobile Systems Security	5	III-IV / 1
ELEC-E7470	Cybersecurity P	5	V / 1
ELEC-E5440	Statistical Signal Processing	5	I-II / 2
ELEC-E5420	Convex Optimization for Engineers	5	I-II / 2
T-61.3050	Machine Learning: Basic Principles I	5	I-II / 1
T-61.5060	Algorithmic Methods of Data Mining I-II	5	I-II / 2
CSE-E5430	Scalable Cloud Computing I-II	5	I-II / 2

*Can be included only once in MSc studies

Communications Engineering - Communications Ecosystem

The Communications Ecosystems track has a systems-oriented curriculum, offering education in the areas of technology, economics, and user behavior in the context of communications networks and services. Students learn multiple skills and systems thinking, and will be able to collaborate with experts of other fields, such as economics, sociology, and design. The core competence of graduates is technical, business, and social mastery of communication systems.

The track consists of 40 cr of compulsory courses and 20 cr of optional courses. In the optional courses it's possible to focus on human centric communications or networking business or take more technical courses. Courses can also be chosen from all groups.

Code	Name	Credits	Period/Year
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compulsory courses (40 credits):

ELEC-E0100	Introduction to Master's Studies at Aalto ELEC	0	I-II / 1
ELEC-E7110	Trends in Communications Engineering Research	5	I-II / 1
ELEC-E7120	Wireless Systems	5	I / 1
ELEC-E7130	Internet Traffic Measurements and Analysis	5	I / 1
ELEC-E7130	Patterns in Communications Ecosystems	5	IV-V / 1
ELEC-E7820	Operator Business P	5	I / 2
ELEC-E7870	Value Network Design for Internet Services	5	III-IV / 1
ELEC-E7850	User Interfaces	5	II / 1
TU-E2000	Aalto Introduction to Services	3-6	I / 2

optional courses (choose 20 credits):**Human Centric Communications**

ELEC-E7860	Research Project in User Interfaces	5-10	III-IV / 1
ELEC-E7880	Quality of Experience	3	I-IV
T-61.5010	Information Visualization	5	IV / 2
ME-E4360	Design of WWW Services	4	I-II / 2
T-111.4800	Social Media	4	I-II / 2

Networking Business

ELEC-A7900	Telecommunications Forum	5	I-II / 1
TU-C2010	Introduction to Strategic Management	5	I-II / 1
TU-E2110	Innovation in Operations and Service	3-5	III-IV / 1
TU-E4040	Opportunity Prototyping	3	I / 1

other recommended courses

ELEC-E7310	Routing and SDN	5	II / 1
ELEC-E7320	Internet Protocols	5	III-IV / 1
T-61.3050	Machine Learning: Basic Principles	5	I-II / 2

Computer Science

Professor in charge: Petri Vuorimaa

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.

Abbreviation: CS

Code: SCI3042

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 six different tracks, which focus on algorithms, software systems, security, 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
- Secure Systems
- Web Technologies, Applications, and Science
- Interactive Technologies
- Algorithms, Logic, and Complexity
- Big Data and Large-Scale Computing

Major core courses

Students have to select at least five courses from the major core course list, including the track compulsory core course. The core courses can also be done as part of Bachelor studies. If any of these courses have been taken as part of the Bachelor studies, they can be substituted with any optional courses of the track the student is studying. In addition to major core courses, each track has compulsory and optional courses.

CODE	NAME	CREDITS	PERIOD/YEAR
CSE-C3200	Operating Systems	5	I/1st year
CSE-C3210	Web Software Development	5	II-III/1st year
CSE-C3400	Information Security	5	I/1st year
ME-C3100	Computer Graphics	5	I-II/1st year
T-79.4202	Principles of Algorithmic Techniques	5	I-II/1st year
T-79.4101	Discrete Models and Search	5	III-IV/1st year
T-61.3050	Machine Learning: Basic Principles	5	I/1st year
ELEC-E7850	User Interfaces	5	II/1st year

Software Systems and Technologies

Professor in charge: Keijo Heljanko

Extent: Long or compact (40-65 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).

Content and structure

Students have to select at least five courses from the major core course list, including the track compulsory core course. The core courses can also be done as part of Bachelor studies. If any of these courses have been taken as part of the Bachelor studies, they can be substituted with any optional courses of the track.

In addition to major core courses, the students have to take the track compulsory courses. They can also include courses from the optional courses list of the track.

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

CODE	NAME	CREDITS	PERIOD/YEAR
<u>CSE-C3200</u>	Operating Systems	5	I/1st year
<u>CSE-C3210</u>	Web Software Development	5	II-III/1st year
<u>CSE-C3400</u>	Information Security	5	I/1st year
<u>ME-C3100</u>	Computer Graphics	5	I-II/1st year
<u>T-79.4202</u>	Principles of Algorithmic Techniques	5	I-II/1st year
<u>T-79.4101</u>	Discrete Models and Search	5	III-IV/1st year
<u>T-61.3050</u>	Machine Learning: Basic Principles	5	I/1st year
<u>ELEC-E7850</u>	User Interfaces	5	II/1st year

Track compulsory courses (15 credits)

Code	name	credits	period/year
<u>T-110.5121</u>	Mobile Cloud Computing	5	I-II/1st year
<u>CSE-E5000</u>	Seminar on Software Systems, Technologies and Security	5	I-II, III-V/1st year
<u>T-106.5600</u>	Concurrent Programming	5	I-II/2nd year

Track optional courses

CODE	NAME	CREDITS	PERIOD/YEAR
<u>CSE-E5430</u>	Scalable Cloud Computing	5	I-II/2nd year
<u>T-110.5111</u>	Computer Networks II – Advanced Features	5	I-II
<u>T-110.5150</u>	Applications and Services in Internet	5	I-II
<u>T-106.5300</u>	Embedded Systems	5	III-IV/1st year
<u>T-110.5102</u>	Laboratory Works in Networking and Security	5-10	I-II
<u>T-110.5130</u>	Mobile Systems Programming	5	III-IV/1st year
<u>CSE-E5440</u>	Energy-efficient Mobile Computing	5	V/1st year
<u>CSE-E5490</u>	Network Services Business Models	5	III-IV

T-110.7111	Internet Technologies for Mobile Computing	2-10	IV
CSE-E4430	Methods and Tools for Network Systems	5	I-II
CSE-E5280	Learning Technologies	5	I-II
T-106.5550	Research Methods	5-8	III-IV
T-106.5221	Transaction Management in Databases	5	III-IV
T-106.4200	Johdatus kääntäjätekniikkaan	5	I-II
ICS-E5010	Computer Aided Verification and Synthesis	5	III-IV

Secure Systems

Professor in charge: Tuomas Aura

Extent: Long or compact (40-65 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

Information security is a basic requirement for all new products and services that make use of software or network connections. The Secure Systems track covers the fundamental models and technologies of computer and network security, such as access control and data protection, as well as timely topics in the security of mobile, embedded and cloud-based systems. Students will learn to analyze threats caused by a creative adversary and to design secure, usable and deployable security solutions. The track also provides a view to current research in systems security. Students are encouraged to combine information-security studies with learning product development skills in some application area.

Content and structure

Students have to select at least five courses from the major core course list, including the track compulsory core course. The core courses can also be done as part of Bachelor studies. If any of these courses have been taken as part of the Bachelor studies, they can be substituted with any optional courses of the track.

In addition to major core courses, the students have to take the track compulsory courses. They can also include courses from the optional courses list of the track.

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

CODE	NAME	CREDITS	PERIOD/YEAR
CSE-C3400	Information Security	5	I/1st year
CSE-C3200	Operating Systems	5	I/1st year
CSE-C3210	Web Software Development	5	II-III/1st year
ME-C3100	Computer Graphics	5	I-II/1st year
T-79.4202	Principles of Algorithmic Techniques	5	I-II/1st year
T-79.4101	Discrete Models and Search	5	III-IV/1st year
T-61.3050	Machine Learning: Basic Principles	5	I/1st year

[ELEC-E7850](#) User Interfaces 5 II/1st year

Track compulsory courses (min 10 credits)

CODE	NAME	CREDITS	PERIOD/YEAR
SELECT AT LEAST TWO OF THE FOLLOWING*:			
T-110.5241	Network Security	5	II
CSE-E5480	Mobile Systems Security	5	III-IV/1st year
CSE-E5000	Seminar on Software Systems, Technologies and Security *	5	I-II, III-V

*Students who have no other computer-science seminar course in their Master's degree must select CSE-E5000

Track optional courses

CODE	NAME	CREDITS	PERIOD/YEAR
T-79.4502	Cryptography and Data Security	5	I-II
T-110.5102	Laboratory Works in Networking and Security	5-10	III-IV
T-110.6220	Special Course in Information Security	2-10	I-II,III-IV,V

Web Technologies, Applications and Science

Professor in charge: Petri Vuorimaa

Extent: Long or compact (40-65 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 students have to select at least five courses from the major core course list, including the track compulsory core course. The core courses can also be done as part of Bachelor studies. If any of these courses have been taken as part of the Bachelor studies, they can be substituted with any optional courses of the track.

In addition to major core courses, the students have to take the track compulsory courses. They can also include courses from the optional courses list of the track.

