

Aalto University

Student Services

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Study Guide 2013–2014

Study Guide 2013–2014

# *International Master's Programmes School of Science (SCI)*

*International Master's Programmes  
School of Science (SCI)*

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Dear reader,

This Study Guide contains information about the International Master's Programmes and the study practices and processes at the Aalto University School of Science. You can find further information in the following electronic systems:

- **WebOodi** services include information and descriptions of courses, registering for courses; examinations and teaching, as well as ordering course handouts, checking completed credits and ordering transcripts of records. Also the oodiHOPS tool in WebOodi can be used to plan one's studies on a course level.
- **Noppa** is a web portal for everyday course work and communication. You can find course home pages, course schedules, course results, lecture materials and course news in the portal. Noppa, WebOodi and Study Guide complete each other and are useful tools in planning one's studies.
- **Into** portal is designed for Aalto University students for information and instructions relating to studies, Aalto services and the University. In Into you can find, for instance, the calendar of the academic year, graduation schedule, degree programme news and events at Aalto University. The School of Science pages are at <https://into.aalto.fi/display/enmastersci/>.



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# 1. AALTO UNIVERSITY

Aalto University is a multidisciplinary science and art community in the fields of science, economics, and art and design. The University is founded on Finnish strengths, and its goal is to develop as a unique entity to become one of the world's top universities. Aalto University's cornerstones are its strengths in education and research. There are approximately 20,000 basic degree and graduate students, 10,6% of which are international, as well as a staff of 5,330 of which 366 are professors. 16% of the professors and postdocs are international.

## **Students as part of the Aalto community**

Aalto University is focused on its student-centred and enthusiastic culture where critical thinking and an open mind are essential. We strive to create an environment where all work at the university promotes equality, ethicality and transparency.

Internationalisation is an important focus area in the Aalto University strategy. Over 2000 international students from more than 90 nationalities study at Aalto University. Aalto University seeks to continuously increase the number of international undergraduate and postgraduate students. At the moment Aalto University has over 70 Master's degree programmes in English and one Bachelor's degree programme in English. Doctoral studies in all fields can be completed in English.

## **Interdisciplinary studies**

Aalto University is benefiting from its multidisciplinary character by launching research projects, study programmes and courses that combine the expertise of technology, economics and art and design. The Schools of Aalto University jointly provide Aalto studies that are open to everyone studying at the University. Aalto studies include individual courses and broader study programmes. The interdisciplinary Master's degree programmes of Aalto University are International Design Business Management (IDBM) and Creative Sustainability. In addition, we have workshops for novel expertise called Factories. Design Factory, Media Factory and Service Factory are designed to facilitate new forms of collaboration in an environment where academic teams, researchers and students of the different Aalto University schools work together with companies and communities. The themes of teaching and learning are an important part of the Factory activities – the new knowledge produced by research is smoothly transferred to teaching.

For further details about Aalto University please visit [aalto.fi](http://aalto.fi) and for details of the study programmes visit [aalto.fi/studies](http://aalto.fi/studies)

## 2. SCHOOL OF SCIENCE

Aalto University School of Science is the largest of the six Aalto University schools. The school is well-known for its high impact research. For example, 40% of the Aalto University Doctors graduated from the School of Science in 2012. The School is home to five Centres of Excellence in Research funded by the Academy of Finland. In two of them, the School cooperates with other universities. The main focus areas of research are computation and modeling, materials research, design and ICT and media.

Aalto University School of Science consists of seven departments, three separate institutes and four strategic initiatives.

Departments:

- Department of Applied Physics
- Department of Biomedical Engineering and Computational Science
- Department of Computer Science and Engineering
- Department of Industrial Engineering and Management
- Department of Information and Computer Science
- Department of Mathematics and Systems Analysis
- Department of Media Technology

Separate institutes:

- O. V. Lounasmaa Laboratory
- Helsinki Institute for Information Technology HIIT
- European Institute of Innovation and Technology (EIT) ICT Labs

The School is also a partner in the Helsinki Institute of Physics (HIP), coordinated by the University of Helsinki. In addition, the Business, Innovation, and Technology (BIT) research unit operates as part of the Department of Industrial Engineering and Management.