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

CODE	NAME	CREDITS	PERIOD/YEAR
ELEC-E7850	User Interfaces	5	II/1st year
CSE-C3210	Web Software Development	5	II-III/1st year
CSE-C3400	Information Security	5	I/1st year
CSE-C3200	Operating Systems	5	I/1st year
ME-C3100	Computer Graphics	5	I-II/1st year
T-79.4202	Principles of Algorithmic Techniques	5	I-II/1st year
T-79.4101	Discrete Models and Search	5	III-IV/1st year
T-61.3050	Machine Learning: Basic Principles	5	I/1st year

Track compulsory courses

CODE	NAME	CREDITS	PERIOD/YEAR
ME-E4360	Design of WWW Services	5	I-II/1st year
ME-E4300	Semantic Web	5	III-IV/1st year
ME-E4400	Information Retrieval	5	III-IV/1st year

Track optional courses

CODE	NAME	CREDITS	PERIOD/YEAR
CSE-E5820	User Interface Construction	5	II/1st year
T-75.5300	Web Services	4	I-II/2nd year
T-111.5360	WWW-applications	4	I-II/2nd year
T-75.5600	Special Assignment in WWW and Knowledge Technology	2-8	I-V
T-111.5501	Seminar on Media Technology	4-8	Varies yearly
ICS-E5040	Modern Database Systems	5	III-IV/1st year
ME-E4500	Explorative Information Visualization	5	I-II

Interactive Technologies

Professor in charge: Antti Oulasvirta

Extent: Long or compact (40-65 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 novel computing platforms like wearable computing and augmented reality, but how to design usable applications for them? Text entry on smartphones is a recognized bottleneck in mobile computing; how could we improve it with machine learning techniques? Many user interfaces we use are poorly designed, but is there an “optimal” user interface for a task? Instead of mouse and touchscreens, why are we not yet controlling computers with our eyes or hand gestures? What do users expect from Internet technologies such as 5G? What makes some social media services so popular while others with similar features die off? How do we design user interfaces when the computers they control “disappear”? The effective design of interactive computing for human use is a significant challenge with real economic and societal impact. This course will equip students with the skills and knowledge needed to tackle these hard problems, skills in high demand in industry.

The IxT track offers 1) a broad overview of the interdisciplinary study of human–computer interaction (HCI) and 2) a deep specialization in its technical aspects close to students in engineering and computational sciences. The track is unique in Europe in its focus on technical aspects of user interfaces and deep integration with state-of-the-art research. The teachers are world-known leaders in computational HCI, mobile interaction, media technology, and closely related fields like graphics and applied social psychology. Some of the optional 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).

The curriculum spans the software and hardware aspects of interactive technologies, covering input devices, interactive media, interaction techniques, user interface technologies, interactive applications, social media, and multimodal interactive systems. In the first courses, students learn the scientific basis in modeling, theories, and methods of HCI. Toward the end, they learn to apply them to realistic design problems. The track requires previous education (major or minor) in engineering, computer science, or a closely related topic.

Specialization in Interactive Technologies provides a basis for careers in the ICT industry, public sector, and research. At the end of the specialization, students can go on to careers where they lead in the design, implementation, or research of interactive technologies. They are skilled at applying methods in computer science, engineering, and design. They are 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 and they know how to address them in practical interdisciplinary development processes. They have the meta-cognitive skills to critically evaluate different approaches to interaction and to develop competences by following technically advanced research literature.

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 to solve problems in design

- Interacting with diverse faculty across departments at Aalto as well as University of Helsinki
- An end-to-end project on a state-of-the-art user interface with a company or a research group.

Content and structure

Students have to select at least five courses from the major core course list, including the track compulsory core course. The core courses can also be done as part of Bachelor studies. If any of these courses have been taken as part of the Bachelor studies, they can be substituted with any optional courses of the track.

In addition to major core courses, the students have to take the track compulsory courses. They can also include courses from the optional courses list of the track.

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

CODE	NAME	CREDITS	PERIOD/YEAR
ELEC-E7850	User Interfaces	5	II/1st year
CSE-C3210	Web Software Development	5	II-III/1st year
CSE-C3400	Information Security	5	I/1st year
CSE-C3200	Operating Systems	5	I/1st year
ME-C3100	Computer Graphics	5	I-II/1st year
T-79.4202	Principles of Algorithmic Techniques	5	I-II/1st year
T-79.4101	Discrete Models and Search	5	III-IV/1st year
T-61.3050	Machine Learning: Basic Principles	5	I/1st year

Track compulsory courses

CODE	NAME	CREDITS	PERIOD/YEAR
ME-E4200	Experimental User Interfaces	5	III-IV/2
T-111.4800	Social Media	4	I-II
ELEC-E7860	Research Project in User Interfaces	5-10	III/2
ELEC-E7870	Advanced topics in User Interfaces PV	3-5	I-II, III-V
SELECT ONE OF THE FOLLOWING:			
DOM-E5058	Information Visualization and Design	3-6	III/1
T-61.5010	Information Visualization	5	IV/1

Track optional courses

CODE	NAME	CREDITS	PERIOD/YEAR
Becs-114.5501	Experimental and Statistical Methods in Biological Sciences I	5	I
SP034i/029	Social Psychology of Information and Communication Technologies (University of Helsinki)*	TBT	TBD

SP032/029	Methodology for Research on Information and Communication (University of Helsinki)*	5	TBD
ME-C2600	Ihminen havaitsijana	5	III-IV
ME-E4100	Advanced Computer Graphics	5	III-V
T-61.3050	Machine Learning: Basic Principles (ICS)	5	I-II
T-61.5070	Computer Vision	5	III-IV
ME-E4360	Design of WWW Services	5	I-II
CSE-C3210	Web Software Development	5	II-III
T-106.5550	Research methods P	5-8	III-IV
ME-E4500	Explorative Information Visualization	5	I-II
582666	Interactive Systems (University of Helsinki, Computer Science)*	6	
ELEC-E7880	Quality Experience	3	

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

Algorithms, Logic, and Complexity

Professor in charge: Kaisa Nyberg

Extent: Long or compact (40-65 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 Complexity provides the students with a strong theoretical background that covers fundamental conceptual tools for the modelling, design, and analysis of advanced computing systems. As a student in the track on Algorithms, Logic, and Complexity you will receive a solid and versatile methodological education which prepares you for a career as an expert in exploiting and advancing these new exciting computing technologies. The studies are organised by the Department of Information and Computer Science (ICS) and strongly built on its research themes. 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).

Content and Structure

Students have to select at least five courses from the major core course list, including the track compulsory core course. The core courses can also be done as part of Bachelor studies. If any of these courses have been taken as part of the Bachelor studies, they can be substituted with any optional courses of the track.

In addition to major core courses, the students have to take the track compulsory courses. They can also include courses from the optional courses list of the track. Also other optional courses can be included per agreement with a professor in charge of the track.

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

CODE	NAME	CREDITS	PERIOD/YEAR
<u>T-79.4202</u>	Principles of Algorithmic Techniques	5	I-II/1st year
<u>T-79.4101</u>	Discrete Models and Search	5	III-IV/1st year
<u>CSE-C3210</u>	Web Software Development	5	II-III/1st year
<u>CSE-C3400</u>	Information Security	5	I/1st year
<u>CSE-C3200</u>	Operating Systems	5	I/1st year
<u>ME-C3100</u>	Computer Graphics	5	I-II/1st year
<u>T-61.3050</u>	Machine Learning: Basic Principles	5	I/1st year
<u>ELEC-E7850</u>	User Interfaces	5	II/1st year

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

CODE	NAME	CREDITS	PERIOD/YEAR
<u>T-79.5207</u>	Advanced Course in Algorithms	5	III-IV
<u>ICS-E5020</u>	Distributed Algorithms	5	I-II
<u>ICS-E5010</u>	Computer-Aided Verification and Synthesis	5	III-IV
<u>T-79.5501</u>	Cryptology	5	III-IV
<u>T-79.5103</u>	Computational Complexity Theory	5	III-IV
<u>T-79.5105</u>	Answer Set Programming	5	I-II

Track optional courses

CODE	NAME	CREDITS	PERIOD/YEAR
<u>ICS-E5030</u>	Advanced Combinatorics in Computer Science	5	I-II
<u>T-79.4302</u>	Parallel and Distributed Systems	5	I-II
<u>ICS-E5050</u>	Advanced Course in Boolean Satisfiability	5	III-IV
<u>T-79.4502</u>	Cryptography and Data Security	5	I-II
<u>T-61.5060</u>	Algorithmic Methods of Data Mining	5	I-II
<u>ICS-E4020</u>	Programming Parallel Computers	5	V
<u>ICS-E4000</u>	Artificial Intelligence	5	III-IV
<u>MS-C1080</u>	Introduction to Abstract Algebra	5	III
<u>MS-E1051</u>	Combinatorics	5	II
<u>MS-E1110</u>	Number Theory	5	II

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

Big Data and Large-Scale Computing

Professor in charge: Aristides Gionis

Extent: Long or compact (40-65 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 will educate professionals who are capable of dealing with the different aspects of modern data analysis and machine learning: data science and efficient data processing, cloud computing, distributed and parallel computing, data analysis, and information visualization. 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).

Content and Structure

Students have to select at least five courses from the major core course list, including the track compulsory core course. The core courses can also be done as part of Bachelor studies. If any of these courses have been taken as part of the Bachelor studies, they can be substituted with any optional courses of the track.

In addition to major core courses, the students have to take the track compulsory courses. They can also include courses from the optional courses list of the track. Also other optional courses can be included per agreement with a professor in charge of the track.

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

CODE	NAME	CREDITS	PERIOD/YEAR
T-79.4202	Principles of Algorithmic Techniques	5	I-II/1st year
T-61.3050	Machine Learning: Basic Principles	5	I/1st year
T-79.4101	Discrete Models and Search	5	III-IV/1st year
CSE-C3210	Web Software Development	5	II-III/1st year
CSE-C3400	Information Security	5	I/1st year
CSE-C3200	Operating Systems	5	I/1st year
ME-C3100	Computer Graphics	5	I-II/1st year
ELEC-E7850	User Interfaces	5	II/1st year

Track compulsory courses

CODE	NAME	CREDITS	PERIOD/YEAR
T-61.5060	Algorithmic Methods of Data Mining	5	I-II
CSE-E5430	Scalable Cloud Computing	5	I-II
ICS-E5040	Modern Database Systems	5	III-IV

Track optional courses

Code	Name	Credits	Period/Year
ICS-E4020	Programming Parallel Computers	5	V
ICS-E4000	Artificial Intelligence	5	III-IV
ICS-E4030	Kernel Methods in Machine Learning	5	I-II
ICS-E5010	Computer-Aided Verification and Synthesis	5	III-IV
T-61.5130	Machine Learning and Neural Networks	5	II
T-61.5140	Machine Learning: Advanced Probabilistic Methods	5	III-IV
T-61.5070	Computer Vision	5	III-IV
T-61.5010	Information Visualization	5	IV
T-110.5121	Mobile Cloud Computing	5	I-II
ELEC-E5510	Speech Recognition	5	II
ELEC-E5420	Convex Optimization for Engineers L	7	I-II
T-79.5207	Advanced Course in Algorithms	5	III-IV
T-106.5600	Concurrent Programming	5	I-II
T-61.5910	Research Project in Computer and Information Science	10	I-II

Also optional courses can be included per agreement with a professor in charge of the track.

Game Design and Production

Professor in charge: Perttu Hämäläinen

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.

Code: SCI3046

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"

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. Multidisciplinary 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.

Major compulsory courses

CODE	NAME	CREDITS	PERIOD/YEAR
ME-C3100	Computer Graphics	5	I-II
T-61.3050	Machine Learning: Basic Principles	5	I-II
ELEC-E5420	Convex Optimization for Engineers	5	I-II
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

Major optional courses

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
CSE-E4751	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
T-61.5010	Information Visualization	5	IV
ELEC-E7850	User Interfaces	5	II
ME-E4200	Experimental User Interfaces	5	III
CSE-C3800	Käyttöliittymät ja käytettävyys	5	I-II
ME-E4100	Advanced Computer Graphics	5	III-V
CSE-C3210	Web Software Development	5	II-III/1st year
CSE-C3400	Information Security	5	I/1st year
T-79.4202	Principles of Algorithmic Techniques	5	I-II/1st year
T-79.4101	Discrete Models and Search	5	III-IV/1st year
ICS-E4020	Programming Parallel Computers	5	V

ICS-E4000	Artificial Intelligence	5	III-IV
ICS-E4030	Kernel Methods in Machine Learning	5	I-II
T-61.5130	Machine Learning and Neural Networks	5	II
T-61.5140	Machine Learning: Advanced Probabilistic Methods	5	III-IV
T-61.5070	Computer Vision	5	III-IV
T-110.5121	Mobile Cloud Computing	5	I-II

ICT Innovation

Please note that this is a double degree programme implemented through international collaboration which is why its structure may deviate from the regular structure of the Master's Degree Programme in Computer, Communication and Information Sciences.

Degree(s) awarded	Master of Science (Technology) from Aalto University Master of Science or similar degree from partner university
Majors	Digital Media Technology (SCI3023) Cloud Computing and Services (SCIXXXX) Embedded Systems (SCI3024) Human-Computer Interaction and Design (SCI3020) Service Design and Engineering (SCI3022)
Minor	Innovation & Entrepreneurship (SCI3100)

Contact information

Programme website: www.masterschool.eitictlabs.eu

Into: <https://into.aalto.fi/display/eneitictinno/>

Administration: Study Coordinator Aino Roms, Study Affairs Secretary Stefanie Schulz (student affairs)

Head of the programme: Prof. Heikki Saikkonen

Programme description

Master's Programme in ICT Innovation is a European double degree programme for students who want to know both the technical and entrepreneurial aspects of information and communications technology. The ICT Innovation programme follows the general structure of the EIT ICT Labs Master School. It is a full-time two-year 120 ECTS master's programme, combining a 90 ECTS technical part with a 30 ECTS standardised module on Innovation and Entrepreneurship (I&E). The programme is completed by studying at two different universities in two countries. Graduates will receive a Master's degree from both of these universities. Aalto University offers five majors within the ICT Innovation programme.

Admission criteria

A degree equivalent to a Bachelors degree of 180 ECTS credits. The specific admission requirements vary for each major. The language of instruction of the programme is English. The applicants must have an excellent command of English. For further information on admission,

application deadline and English language proficiency please see www.masterschool.eitictlabs.eu.

Mobility of students

The table below describes the study track options currently available in EIT ICT Labs Master School in the five majors where Aalto University is involved. First year universities are called entry universities and second year universities are exit universities. Some universities are only available as exit points.

University name and country	Digital Media Technology	Cloud Computing and Services	Embedded Systems	Human Computer Interaction and Design	Service Design and Engineering
Aalto University School of Science, Finland	Exit	Entry + Exit	Exit	Entry + Exit	Entry + Exit
Budapest University of Technology and Economics, Hungary	Exit				
University College London, UK	Exit			Exit	
Eötvös Loránd University, Budapest, Hungary					Exit
KTH Royal Institute of Technology, Stockholm, Sweden	Entry + Exit	Exit	Entry + Exit	Entry + Exit	
Technische Universität Berlin, Germany		Entry + Exit	Entry + Exit	Exit	
Delft University of Technology, The Netherlands	Entry + Exit	Entry + Exit			
Eindhoven University of Technology, The Netherlands			Entry + Exit		Exit
University of Twente, The Netherlands				Entry + Exit	
University of Trento, Italy	Exit		Exit	Exit	Entry + Exit
University of Turku, Finland			Exit		

Université Paris-Sud, France	Exit	Entry + Exit
University of Rennes 1, France	Entry + Exit	
Åbo Akademi University, Turku, Finland		Exit

Programme structure

20-30 ECTS Mandatory courses
 30-40 ECTS Elective and Specialized courses
 30 ECTS Innovation & Entrepreneurship Minor
 30 ECTS Master's Thesis

Language courses for all majors

According to the degree regulations at Aalto University, students must take at least 3 ECTS of foreign language studies for the degree. In Master's Programme in ICT Innovation the students have the option to choose between an English course, fulfilling both oral and written requirements (o,w) or at least 3 ECTS of Finnish courses. We recommend the English course [LC-1310](#)

Academic Communication for everyone. Taking the Finnish course(s) as part of the degree requires an application for exemption from the foreign language course requirement. Please contact your study affairs secretary for more information.

Innovation & Entrepreneurship Minor

The I&E minor at Aalto is developed in co-operation with the Aalto Venture Program (AVP, <http://avp.aalto.fi/>). The focus of the Aalto I&E program is on entrepreneurship in ICT. The content of I&E minor is same for all five majors.

Compulsory I&E courses during the entry year 2015-2016 and summer 2016

Code	Course name	Credits
CSE-E4751	Introduction to IT Business and Venturing	2 ECTS
CSE-E4755	Management of a Technology Venture	6 ECTS
TU-E4010	High Growth Entrepreneurship with varying content 1	8 ECTS
CSE-E5754	Growth and Internationalization of Technology SMEs	4 ECTS
T-106.5320	ICT Innovation Summer School	4 ECTS

Compulsory I&E course during the second year 2015-2016

Code	Course name	Credits
T-106.5330	ICT Innovation I&E Minor Thesis	6 ECTS

Digital Media Technology

Professors of the major

T-111	Prof. Petri Vuorimaa
T-111	Prof. Lauri Savioja
T-111	Prof. Tapio Takala
T-111	Prof. Perttu Hämäläinen
T-111	Prof. Jaakko Lehtinen
T-111	Prof. Tapio Lokki
T-75	Prof. Eero Hyvönen

Entry points: KTH and TU Delft

Exit points with specializations:

AALTO: Hypermedia
KTH: Media Processing and Communications
TU Delft: Medical Imaging
BME: Media Communications Services
UCL: Virtual Environments

Objectives of the programme

The main focus of the Digital Media Technology (DMT) technical major is on the enabling technologies for digital media systems, including technologies for generation of (interactive) media, processing and coding of media and for wired and wireless transfer and storage of media content.

Applications that use these technologies include teleconferencing, interactive multimedia applications, entertainment, computer games, telemedicine and surveillance etc. The master will be based on a systems engineering approach in order to successfully integrate media technologies in applications such as “smart spaces”, “health and well-being”, and “smart cities”, thematic areas of EIT ICT Labs.

Second year at Aalto

Aalto specialization – Hypermedia

Second autumn 2015

Compulsory courses (16 ECTS)

Code	Course name	Credits
T-75.5300	Web Services	4 ECTS
CSE- C3210	Web Software Development	5 ECTS
T-111.5360	WWW Applications	4 ECTS
	Language course: Compulsory degree requirement, both oral and written	3

requirements *

ECTS

(*) See 'Language courses for all majors' above.

Compulsory I&E Courses (6 ECTS)

Code	Course name	Credits
T-106.5330	ICT Innovation I&E Minor Thesis	6 ECTS

Optional Courses (8 ECTS)

Code	Course name	Credits
T-75.5600	Special Assignment in WWW and Knowledge Technology	2-8 ECTS
ME-E4500	Explorative Information Visualization	5 ECTS
T-121.5300	User Interface Construction	4 ECTS
T-111.5501	Seminar on Media Technology	4 ECTS
T-110.5121	Mobile Cloud Computing	5 ECTS

Total 30 ECTS

Second spring 2016

Code	Course name	Credits
T-XXX.D	Master's Thesis	30 ECTS

Total for the whole year: 60 ECTS

Cloud Computing and Services

Professors of the major

T-110	Prof. Jukka K. Nurminen
T-110	Prof. Tuomas Aura
T-110	Prof. Antti Ylä-Jääski
T-110	Prof. Keijo Heljanko
T-110	Mario di Francesco
T-110	N. Asokan

Entry points: AALTO, TU Berlin, TU Delft and U Rennes 1

Exit points with specializations:

AALTO: Mobile Services

KTH: Data Intensive Computing

TU Berlin: Cloud operation

TU Delft: Distributed Data Processing

Objectives of the programme

The program objective is to educate engineers who will be able to design, implement and maintain distributed software systems for a wide range of applications including peer-to-peer, cloud computing, web-services provision and internet-based applications. The program will provide students with a system of knowledge both in formal foundations, technological platforms and practical skills in implementing distributed software applications. The program will also provide an insight into current and future directions of the distributed software development.