The School of Science provides students with a variety of options from information networks to applied physics. We have four degree programmes (both bachelor and master level studies), 10 international Master's programmes, one cross-disciplinary Aalto programme plus one N5T programme and two Erasmus Mundus programmes leading to an international double degree. The School of Science is responsible for the Aalto University common basic courses in mathematics, physics, computer science and engineering as well as industrial engineering and management.

### **The School of Science in a nutshell (2012)**

Degree students (Bachelor+Master)	2,686
Doctoral students	450
International students	12,6%
Personnel	1,500
Professors	91
Degrees awarded in 2012	
Bachelor of Science in Technology, B.Sc. (Tech.)	210
Master of Science in Technology, M.Sc. (Tech.)	223
Doctoral degrees	77
Total	510



## 2.1 International Master's Programmes

The Aalto University School of Science offers currently 14 international Master's programmes. The language of instruction in these programmes is English.

Six of the Master's programmes belong to **Degree Programme in Computer Science and Engineering**:

- Master's Programme in Bioinformatics
- Master's Programme in Foundations of Advanced Computing
- Master's Programme in Machine Learning and Data Mining
- Master's Programme in Mobile Computing - Services and Security
- Master's Programme in Service Design and Engineering
- Master's Programme in ICT Innovation (EIT ICE Labs Master School)

In addition there are two Erasmus Mundus programmes related to Computer Science that involve a consortium of universities and offer a double degree:

- NordSecMob - Master's Degree Programme in Security and Mobile Computing
- euSYSBIO - Master's Degree Programme in Computational and Systems Biology

**Degree Programme in Industrial Engineering and Management** offers two Master's programmes:

- Master's Programme in Service Management and Engineering
- Master's Programme in Strategy

In **Degree Programme in Engineering Physics and Mathematics** there are two Master's Programmes as well:

- Master's Programme in Applied and Engineering Mathematics (N5T double degree programme jointly organized with Chalmers University of Technology in Sweden, Technical University of Denmark, The KTH Royal Institute of Technology in Sweden and The Norwegian University of Science and Technology)
- Master's Programme in Physics of Advanced Materials

The School of Science offers also

- Master's Degree Programme in Brain and Mind

In addition, The School of Science participates in a cross-disciplinary Aalto programme:

- Master's Degree Programme in International Design Business Management

### Admission process

General admission criteria to the Master's programmes are a high-quality Bachelor's degree in a relevant field specified in the programme-specific requirements. The programme applied for will make the final decision on the suitability of the previous degree. Students in their final year of the Bachelor's degree studies are eligible to apply, provided that they complete their Bachelor's degree by the end of July of the year of application. The Master's programmes are availa-

ble for both Finnish and international applicants. Also the students with a B.Sc. (Tech.) degree from Aalto University School of Science are welcome to apply.

The application period 2014 (for studies starting in September 2014) is 16 December 2013 – 31 January 2014. Please note that there are separate admission procedures and application deadlines for the Erasmus Mundus programmes (NordSecMob and euSYSBIO) and for the Master's Programme in Applied and Engineering Mathematics.

For more information on admission, please refer to a website at [aalto.fi/studies](http://aalto.fi/studies).

## **2.2 Administration and Contact Information**

When sending e-mail to the personnel, please use the form:  
firstname.lastname@aalto.fi

### **Dean**

Risto Nieminen  
tel. +358 (0)50 560 4825

### **Manager of Student Services and Study Affairs**

Mari Knuuttila  
tel. +358 (0)50 537 3358

### **Manager of International Relations**

Eija Kujanpää  
tel. +358 (0)50 537 3355

### **School of Science Study and Student Services**

Visiting address: Computer Science building, room A225, Konemiehentie 2, 02150 Espoo  
Postal address: P.O. Box 15400, FI-00076 Aalto, Finland  
Visiting hours: Mon-Fri 9-11 a.m. and 12 - 2 p.m.  
Email: [studentservices@aalto.fi](mailto:studentservices@aalto.fi)