Graduates of the programme are able to

- analyse and design a complex distributed IT-system based on network, storage, and processing components
- describe a service-based system using dedicated description languages
- calculate and assess the necessary quantitative capacities of the system components to achieve specified performance goals
- can apply up-to-date technology in fault tolerance and security to achieve privacy and dependability goals in complex distributed systems
- identify business opportunities in the area of cloud computing and to turn them into operation
- communicate technical issues to professionals and non-professionals
- work in multidisciplinary and multinational teams and take over responsibilities
- have business skills to understand and execute a business development process, and have insight in legal and societal aspects of products and services

First year at Aalto

First autumn 2015

Compulsory courses (23 ECTS)

Code	Course name	Credits
CSE-E5430	Scalable Cloud Computing	5 ECTS
T-110.5111	Computer Networks II – Advanced Features	5 ECTS
T-110.5121	Mobile Cloud Computing	5 ECTS
CSE-E4430	Methods and Tools for Network Systems	5 ECTS
	Language course: Compulsory degree requirement, both oral and written requirements *	3 ECTS

(*) See ‘Language courses for all majors’ above.

Compulsory I&E Courses (8 ECTS)

Code	Course name	Credits
CSE-E4751	Introduction to IT Business and Venturing	2 ECTS
CSE-E4755	Management of a Technology Venture	6 ECTS

First spring 2016

Compulsory courses (5 ECTS)

Code	Course name	Credits
CSE-E5000	Seminar on Software Systems, Technologies and Security	5 ECTS

Compulsory I&E Courses (16 ECTS)

Code	Course name	Credits
TU-E4010	High Growth Entrepreneurship with varying content 1	8 ECTS
CSE-E5754	Growth and Internationalization of Technology SMEs	4 ECTS
T-106.5320	ICT Innovation Summer School	4 ECTS

Optional courses - select 8 ECTS of over two semesters

Code	Course name	Credits	Semester
T-79.4302	Parallel and Distributed Systems	5 ECTS	autumn
T-110.5150	Applications and Services in Internet	5 ECTS	autumn
CSE-C3400	Information Security	5 ECTS	autumn
T-110.5241	Network Security	5 ECTS	autumn
CSE-E5002	Special Assignment in Software Systems, Technologies and Security		autumn / spring
CSE-E5001	Special Course in Software Systems, Technologies and Security		autumn / spring
T-110.6220	Special Course in Information Security		autumn / spring
T-110.5102	Laboratory Works in Networking and Security	5 ECTS	spring
T-110.5130	Mobile Systems Programming	5 ECTS	spring
CSE-E5440	Energy-efficient Mobile Computing	5 ECTS	spring
T-110.7111	Internet Technologies for Mobile Computing	4 ECTS	spring

Total for the whole year: 60 ECTS

Second year at Aalto

Aalto specialization – Mobile Services

The courses cover the theoretical and practical aspects of designing mobile distributed systems and services. In the seminar the students learn to read technical and research literature on selected thematic topics and mobile computing, as well as scientific writing and presentation. In the Master's thesis project, the students can focus on problems arising from the thematic research projects in the Helsinki Node of EIT ICT Labs.

Second autumn 2015

Compulsory courses (19 ECTS)

Code	Course name	Credits
	Language course: Compulsory degree requirement, both oral and written requirements *	3 ECTS
CSE-E5000	Seminar on Software Systems, Technologies and Security	5 ECTS
Select one of the following		
CSE-E5430	Scalable Cloud Computing	5 ECTS
T-110.5121	Mobile Cloud Computing	5 ECTS

(*) See 'Language courses for all majors' above.

Compulsory I&E Courses (6 ECTS)

Code	Course name	Credits
T-106.5330	ICT Innovation I&E Minor Thesis	6 ECTS

Optional Courses (11 ECTS)

Code	Course name	Credits
T-79.4302	Parallel and Distributed Systems	5 ECTS
T-110.5102	Laboratory Works in Networking and Security	5 ECTS
T-110.5130	Mobile Systems Programming	5 ECTS
T-110.5150	Applications and Services in Internet	5 ECTS
CSE-C3400	Information Security	5 ECTS
T-110.5241	Network Security	5 ECTS
CSE-E4430	Methods and Tools for Network Systems	5 ECTS
T-110.7111	Internet Technologies for Mobile Computing	4 ECTS
T-110.6000	Internet and Computing Forum	2 ECTS

Select one of the following (the one that was not selected for compulsory):

CSE-E5430	Scalable Cloud Computing	5 ECTS
T-110.5121	Mobile Cloud Computing	5 ECTS

Total 30 ECTS

Second spring 2016

Code	Course name	Credits
T-XXXD	Master's Thesis	30 ECTS

Total for the whole year: 60 ECTS

Embedded Systems

Professor of the major

T-106

Prof. Heikki Saikkonen

Academic coordinator:

D.Sc. (eng.) Vesa Hirvisalo

Entry points: KTH, TU Berlin and TU/e

Exit points with specializations:

KTH: Embedded Platforms and Internet of Things

AALTO: Mobile Cyber-Physical Systems

TU Berlin: Embedded Multicore Processing

UNITN: Real-Time Systems and Design of Cyber-Physical systems

TU/e: Embedded Networking

UTU and ÅA: Energy Efficient Computing

Objectives of the programme

Cyber-physical systems (CPS) combine computational and physical elements. A mobile CPS is designed as a network that includes mobile and wireless elements. The technology for mobile CPS forms the corner stone for many novel application areas and businesses, such as augmented and mixed reality systems, infotainment systems, and games. Especially, the rise in popularity of smartphones has increased interest in the area of mobile CPS. The students will acquire skills to develop applications and services that are based on mobile CPS technologies. The topics covered include programming web and multimedia systems, processing of video and audio, designing user interfaces, and mastering the embedded systems design flow.

Second year at Aalto

Aalto specialization – Mobile Cyber-Physical Systems

Second autumn 2015

Compulsory courses

Code	Course name	Credits
T-111.5350	Multimedia Programming	4 ECTS
T-106.5840	Seminar on embedded systems	3-10 ECTS
T-106.5740	Embedded systems project	5-10 ECTS
	Language course: Compulsory degree requirement, both oral and written requirements *	3 ECTS

(*) See 'Language courses for all majors' above.

Compulsory I&E Courses (6 ECTS)

Code	Course name	Credits
T-106.5330	ICT Innovation I&E Minor Thesis	6 ECTS

Optional courses

Code	Course name	Credits
T-61.5100	Digital Image Processing	5 ECTS
S-89.5150	Speech Recognition	5 ECTS
T-111.5350	Multimedia programming	4 ECTS
CSE-E5820	User Interface Construction	5 ECTS
T-75.5300	Web Services	4 ECTS

Total 30 ECTS

Second spring 2016

Code	Course name	Credits
T-XXXX	Master's Thesis	30 ECTS

Total for the whole year: 60 ECTS

Human Computer Interaction and Design

Professors of the major

T-121	Prof. Marko Nieminen
T-111	Prof. Tapio Takala
T-61	Prof. Samuel Kaski
Academic coordinator:	Mika P. Nieminen

Entry points: Aalto, KTH, Université Paris-Sud (UPS) and University of Twente (UT)

Exit points with specializations:

KTH: Mobile and ubiquitous interaction

AALTO: User Modeling for advanced human-computer interaction

TU Berlin: Multi-modal interaction

UPS: Situated interaction

UT: Intelligent systems

UCL: Affective computing

Objectives of the programme

Human Computer Interaction and Design (HCID) focuses on the study, design, development and evaluation of novel user interfaces and interactive systems taking into account human aspects, at the cognitive and sensory-motor levels, technological aspects, as well as business aspects.

New ICT technologies are transforming our daily lives. Smart devices (mobile phones, PDAs, tablet computers), smart products (car, navigation) and smart environments (ambient intelligence) are enabling new services such as navigation, information providing, learning, making reservations or buying of goods are delivered.

Increasingly, the interaction with these devices is not through simple buttons or keystrokes but with more flexible and intuitive interaction methods such as multi-touch, speech, gestures, and with advanced display systems such as augmented and virtual reality. Smart devices and services are also able to show intelligent behaviour recognizing intentions of the user and anticipating the user's needs. These technologies are central in Human-Computer Interaction and Design.

The design of intuitive user interfaces, however, is not only a matter of the right technology but also a matter of good interaction design: study user's social and cognitive behaviour in relation to using technology, taking the user as a central driver for design, designing for the right user experience, and testing and evaluating the design within context, are keys to understanding and designing successful user experience.

First year at Aalto

First autumn 2015

Compulsory courses (13 ECTS)

Code	Course name	Credits
	Language course: Compulsory degree requirement, both oral and written requirements *	3 ECTS
CSE-E58000	User-Centered Methods for Product and Service Design	5 ECTS

Select one of the following courses:

CSE-E5820	User Interface Construction	5 ECTS
ELEC-E7850	User Interfaces	5 ECTS

(*) See 'Language courses for all majors' above.

Compulsory I&E Courses (8 ECTS)

Code	Course name	Credits
CSE-E4751	Introduction to IT Business and Venturing	2 ECTS
CSE-E4755	Management of a Technology Venture	6 ECTS

Total 21 ECTS

First spring 2016

Compulsory courses (20 ECTS)

Code	Course name	Credits
CSE-E5888	Design Project	10 ECTS
CSE-E5810	Usability Evaluation	5 ECTS
ME-E4200	Experimental User Interfaces	5 ECTS

Compulsory I&E Courses (16 ECTS)

Code	Course name	Credits
TU-E4010	High Growth Entrepreneurship with varying content 1	8 ECTS
CSE-E5754	Growth and Internationalization of Technology SMEs	4 ECTS
T-106.5320	ICT Innovation Summer School	4 ECTS

Total 36 ECTS

Optional courses - Select at least 3 ECTS over the two semesters:

Code	Course name	Credits	Semester
T-61.3050	Machine Learning: Basic Principles	5 ECTS	autumn
ME-C3100	Computer Graphics	5 ECTS	autumn
ME-E4360	Design of WWW services	4 ECTS	spring
T-61.5010	Information Visualization	5 ECTS	spring
ICS-E4000	Artificial Intelligence	5 ECTS	spring
ME-E4100	Advanced Computer Graphics	5 ECTS	spring

Total for the whole year: 60 ECTS

Second year at Aalto

Aalto specialization – User Modeling for advanced human-computer interaction

Second autumn 2015

Compulsory courses (8 ECTS)

Code	Course name	Credits
	Language course: Compulsory degree requirement, both oral and written requirements *	3 ECTS
T-61.3050	Machine Learning: Basic Principles (If basics done at entry university, select more electives)	5 ECTS

(*) See 'Language courses for all majors' above.

Compulsory I&E Courses (6 ECTS)

Code	Course name	Credits
T-106.5330	ICT Innovation I&E Minor Thesis	6 ECTS

Optional courses (16 ECTS)

Code	Course name	Credits	Period
T-61.5100	Digital Image Processing	5 ECTS	autumn
T-61.5130	Machine Learning and Neural Networks	5 ECTS	autumn
S-89.5150	Speech Recognition	5 ECTS	autumn
ELEC-E7850	User Interfaces	5 ECTS	autumn
CSE-E5699	Individual Studies in Software and Service Engineering	1-10 ECTS	autumn/spring
T-61.60X0	Special Course in Computer and Information Science	3-10 ECTS	autumn/spring
T-61.5910	Research Project in Computer and Information Science	5-10 ECTS	autumn/spring

Total: 30 ECTS

Second spring 2016

Code	Course name	Credits
T-XXXX	Master's Thesis	30 ECTS

Total for the whole year: 60 ECTS

Service Design and Engineering

Professor of the major

T-106

Heikki Saikkonen

Academic coordinator:

Håkan Mitts

Entry points: AALTO, UNITN

Exit points and specializations:

Aalto: Mobile service systems
 TU/e: Service-oriented business process management
 ELTE: Distributed service systems
 UNITN: Service-oriented social informatics

Objectives of the programme

The Aalto academic year is divided into 5 periods with courses running in one or in several periods. Also some courses are run as intensive courses and take only half a period. The basic structure of the program for the year 2015-2016 is shown below. The main desideratum for designing the SDE Technical Common Base is to ensure that SDE students, after the first year, have comparable technical understanding of important topics related to SDE.

First year at Aalto

First autumn 2015

Compulsory courses (18 ECTS)

Code	Course name	Credits
TU-E2000	Aalto Introduction to Services	5 ECTS
CSE-E4660	ICT Enabled Service Business and Innovation	5 ECTS
CSE-C3210	Web Software Development	5 ECTS
	Language course: Compulsory degree requirement, both oral and written requirements *	3 ECTS

(*) See 'Language courses for all majors' above.

Compulsory I&E Courses (8 ECTS)

Code	Course name	Credits
CSE-E4751	Introduction to IT Business and Venturing	2 ECTS
CSE-E4755	Management of a Technology Venture	6 ECTS

First spring 2016

Compulsory courses (10 ECTS)

Code	Course name	Credits
CSE-E4600	Software Project Management	5 ECTS
T-76.5150	Software Architectures	5 ECTS

Compulsory I&E Courses (16 ECTS)

Code	Course name	Credits
TU-E4010	High Growth Entrepreneurship with varying content 1	8 ECTS
CSE-E5754	Growth and Internationalization of Technology SMEs	4 ECTS
T-106.5320	ICT Innovation Summer School	4 ECTS

Optional courses – Select at least 18 ECTS over the two semesters:

Code	Course name	Credits
CSE-E4650	Enterprise Architectures (highly recommended)	5 ECTS
T-61.5010	Information visualization (highly recommended)	5 ECTS

Other relevant courses on agreement with the academic coordinator.

Total for the whole year: 60 ECTS

Second year at Aalto

Aalto specialization – Mobile Service Systems

The starting point for the second year in SDE at Aalto is to create a personal study plan for each student that matches the student's own interests as well as the needs of the research project that forms the foundation of the student's Master's thesis.

Aalto offers a specialization in Mobile service systems with thematic coupling to Smart Spaces. The courses cover the theoretical and practical aspects of designing digital services with a strong mobile focus. In the Master's thesis project, the students can focus on problems arising from the thematic research projects in the Helsinki Node of EIT ICT Labs.

Second autumn 2015

Compulsory courses (9 ECTS)

Code	Course name	Credits
	Language course: Compulsory degree requirement, both oral and written requirements *	3 ECTS

Other relevant courses on agreement with the academic coordinator.

(*) See 'Language courses for all majors' above.

Compulsory I&E Courses (6 ECTS)

Code	Course name	Credits
T-106.5330	ICT Innovation I&E Minor Thesis	6 ECTS

Optional Courses (21 ECTS)

Code	Course name	Credits
T-110.5121	Mobile Cloud Computing (highly recommended)	5 ECTS
CSE-E5697	Special Course in Software and Service Engineering 1-10 ECTS (highly recommended)	5 ECTS

Other relevant courses on agreement with the academic coordinator.

Total 30 ECTS

Second spring 2016

Code	Course name	Credits
T-XXXD	Master's Thesis	30 ECTS

Total for the whole year: 60 ECTS

Machine Learning and Data Mining

Professor in charge: Samuel Kaski

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.

Abbreviation: Macadamia

Code: SCI3044

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 and social networks. 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).

Content and Structure

The students have to take the seven 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
T-61.3050	Machine Learning: Basic Principles	5	I-II/1st year
T-61.5130	Machine Learning and Neural Networks	5	II/1st year
T-61.5140	Machine Learning: Advanced Probabilistic Methods	5	III-IV/1st year
T-61.5060	Algorithmic Methods of Data Mining	5	I-II/1st year
ICS-E4030	Kernel Methods in Machine Learning	5	I/2nd year
T-61.5010	Information Visualization	5	IV/1st year
T-61.5910	Research Project in Computer and Information Science	5	I-II/2nd year

Major optional courses (choose 15-25 credits)

CODE	NAME	CREDITS	PERIOD/YEAR
T-61.5070	Computer Vision	5	III-IV/1st year
S-89.5150	Speech Recognition	5	II/2nd year
T-61.5020	Statistical Natural Language Processing	5	III-IV/1st year
T-61.5050	High-Throughput Bioinformatics	5	II/2nd year
ICS-E4000	Artificial Intelligence	5	III-IV/1st year
T-61.5100	Digital Image Processing	5	I-II/1st year
T-61.3025	Principles of Pattern Recognition	5	III/1st year
T-61.5900	Special Assignment in Computer and Information Science	5-10	I-V
T-61.60XX	Special Course in Computer and Information Science	3-10	I-V

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

Mobile Computing, Services and Security

Professor in charge: Antti Ylä-Jääski

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.

Abbreviation: Mobile

Code: SCI3045

School: School of Science

Objectives

Studies in the Mobile Computing, Services and Security major give students a broad understanding of the latest and future technologies for mobile and cloud computing from several perspectives. Students will gain practical engineering knowledge of and theoretical insights into the challenges of network application development, service architectures, secure systems engineering, and mobile and cloud platforms. The graduates are well prepared, for example, for industrial R&D jobs, various expert roles, or doctoral studies at Aalto University and abroad.

Structure and content

The program covers topics on mobile and wireless networks, network architecture, network-based services and applications, services business, and secure systems engineering. The studies are closely linked with the research done by the teachers, for example, on the Internet of Things, cloud services, mobile platform security, energy and green ICT, pervasive and ubiquitous computing, and mobility protocols. 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 learn writing and presentation skills and to follow the latest research.

Major compulsory courses (40 credits)

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

CODE	NAME	CREDITS	PERIOD
CSE-C3210	Web Software Development	5	II-III
CSE-C3400	Information Security	5	I
CSE-E4430	Methods and Tools for Network Systems	5	I-II
T-110.5111	Computer Networks II - Advanced Features	5	I-II
T-110.5150	Applications and Services in Internet	5	I-II
T-110.5102	Laboratory Works in Networking and Security	5	III-IV
T-110.5121	Mobile Cloud Computing	5	I-II
CSE-E5000	Seminar on Software Systems, Technologies and Security	5	I-II, III-V

Major optional courses

Choose enough courses from the list below to meet the required number of credits.

CODE	NAME	CREDITS	PERIOD/YEAR
INTERNET AND SERVICES:			
T-110.5130	Mobile Systems Programming	5	III-IV
T-110.6000	Internet and Computing Forum (not organised 2015-2016)	2	III-IV
CSE-E5002	Special Assignment in Software Systems, Technologies and Security	1-10	I-II, III-V
T-110.7111	Internet Technologies for Mobile Computing	5	III-IV
CSE-E5490	Network Services Business Models	5	III-IV
CSE-E5430	Scalable Cloud Computing	5	I-II
SECURE SYSTEMS:			
T-	Network Security	5	II

[110.5241](#)

CSE- E5480	Mobile Systems Security	5	III-IV
T-79.4502	Cryptography and Data Security	5	III-IV
T-79.5501	Cryptology	5	III-IV
T- 110.6220	Special course in information security	5	I-II, III-IV, V

Other courses on relevant topics may be included by prior agreement of the professors of the major.

Signal, Speech and Language Processing

Professor in charge: Mikko Kurimo

Professors: Paavo Alku, Visa Koivunen, Jorma Skyttä, Sergiy Vorobyov, Risto Wichman

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

Abbreviation: SSLP

Code: ELEC3010

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 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 minor (20-25 cr). Students taking a long major may include an optional minor in their elective studies.

Signal, Speech and Language Processing - Signal Processing

Code	Name	Credits	Period/Year
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Compulsory courses (30 credits):

ELEC-E0100	Introduction to Master's Studies at Aalto ELEC	0	I-II / 1
ELEC-E5410	Signal Processing for Communications	5	I-II / 1
T-61.3050	Machine learning: Basic principles	5	I / 1

Choose 20 credits:

ELEC-E5420	Convex Optimization for Engineers	5	I-II / 1
ELEC-E5430	High Volume Data Processing	5	III-IV / 1
ELEC-E5440	Statistical Signal Processing	5	I-II / 1
T-61.3025	Principles of Pattern Recognition	5	III / 1
T-61.5100	Digital Image Processing	5	I-II / 1
T-61.5060	Algorithmic Methods of Data Mining	5	I-II / 1

Optional courses, choose 30 credits (long major) or 10 credits (compact major): As optional courses students can choose any courses from the above list of compulsory courses or courses from a specific field of specialization listed below. Courses can be selected either from one field or can be combined from several fields.