Student Affairs Secretary	Stefanie Schulz	tel. +358 (0)50 659 9264
Student Affairs Secretary	Ville Hartikainen	tel. +358 (0)50 361 6443
Planning Officer	Tiina Kerola	tel. +358 (0)50 362 6410
Study Coordinator	Sari Salmisuo	tel. +358 (0)50 408 4540

### **2.2.1 Degree Programme in Computer Science and Engineering (CSE)**

#### **Head of the Degree Programme in Computer Science and Engineering**

Professor Tuomas Aura  
tel. +358 (0)50 308 1702

#### **Student Services of Degree Programme in CSE**

Postal address: P.O. Box 15400, 00076 AALTO  
Visiting address: Computer Science Building, 2nd floor

Konemiehentie 2, Otaniemi, 02150 Espoo

Degree programme home page: <https://into.aalto.fi/display/entik/>

Planning Officer	Juuli Kenkkilä, tel. +358 (0)50 537 3352, room C213
Study Affairs Secretary	Paula Nyman, tel. +358 (0)50 401 2490, room C212
Study Coordinator	Päivi Koivunen, tel. + 358 (0)50 590 2456, room C211 <ul style="list-style-type: none"> <li>• Master's Programme in Bioinformatics</li> <li>• Master's Programme in Foundations of Advanced Computing</li> <li>• Master's Programme in Machine Learning and Data Mining</li> <li>• Master's Programme in Mobile Computing - Services and Security</li> <li>• Master's Programme in Service Design and Engineering</li> <li>• euSYSBIO</li> </ul>
Study Coordinator	Anna Stina Sinisalo, tel. +358 (0)50 512 2693, room A218 <ul style="list-style-type: none"> <li>• NordSecMob</li> </ul>
Study Coordinator	Aino Lyytikäinen, tel. +358 (0)50 512 2693, room A218 <ul style="list-style-type: none"> <li>• Master's Programme in ICT Innovations (EIT ICT Labs master School)</li> </ul>
Student Adviser	Tuulia Merinen, advisors-cse@aalto.fi, room C111

## 2.2.2 Degree Programme in Industrial Engineering and Management (IEM)

### Head of the Degree Programme in Industrial Engineering and Management

Professor Eero Eloranta

tel. +358 (0)50 432 3411

### Student Services of Degree Programme in IEM

Postal address: P.O. Box 15500, 00076 AALTO

Visiting address: Tuas-building, Otaniementie 17, 02150 Espoo.

Office email address: advisors-iem(at)aalto.fi

Degree programme home page: <https://into.aalto.fi/display/entuo/>

Planning Officer	Maria Ranta, tel. +358 (0)50 560 3078, room 1156 <ul style="list-style-type: none"> <li>• Master's Programmes</li> </ul>
IDBM Coordinator	Kirsi Polvinen, tel +358 9 (0) 50 571 5678
Study Secretary	Anne Johansson, tel. +358 (0)50 560 9502, room 1157
Study Secretary	Nina Ramberg, tel. +358 (0)50 337 4914, room 1161

Student Advisor

Artturi Patrakka, iem-advisors@aalto.fi, room 1173

### 2.2.3 Degree Programme in Engineering Physics and Mathematics (TFM)

#### Head of the Degree Programme in Engineering Physics and Mathematics

Professor Matti Kaivola  
tel. +358 (0)50 301 5683

#### Student Services of Degree Programme in TFM

Postal address: P.O. Box 14100, 00076 AALTO

Visiting address: K-building, Otakaari 4, 02150 Espoo

Degree programme home page: <https://into.aalto.fi/display/entfm/>

Planning Officer

Johanna Bovellán, tel. +358 (0)50 511 3169, room K138

- Master's Programme in Physics of Advanced Materials

Study Coordinator

Anu Kuusela, tel. +358 (0)50 562 8427, Konemiehentie 2, room A218

- Master's Programme in Applied and Engineering Mathematics

Study Affairs Secretary

Taru Bister-Hämäläinen, tel. +358 (0)50 592 9910, room K140, taru.bister(at)aalto.fi