Signal processing:

ELEC-E5490	Convex Optimization Project L	3	III-IV
ELEC-E5450	Signal Processing Seminar I L V	2-5	I-II
ELEC-E5460	Signal Processing Seminar II L V	2-5	III-IV
ELEC-E5400	Project Work in Signal Processing	1-10	I-V

pattern recognition and machine learning:

T-61.5020	Statistical Natural Language Processing P	5	III-IV
T-61.5050	High-Throughput Bioinformatics P	5	II
T-61.5070	Computer Vision P	5	III-IV
T-61.5080	Signal Processing in Neuroinformatics P	5	I-II
T-61.5030	Machine Learning and Neural Networks P	5	II
T-61.5140	Machine Learning: Advanced Probabilistic Methods P	5	III-IV
T-61.5010	Information Visualization	5	IV
ICS-E4000	Artificial Intelligence	5	III-IV
ICS-E4030	Kernel Methods in Machine Learning	5	I-II

Signal processing in medical technology:

Tfy-99.3275	Biosignal Processing	5	I-II odd years
Tfy-99.4275	Signal Processing in Biomedical Engineering P	5	I-II even years
Tfy-99.4281	Kuvankäsittely lääketieteellisessä tekniikassa L	5	III-V
Tfy-99.7280	Medical Imaging P	5	III-iV

Signal processing in automation:

ELEC-E8118	Robotic Vision L	5	III
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Telecommunications and information theory:

ELEC-E7240	Coding Methods	5	III
ELEC-E7210	Communications Theory	5	II
ELEC-E7129	Wireless Systems	5	I
ELEC-E7230	Mobile Communications Systems	5	I
ELEC-C7220	Information Theory	5	II
MS-E2152	Peliteoria	5	I-II

microelectronics design:

ELEC-E3510	Basics of IC Design	5	III
ELEC-E3520	Digital Microelectronics I L	5	III
ELEC-E3540	Digital Microelectronics II L	5	IV-V

remote sensing:

Maa-57.3110	Käytännön kaukokartoitus L	5	II
Maa-57.3200	Tutkakuvat kaukokartoituksessa L	3	I
Maa-57.3210	Kaukokartoitusaineiston luokittelu ja mallintaminen L	4	
ELEC-E4230	Microwave Earth Observation Instrumentation P Kaukokartoituksen jatkokurssi	5	

speech and audio signal processing and acoustics

ELEC-E5600	Communication Acoustics	5	I
ELEC-E5610	Acoustics and the Physics of Sound	5	II
ELEC-E5650	Electroacoustics	5	IV-V
ELEC-E5620	Audio Signal Processing	5	III-IV
ELEC-E5630	Acoustics and Audio Technology Seminar (varying content)	5	IV-V
ELEC-E5500	Speech Processing	5	I
ELEC-E5510	Speech Recognition	5	II
ELEC-E5520	Speech and Language Processing Methods	2	III-IV
ELEC-E5530	Speech and Language Processing Seminar	3	III-IV
T-61.5020	Statistical Natural Language Processing	5	III-IV

mathematics and optimization

MS-E2148	Dynamic Optimization	5	III
MS-E1111	Galois Theory P	5	IV
MS-E2134	Decision making and problem solving	5	I
MS-C2128	Ennustaminen ja aikasarja-analyysi	5	II

programming and software projects

ELEC-C7310	Sovellusohjelmointi	5	
CSE-C2610	Software Project 1	5	
CSE-C2620	Ohjelmistoprojekti 2	5	
CSE-C3200	Käyttöjärjestelmät	5	
CSE-C3600	Software Design and Modelling	5	
CSE-C3610	Software Engineering	5	
CSE-E5430	Scalable Cloud Computing	5	
T-106.5300	Embedded Systems	5	
T-106.5740	Project in Embedded Systems	5	I-II, III-IV
ELEC-E8001	Embedded Real-Time Systems	5	I-II
ELEC-E8408	Embedded Systems Development	5	III-IV

Signal, Speech and Language Processing - Speech and Language Processing

Code	Name	Credits	Period/Year
compulsory courses (30 credits):			
ELEC-E0100	Introduction to Master's Studies at Aalto ELEC	0	I-II / 1
ELEC-E5410	Signal Processing for Communications	5	I-II / 1
T-61.3050	Machine learning: Basic principles	5	I / 1
ELEC-E5500	Speech Processing	5	I-II / 1
ELEC-E5510	Speech Recognition	5	II / 1
ELEC-E5520	Speech and Language Processing Methods	2	III-IV / 1
ELEC-E5530	Speech and Language Processing Seminar V	3-5	III-IV / 1
T-61.5020	Statistical Natural Language Processing	5	III-IV / 1
Optional courses, choose 30 credits (long major) or 10 credits (compact major):			
ELEC-E5540	Special assignment in Speech and Language Processing	1-10	I-V
ELEC-E5420	Convex Optimization for Engineers	5	I-II
ELEC-E5490	Convex Optimization Project L	3	III-IV
ELEC-E5440	Statistical Signal Processing	5	I-II
	Kieliteknologian johdantokurssi (HY) (as JOO-studies)		
	Fonetiikan perusteet (HY) (as JOO-studies)		
T-61.3040	Statistical Signal Modeling	5	I-II
T-61.5130	Machine Learning and Neural Networks	5	II
T-61.3025	Principles of Patter Recognition	5	III
T-61.5100	Digital Image Processing P	5	I-II
T-61.5070	Computer Vision P	5	III-IV
ICS-E4030	Kernel Methods in Machine Learning	5	I-II
T-61.5140	Machine Learning: Advanced Probabilistic Methods	5	III-IV
BECS-114.1100	Laskennallinen tiede	5	I-II

BECS-E2601	Bayesian Data Analysis	5	I-II
ELEC-E5600	Communication Acoustics	5	I
ELEC-E5620	Audio Signal Processing	5	III-IV
ELEC-E5430	Signal Processing for Large Scale Data Analysis	5	III-IV
CSE-C3800	Usability and User Interfaces	5	I-II

Master's Degree Programme in Security and Mobile Computing (NordSecMob)

Please note that this is a double degree programme implemented through international collaboration which is why its structure may deviate from the regular structure of the Master's Degree Programme in Computer, Communication and Information Sciences.

Degree(s) awarded	Master of Science (Technology) from Aalto University Master of Science or similar degree from partner university
Major	Security and Mobile Computing (T3011)

Contact information

Programme website: <http://nordsecmob.aalto.fi/en/>

Administration: Study Coordinator Aino Roms

Programme director: Prof. Antti Ylä-Jääski

Programme description

The Nordic countries are very innovative in mobile communications and an industrial and scientific cluster has formed to serve this area. The NordSecMob - Master's Programme in Security and Mobile Computing is based on the research cooperation between the participating universities and it offers in-depth knowledge in the field of data communications, mobile computing and information security.

This Master's programme extends the students computer science skills towards the mobile computing area. The courses in the programme address the modern data communications architecture evolution from several aspects. The students will gain practical knowledge and theoretical insights in the fields of network applications, services, information security and mobile networking. After completion of this programme, the graduates will have a broad knowledge basis of mobile computing and they will be able to design and develop their own solutions for the mobile Internet, having both the practical skills and the capability to follow the scientific research. The Internet technologies form the technical framework of the NordSecMob programme. The key subject areas for both the Internet and mobile networks are applications and services, including service management issues like mobility, quality of service, charging and security. The students are required to both study and create practical implementations based on the current technologies and to learn the emergent trends in the research community. Special attention is paid to the information security, which is a critical issue when developing and deploying services on public networks.

NordSecMob is a full-time Master of Science degree programme with duration of two years. The programme is coordinated by the Aalto University School of Science (AALTO), Department of Computer Science and Engineering. The other four Nordic partner universities are The Royal Institute of Technology (KTH) in Sweden, The Norwegian University of Science and Technology (NTNU), The Technical University of Denmark (DTU) and University of Tartu (UT) in Estonia.

The NordSecMob programme gives the students a chance to experience the cultures of two Northern European countries. After completing the two-year programme successfully, the students will be awarded two officially recognized M.Sc. degrees: one from each university where they studied.

The NordSecMob programme graduates are equipped to be employed internationally by both industry and academia, having acquired the necessary skills for various work opportunities including expert role, R&D, research and management positions. This programme gives a solid basis to continue academic career towards the doctoral level; it also provides the students with experience of international R&D environments and enables access to major international networks.

Admission criteria

Admission criteria to the programme is a high quality Bachelor's degree encompassing a minimum of 180 ECTS credits in Engineering (Computer Science or Information Technology) or equivalent studies i.e. a degree consisting of at least three years of full-time studies.

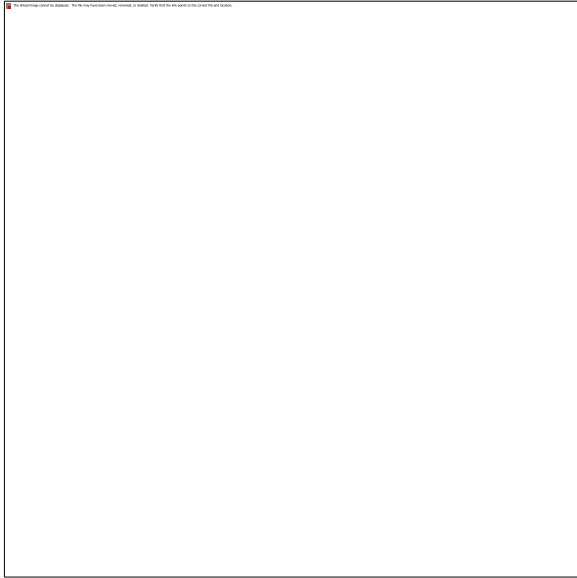
The applicants should have solid knowledge of mathematics (discrete mathematics), programming skills, data structures and algorithms, computer architecture and basics of computer networks. In addition, basic knowledge of the following subject areas will be an advantage: software engineering, operating systems, concurrent programming, databases and database management, logic in computer science and principles of theoretical computer science.