Student Advisor

Joonas Kivi, opintoneuvoja-tfm(at)aalto.fi, room K147c

### 2.2.4 Doctoral Studies

#### Student Services

Postal address: P.O. Box 14100, 00076 AALTO

Visiting address: K-building, Otakaari 4, 02150 Espoo

Degree programme home page: <https://into.aalto.fi/display/enddoctoralsci/Homepage>

Planning Officer

Emma Holmlund, tel. +358 (0)50 576 6517, room 141

Study Coordinator

Laura Öhrnberg, tel. +358 (0)50 365 2652, room 139

## 2.3 Academic Affairs Committee and Degree Programme Committees

### Academic Affairs Committee of the School of Science

According to the Aalto University by-laws, every school has an Academic Affairs Committee which has as representatives professors, other academic staff and students. The Academic Af-

fairs Committee (Science Committee) will decide on curricula, degree requirements, admission requirements and other academic issues of the School.

### **Degree Programme Committees**

In addition to the Academic Affairs Committee, the School has Degree Programme Committees and Doctoral Programme Committee.

The Bachelor Degree Programme Committee prepares and develops the curriculum and admission requirements of the Bachelor's Degree Programme in Science and Technology, and advances and unifies Bachelor level education offered.

The field specific Degree Programme Committees confirm the Master's thesis topics, appoint the supervisors and instructors for the theses and approve and grade the theses. In addition, Degree Programme Committees prepare the curricula and admission requirements of the Master level education for the Academic Affairs Committee.

The Doctoral Programme Committee develops the Doctoral programme, prepares the admission requirements of the doctoral students, approves the topics and language of doctoral dissertations, confirms the study plans of doctoral students, appoints the preliminary examiners of dissertations and decides on the permission to print dissertations. In addition, the Committee evaluates the dissertations.

## 3. ACADEMIC ISSUES

### 3.1 Enrolment for the Academic Year

Degree students must register at Aalto University every academic year either as present or as absent (University Act 558/2009, 39 §). Only students who register their presence have a right to study. New students register upon arrival at Aalto University School of Science. The enrolment period for the academic year 2013-2014 is 2 May – 13 September 2013.

Those students, who do not enrol during the enrolment period, will lose the right to pursue their studies. To regain the right to study, re-enrolment fee of 35 Euros is charged. More information and instructions at:

<https://into.aalto.fi/display/enmastersci/Enrolling+for+the+next+academic+year>

### 3.2 Academic Year

The academic year runs from 1 August to 31 July. The opening ceremony of the academic year will be held on Tuesday, 3 September 2013. Orientation Days for new international students will be organized 3 – 6 September 2013.

The teaching periods for the academic year 2013-2014 are as follows:

#### Autumn term 2013

1 <sup>st</sup> evaluation period	Mon 26 August – Sat 7 September 2013
Period I	Mon 9 September – Sat 19 October 2013
Feedback week of period I	Mon 21 October – Sat 26 October 2013
Period II	Mon 28 October – Sat 7 December 2013
Feedback week of period II	Mon 9 December – Sat 14 December 2013
2 <sup>nd</sup> evaluation period	Mon 16 December – Sat 21 December 2013

#### Spring term 2014

Period III	Tue 7 January – Sat 15 February 2014
Feedback week of period III	Mon 17 February – Sat 22 February 2014
Period IV	Mon 24 February – Sat 5 April 2014
Feedback week of period IV	Mon 7 April – Sat 12 April 2014
Period V	Mon 14 April – Fri 30 May 2014

The teaching associated with courses is provided during first six weeks of the teaching periods. The periods end with a 'feedback week' reserved for the finalisation of coursework, presentation of course results and evaluation of the students' learning with various methods. In addition to the teaching periods specified above, teaching may be organised in the summer.

#### Examinations are held

- during an evaluation period
- during a feedback week
- on Saturday exam dates
- on evening exam dates in May (weeks 19 - 21).

**Saturday exams:**

Autumn term 2013: 7 September, 19 October, 26 October, 16 November, 30 November, 14 December, 21 December

Spring term 2014: 11 January, 18 January, 1 February, 22 February, 1 March, 8 March, 12 April, 26 April, 17 May, 24 May

**3.3 Course and Examination Schedules: INTO and NOPPA**

The course and examination schedules are on the **Into -portal**. In Into you can find, for instance, the calendar of the academic year, graduation schedule, degree and master's programme news and events at Aalto University. The School of Science pages are at <https://into.aalto.fi/display/enmastersci/>

Detailed course information is on the **Noppa –portal**. Noppa is a web portal for everyday course work and communication. For students it provides personalised information about the courses they are taking. For teachers it is a tool for publishing e.g. course schedules, lecture materials and course news <https://noppa.aalto.fi/noppa/app>

**3.4 Courses****Course Registration**

Students have to register for the courses prior to their beginning. Usually this is done online in WebOodi –system (<https://oodi.aalto.fi/a/>). Registration for courses begins usually two weeks before the course begins. Since the practices may vary depending on the course, it is important to check the course registration information in Noppa –portal <https://noppa.aalto.fi/>.

**Partial Change or Removal of a Course**

If the course is removed from the study programme, exams for the course will be still held at least during the next academic year. More information can be found in the Degree Regulation 47 §.

**3.5 Examinations**

If the degree requirements for a course include a written or oral examination, the opportunity to take the examination is organised at least twice a year. In addition, the teacher of the course may arrange additional opportunities to take the examination. The testing of extensive courses may consist of two or more examinations.

The students must register in WebOodi for all examinations organised at Aalto University. The registration period for each exam starts usually one month before the examination and always ends one week before the exam. **Students who fail to register during the registration period cannot attend the examination.** This obligatory registration ensures that there are seats and exam papers for all examinees, and that the supervision is adequate.

Registration for the examination is considered as participation in the examination, unless the student cancels his/her registration before the start of the examination. A student who has

failed the examination three times has to negotiate with the teacher in charge of the course on how to pass the course.

Listed below are the main instructions for examinees. Please read carefully the Examination regulations in the School of Science Into –site

<https://into.aalto.fi/display/enmastersci/Examination+regulations>

- The student shall register for the exam one week prior to the examination.
- The examination halls are announced prior to the examination on the notice board in the main lobby, and often also outside the examination halls.
- The participant may take only his or her ID certificate and writing equipment to the exam room. Other items allowed in the exam are mentioned separately.
- Bags and coats must be left primarily in the cloakrooms. If the cloakrooms are not supervised, bags and coats may be taken inside the examination hall and they are placed where instructed by the exam supervisor. Any mobile phones left in bags should be switched off for the duration of the examination.
- Students are allowed to enter the examination hall within 60 minutes of the official commencement of the examination. However, entering the room during the first 10-15 minutes is prohibited. This is to avoid unnecessary disturbance at the beginning of the exam. Students may leave the exam when the exam supervisor gives permission, but no earlier than 65 minutes from the announced starting time of the exam.
- The exam begins when the exam supervisor gives permission.
- Paper handed out by the supervisor is the only acceptable stationary to be used in the exam.
- All paper handed out is to be returned. The paper containing answers must be clearly marked and separated from any scrap paper.
- The identity of the exam participant will be verified when the student hands in the answers.

### **3.6 Study Register**

All completed courses are registered in the student register of Aalto University. The office of the degree programme responsible for the course takes care of registration.

Teachers are responsible for checking the examinations within one month from the exam date and of submitting the results to the Degree Programme Office as soon as possible. The Degree Programme Office is responsible for taking the course grades to the student register as soon as they are available. The final grade of the course is registered in the student register only when the course is completed.

Students can order an unofficial transcript of records through WebOodi: <https://oodi.aalto.fi/a/> provided that the student's e-mail address is correctly entered in the student register. The Student Services (e-mail: [studentservices@aalto.fi](mailto:studentservices@aalto.fi)) has to be informed about changes in student's contact information or any other changes in student status.