The language of instruction of the programme is English. The applicants must have an excellent command of English. For further information on admission and application deadline, please see <http://nordsecmob.aalto.fi/>.

Mobility of students

A joint curriculum is defined for the programme and it involves always two universities. The 120 ECTS credits are divided into two blocks: 1-2 semesters of teaching (30-60 ECTS credits) will be provided by the home university and 1-2 semesters of teaching (30-60 ECTS credits) will be provided by the host university. The student takes courses focusing on advanced topics on the selected area of specialization:

- AALTO: Technical Information Security and Network Services
- KTH: Communications Systems Design
- NTNU: Information Security
- DTU: Reliable Software Systems
- UT: Mathematical Foundations of Cryptography



The first autumn term studies are taken at one of the three home universities: AALTO, KTH or NTNU. The students with the specialization “Reliable Software Systems” transfer from the home university to DTU for the first spring semester and the second autumn semester. Also the students with the specialization “Mathematical Foundations of Cryptography” move from the home university to UT for the first spring and the second autumn semester. The students with other specialization tracks relocate after the first year studies to the other host universities (AALTO, KTH, NTNU) for the second year studies. The programme includes three semesters of courses followed by a fourth research semester (Master's thesis 30 credits) under the supervision and evaluation of both the home and host university.

This two-year NordSecMob programme, encompassing 120 ECTS credits, leads to two officially recognized M.Sc. degrees issued by the home and host university (double degree).

Programme sctstructure

30-60 ECTS Home university courses
30 ECTS Host university courses
30 ECTS Master’s Thesis in joint supervision

Language courses

According to the degree regulations at Aalto University, students must take at least 3 ECTS of foreign language studies for the degree. In NordSecMob, the students have the option to choose between an English course, fulfilling both oral and written requirements (o,w) or at least 3 ECTS of Finnish courses. We recommend the English course [LC-1310](#) Academic Communication for everyone. Taking the Finnish course(s) as part of the degree requires an application for exemption from the foreign language course requirement. Please contact your study coordinator for more information.

Objectives of the programme

Aalto University specialization: Technical Information Security and Network Services

Professors In charge

T-110	Antti Ylä-Jääski
T-110	Tuomas Aura
T-110	Jukka K. Nurminen

As learning outcomes, the students will be able to apply acquired knowledge of the fundamental technologies and design principles of communication networks, the Internet, and mobile systems including applications, services and service management in order to develop new communication network solutions, service platforms, and service architectures. In addition, they will be able to apply the knowledge acquired on common security mechanisms in software systems and communications networks, including their design principles and limitations, in order to perform threat analysis and security requirements specification and to design and implement secure information systems. Furthermore, the students will also be able to compare and combine the above mentioned knowledge in research and development of communication networks and systems.

Aalto as home university (first year students)

First autumn 2015

Focus: Foundational knowledge and skills for becoming an expert in security and mobile computing.

In the first semester, the students build a body of skills and knowledge that puts them on a fast track to becoming specialists in communications security and mobile computing. They will know the fundamental principles and concepts of information security and cryptography, and have an up-to-date picture of the latest wireless and mobile networking and service delivery technologies.

They will have applied this knowledge in hand-on exercises and will have developed advanced software for distributed systems. Through tailored methodology and English language courses, the students will also have systems engineering skills: modeling, simulations, data analysis, as well as writing and presentation skills, which are needed for the rest of the Master's studies.

Compulsory courses (23 ECTS)

Code	Course name	Credits
CSE-C3400	Information Security	5 ECTS
T-110.5111	Computer Networks II – Advanced Features	5 ECTS
T-79.4502	Cryptosystems and Data Security	5 ECTS
CSE-E4430	Methods and Tools for Network Systems	5 ECTS
	Language course: Compulsory degree requirement, both oral and written requirements*	3 ECTS

(*) See 'Language courses' above.

Optional courses for the autumn term (at least 7 ECTS)

Code	Course name	Credits
T-110.5241	Network Security	5 ECTS
CSE-E5430	Scalable Cloud Computing	5 ECTS
T-110.5121	Mobile Cloud Computing	5 ECTS
T-110.5150	Applications and Services in Internet	5 ECTS
T-106.5600	Concurrent Programming	5 ECTS
T-79.4302	Parallel and Distributed Systems	5 ECTS

Total 30 ECTS

First spring 2016

Focus: Advanced courses in mobile computing, security and services including interactive courses, project works and research assignments.

Building on the foundations laid in the autumn, the students learn advanced topics in areas of their choice and continue to improve their research and hands-on skills. They will have in-depth understanding of some specialist topics in mobility, network services development and communications security. The topics include advanced services in distributed systems, network application frameworks, network services business models and value chains, embedded systems development and latest research in internetworking technologies. The students are able to apply their knowledge and present technical information in written and spoken form.

Compulsory courses (15 ECTS)

Code	Course name	Credits
CSE-E5490	Network Service Business Models	5 ECTS
T-110.5102	Laboratory Works in Networking and Security	5 ECTS
CSE-E5000	Seminar on Software Systems, Technologies and Security	5 ECTS

Optional courses for the spring term (15 ECTS)

Code	Course name	Credits
CSE-E5440	Energy-efficient Mobile Computing	5 ECTS
T-110.5140	Network Application Frameworks	5 ECTS
T-110.5130	Mobile Systems Programming	5 ECTS
CSE-E5002	Special Assignment in Software Systems, Technologies and Security	
CSE-E5001	Special Course in Software Systems, Technologies and Security	
T-110.6220	Special Course in Information Security	
T-110.7111	Internet Technologies for Mobile Computing	4 ECTS
T-110.6000	Internet and Computing Forum	2 ECTS

T-79.5501 Cryptology	5 ECTS
T-106.5300 Embedded Systems	5 ECTS
LC-98.7011 Finnish 1A	2 ECTS
LC-98.7012 Finnish 1B	• ECTS

Total 30 ECTS

Total for the whole year: 60 ECTS

Aalto as host university (second year students)

Second autumn 2015

Focus: Advanced courses in mobile computing, security, and services including interactive courses, project works and research assignments.

Taking into account their personal specialization, the students learn advanced topics in areas of their choice and continue to improve their research and hands-on skills. They will have an up-to-date picture of the latest wireless and mobile networking and service delivery technologies and in-depth understanding of some specialist topics in mobility, network services development and communications security. The topics include next generation wireless networks, new protocols in computer networks, and the latest research in communications security. The students are able to apply their knowledge and present technical information in written and spoken form.

Compulsory courses (13 ECTS)

Code	Course name	Credits
T-110.5111	Computer Networks II – Advanced Features	5 ECTS
CSE-E5000	Seminar on Software Systems, Technologies and Security	5 ECTS
	Language course: Compulsory degree requirement, both oral and written requirements*	3 ECTS

(*) See ‘Language courses’ above.

Optional courses (17 ECTS)

Code	Course name	Credits
T-110.5121	Mobile Cloud Computing	5 ECTS
T-110.5241	Network Security	5 ECTS
T-110.5150	Applications and Services in Internet	5 ECTS
CSE-E5002	Special Assignment in Software Systems, Technologies and Security	
CSE-E5001	Special Course in Software Systems, Technologies and Security	
T-110.6220	Special Course in Information Security	

CSE-E4430	Methods and Tools for Network Systems	5 ECTS
CSE-E5430	Scalable Cloud Computing	5 ECTS
S-38.3001	Telecommunications Forum	2 ECTS
LC-98.7011	Finnish 1 A	2 ECTS
LC-98.7012	Finnish 1 B	2 ECTS

Total 30 ECTS

Second spring 2016

Code	Course name	Credits
T-XXX.D	Master's Thesis	30 ECTS

Total for the whole year: 60 ECTS

Software and Service Engineering

Professor in charge: Casper Lassenius

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.

Abbreviation: SSE

Code: SCI3043

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. User-Centered Design
4. 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
CSE-C3610	Software Engineering *	5	I-II, III-IV
CSE-C3800	User Interfaces and Usability *	5	I-II

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

Software Engineering

Professor in charge: Casper Lassenius

Extent: Long or compact major (40-65 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.

Objectives

Software is at the core of most developed economies and organizations. 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, among others.

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 done for industrial customers representing real-life organizations.

Software engineering majors typically work in industry in roles such as Scrum-master, team lead, software architect, project manager, test lead, 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.

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 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
CSE-C3610	Software Engineering *	5	I-II, III-IV
CSE-C3800	User Interfaces and Usability *	5	I-II

Track compulsory courses (15-18 credits)

Code	Course	Credits	period
CSE-C3600	Software Design and Modelling*	5	I-II
CSE-E5600	Software Project 3	5-8	I-V
CSE-E5690	Seminar in Software and Service Engineering	5	I-V

Track optional courses

SELECT 20-40 CREDITS FROM THE FOLLOWING

Code	Course	Credits	period
CSE-E5695	Portfolio in Software and Service Engineering	1-5	I-V
T-76.5050	Methods for Software Engineering and Business Research	5	I-II
CSE-E4600	Software Project Management	5	IV-V
CSE-E4605	Requirements Engineering	5	III-V
T-76.5150	Software Architectures	5	III-IV
T-76.5613	Software Testing and Quality Assurance	5	II-III
CSE-E5699	Individual Studies in Software and Service Engineering	1-10	I-V
CSE-E5697	Special Course in Software and Service Engineering	1-10	I-V

IN ADDITION, SELECT 0-30 CREDITS FROM THE FOLLOWING

Code	Course	Credits	period
TU-E5000	Innovation and project management	5	II
CSE-E4751	Introduction to IT Business and Venturing	2	I-II

CSE-E4755	Management of a Technology Ventures	6	I-II
TU-C3030	Basics in Research and Development Management	3-5	III-IV
T-128.5780	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.

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 (CSE-E5695).

Kuva 2

Major common courses (10 credits)

CODE	NAME	CREDITS	PERIOD/YEAR
CSE-C3610	Software Engineering *	5	I-II, III-IV
CSE-C3800	User Interfaces and Usability *	5	I-II

Track compulsory courses (15-18 credits)

CODE	NAME	CREDITS	CODE
CSE-C3600	Software Design and Modelling*	5	I-II
CSE-E5600	Software Project 3	5-8	I-V

Track optional courses

SELECT 20-40 CREDITS FROM THE FOLLOWING

Code	Course	Credits	period
CSE- E5695	Portfolio in Software and Service Engineering	1-5	I-V
CSE- E5690	Seminar in Software and Service Engineering	5	I-V
T- 76.5050	Methods for Software Engineering and Business Research	5	I-II
CSE- E4600	Software Project Management	5	IV-V
CSE- E4605	Requirements Engineering	5	III-V
T- 56.5150	Software Architectures	5	III-IV
T- 76.5613	Software Testing and Quality Assurance	5	II-III

IN ADDITION, SELECT 0-30 CREDITS FROM THE FOLLOWING

Code	Course	Credits	period
TU- 22.1500	Innovation and Project Management	5	I-II
CSE- E4751	Introduction to IT Business and Venturing	2	I-II
T- 128.2500	Management of Software Ventures	6	I-II
TU- 53.1211	Organizational development	4	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.

User-Centered Design

Professor in charge: Marko Nieminen

Extent: Long or compact major (40-65 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: UCD

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 government organisations is being used by employees who perform a multitude of tasks. Tiny mobile games are developed for entertaining people. In both cases, users are in a central position for the creation of successful results. In "user-centred design" track students learn concepts, models, methods, procedures, and processes that can be applied in the design and development of systems and services so that the outcomes not only fit users' needs, expectations, and contexts but also deliver excellent user experience.

Core contents of the user-centred design track include the conceptual and methodological basis for working with users in different stages of software and service development. A typical characteristic of contemporary software and service design is its multi-disciplinarity. Users and developers with varying backgrounds create novel, innovative, and efficient concepts and realisations in a collaborative manner. The user-centred methods and tools support these joint design and evaluation activities.

In the real-life-connected study assignments students of user-centred design learn how to analyse user contexts, form user requirements, do interaction design, develop user interfaces, evaluate the usability of a system, and connect these to business goals. They learn how to use qualitative and quantitative data and results in decision making. After completing their studies, students often work in technology companies as user interface and interaction designers, UX managers, software developers, and project managers.

User-Centered Design Long Major 55-65 credits

The long major in user-centred design gives students the opportunity to become interaction design and user experience experts in industry. The long major lays a proper foundation for doctoral studies in the field. 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 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
CSE-C3610	Software Engineering *	5	I-II, III-IV
CSE-C3800	User Interfaces and Usability *	5	I-II

Track compulsory courses

CODE	NAME	CREDITS	PERIOD
CSE-E5800	User-centred Methods for Product and Service Design	5	I-II
CSE-E5888	Design Project	10	III-IV
CSE-E5810	Usability Evaluation	5	IV-V

[CSE-E5820](#) User Interface Construction 5 II

Track optional courses

SELECT MIN 15 CREDITS FROM THE FOLLOWING

CODE	NAME	CREDITS	PERIOD
CSE-E5695	Portfolio in Software and Service Engineering	1-5	I-V
CSE-E5690	Seminar in Software and Service Engineering	5	I-V
CSE-E4605	Requirements Engineering	5	III-V
CSE-E6250	Digital Service Design	1-10	I-V
CSE-E5600	Software Project 3	5-8	I-V
ME-E4200	Experimental User Interfaces	5	III-IV
ME-C2600	Ihminen havaittajana	5	III-IV
ELEC-E7850	User Interfaces	5	II
ELEC-E7860	Research Project in User Interfaces	5	III-IV
TU-C1010	Ihminen ryhmässä	5	I-II
CSE-E5697	Special Course in Software and Service Engineering	1-10	I-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 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.

User-Centered Design Compact Major 40-45 credits

The students take the major common courses (10 cr) and track compulsory courses (10 cr). 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 (CSE-E5695).

Major common courses (10 credits)

CODE	NAME	CREDITS	PERIOD
CSE-C3610	Software Engineering *	5	I-II, III-IV
CSE-C3800	User Interfaces and Usability *	5	I-II

Track compulsory courses (15 credits)

CODE	NAME	CREDITS	PERIOD
CSE-E5800	User-centred Methods for Product and Service Design	5	I-II
CSE-E5810	Usability Evaluation	5	IV-V
CSE-E5820	User Interface Construction	5	II

Track optional courses

SELECT MIN 15-20 CREDITS FROM THE FOLLOWING

CODE	NAME	CREDITS	PERIOD
CSE-E5695	Portfolio in Software and Service Engineering	1-5	I-V
CSE-E5690	Seminar in Software and Service Engineering	5	I-V
CSE-E6250	Digital Service Design	1-10	I-V
ME-C2600	Ihminen havaitsijana	5	III-IV
ELEC-E7850	User Interfaces	5	II
TU-C1010	Ihminen ryhmässä	5	I-II
CSE-E5697	Special Course in Software and Service Engineering	1-10	I-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.

Service Design and Engineering

Professor in charge: Marjo Kauppinen

Extent: Compact major (40-45 credits) and Aalto Service Minor (20 credits). Students who want to take also an optional minor may include it in their elective studies.

Abbreviation: SDE

Objectives

The focus of the Service Design and Engineering track (SDE) is on the role of IT as an enabler of new types of services and how these new services should be designed and implemented. Students learn how to combine service design and software engineering to create effective and productive development processes matching the development and business needs of the organizations involved.

The starting point for SDE is the needs of the service user. SDE students learn to analyze those needs and design new digital services to meet those needs. The services can be commercial or public, combining both IT and non-IT components to create just the right overall user experience.

Content and structure

The SDE track consists of a compact major and the Aalto Service Minor. In addition to the major common courses, the Design Project is the only compulsory course of the SDE track, but it is strongly recommended that students also participate in the Portfolio course in Software and Service Engineering (CSE-E5695).

With the elective studies students can orient themselves towards a number of roles, for instance user research and service design or developing and improving development processes. The student can choose between all SSE courses and design a personal study program. The table lists some example courses.

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

Major common courses (10 credits)

CODE	NAME	CREDITS	PERIOD
CSE-C3610	Software Engineering *	5	I-II, III-IV
CSE-C3800	User Interfaces and Usability *	5	I-II

Track compulsory course (10 credits)

CODE	NAME	CREDITS	PERIOD
CSE-E5888	Design Project	10	III-IV

Track optional courses (20-25 credits)

CODE	NAME	CREDITS	PERIOD
CSE-E5695	Portfolio in Software and Service Engineering	1-5	I-V
CSE-E5690	Seminar in Software and Service Engineering	5	I-V
CSE-C3600	Software Design and Modeling*	5	I-II
CSE-E4600	Software Project Management	5	IV-V
CSE-E4605	Requirements Engineering	5	III-V
T-76.5150	Software Architectures	5	III-IV
T-76.5613	Software Testing and Quality Assurance	5	II
T-76.5050	Methods for Software Engineering and Business Research	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.

Aalto Service Minor

CODE	NAME	CREDITS	PERIOD
TU-E2000	Aalto Introduction to Services P	6	I
Core courses (choose at least two)			
TU-E2010	Industrial Service Operations	3-6	III
MUO-E3008	Designing for Services	5 or 10	III
CSE-E5800	User-Centered Methods for Product and Service Design	5	I-II
CSE-E4660	ICT Enabled Service Business and Innovation	5	I-II
37E00100	Information Economy	6	IV
37E08000	Service Business Models	6	IV
TU-E2010	Industrial Service Operations	3-6	III

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	6	II
37E4400	Critical Issues in Information Systems Research (varying content)	6	V
TU-E2110	Innovation in Operations and Services	3-5	III-IV
TU-E3120	Human Resources in Service Operations	5	I-II
23C550	Services Marketing	6	III

* 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.

Enterprise Systems

Professor in charge: Martti Mäntylä

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.

Structure

The students 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 (CSE-E5695).

Major common courses (10 credits)

CODE	NAME	CREDITS	PERIOD
CSE-C3610	Software Engineering *	5	I-II, III-IV
CSE-C3800	User Interfaces and Usability *	5	I-II

Track compulsory courses (15 credits)

CODE	NAME	CREDITS	PERIOD
CSE-E4650	Enterprise Systems Architecture *	5	I
CSE-E4660	ICT Enabled Service Business and Innovation	5	I-II
CSE-E5650	Seminar on Enterprise Information Systems	5	IV

Track optional courses

CODE	NAME	CREDITS	PERIOD
SELECT 15-30 CREDITS FROM THE FOLLOWING			
CSE-E5695	Portfolio in Software and Service Engineering	1-5	I-V
CSE-E5655	Special Assignment on Enterprise Information Systems	3-10	I-V
CSE-E5690	Seminar in Software and Service Engineering	5	I-V
CSE-E4655	IT Governance	5	II
CSE-E4670	Introduction to Industrial Internet	5	IV
CSE-E5670	Seminar on Industrial Internet	5	I-II
CSE-E5675	Industrial Internet Project	5-10	I-V
CSE-E4675	System of Systems	5	V
CSE-E4680	Law in Digital Society	5-6	IV
CSE-E5680	Seminar on Law and Technology	3	IV
T-86.2010	IS Procurement and Portfolio Management	4-6	V
T-76.5150	Software Architectures *	5	III-V
CSE-E4605	Requirements Engineering *	5	III-V
CSE-E4600	Software Project Management	5	IV-V
57E00500	Capstone: Business Intelligence	6	I
IN ADDITION, SELECT 15-30 CREDITS FROM THE FOLLOWING (LONG MAJOR)			
T-76.5050	Methods for Software Engineering and Business Research	3-5	I-II
CSE-E4751	Introduction to IT Business and Venturing	2	I-II
CSE-E4755	Management of a Technology Venture	6	II
CSE-E5753	Technology Entrepreneurship Seminar	4	IV
Kon-15.4101	Digital Manufacturing	4	I-II
TU-E1150	Managerial Economics	5	III

TU-E1020	Strategies for Growth and Renewal	3	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.