### **3.7 Information Systems**

**WebOodi** (<https://oodi.aalto.fi/a/>)

The registration system for examinations and courses is called WebOodi. In addition, the students can use WebOodi for:



- browsing the study programme information e.g. course descriptions, study period, language of instruction
- planning the studies
- ordering course handouts
- checking and ordering their unofficial study transcript
- checking and changing their contact information

#### **Noppa-portal** (<https://noppa.aalto.fi/>)

The study portal Noppa is a handy tool for students for communication and managing course-work. Noppa consists of course home pages on which the teacher can publish e.g., course overviews, schedules of lectures and exercises, course materials, information about assignments and exams, news and exam results. In other words, all basic information about the courses and their arrangements is collected to one place. At Noppa you can copy and print lecture slides and handouts, assignments and other course materials provided by the teacher. Each student logged into Noppa has his/her own personal start page, 'My Noppa', on which the student can see the news and important deadlines and exam results of all the courses s/he has registered for using WebOodi.

#### **Into** (<https://into.aalto.fi/display/en/Homepage>)

Into is a portal for Aalto University students for information and instructions relating to studies, Aalto services and the news of the University. In Into you can find, for instance, the calendar of the academic year, graduation schedule, degree programme news and events at Aalto University. The School of Science pages are at: <https://into.aalto.fi/display/enmastersci/>.

### **3.8 Completed Courses, Legal Protection and Disciplinary Actions**

In case there are problems regarding the course credits, the student should first discuss the problem with the teacher in charge of the course. If a mutually acceptable solution cannot be found, the student should next contact the planning officer of the degree programme.

Students should also read the Aalto University Code of Academic Integrity and Handling Violations Thereof at:

<https://into.aalto.fi/display/enregulations/Aalto+University+Code+of+Academic+Integrity+and+Handling+Violations+Thereof> and The Finnish Advisory Board on Research Integrity's guidelines for Responsible Conduct of Research <http://www.tenk.fi/en/responsible-conduct-research-guidelines/responsible-conduct-research>

#### **Completed Courses and the Student's Right for Information**

According to the University Act (558/2009) 44 §, the student is entitled to know the evaluation criteria applied to passing a course. S/he has the opportunity to examine the written or otherwise stored grading of the course. The mentioned written or otherwise preserved material has to be stored for at least six months from the publishing of the grades.

#### **Corrections to Grades**

According to the University Act (82 §) a student who is dissatisfied with the grading of his/her study attainment, other than Master's thesis, doctoral dissertation or licentiate research, may request orally or in writing a rectification of the grading from the teacher who evaluated the attainment.

The request for correction must be made within fourteen days of the date when the student has had the opportunity to examine the grades and the application of the evaluation criteria to his/her own work. A student who is dissatisfied with the result of the correction request may bring the matter before the Aalto University Degree Committee within 14 days of receiving the teacher's decision.

A student, who is dissatisfied with the grading of his or her Master's thesis, may request in writing a rectification of the grading from the Aalto University Degree Committee. The request for rectification must be made within 14 days of the date when the student has had the opportunity to examine the grade and the statement of the supervisor.

The rectification is submitted as a free-form written application to the following address:  
Aalto University Degree Committee, Registry, P.O. Box 11000, 00076 AALTO

### **Disciplinary Actions**

A decision on a warning for a student having broken the rules of conduct either in the area of teaching or research mentioned in the University Decree 45 §, is given by the University rector; and on a suspension from the university for a definite period of time by the University Board.

The student has to be informed on the proven misconduct he or she stands accused for, as well as given the opportunity to be heard in the matter (University Decree 45 §).

### **3.9 Recommendation and Limitation to the Duration of Studies**

The Finnish University Act (558/2009) includes recommendations and limitations to the duration of studies. The duration of studies is counted from the date the student accepts the study place in the university. The recommended time to complete a Master of Science degree is two years of full-time studying.

The student has a right to complete his/her degree in two years after the recommended time. If the student has not completed his/her degree in that time, s/he can apply for extension from the school. The extension period should be applied for in the beginning of the student's last academic year before the study right expires.

Further information about the duration of studies is available at:

<https://into.aalto.fi/display/enmastersci/Normative+and+maximum+durations+of+degrees>.

You can also ask for more information from the Planning Officers of the Degree Programmes.

### **3.10 Credit Transfer**

A student may transfer credits completed at other Finnish or foreign university or other educational institute to the degree as well as replace studies included in the degree with other studies of corresponding level. In issues regarding the approval of studies, please contact the Degree Programme Office or Master's programme coordinator..

Further information about credit transfer is available in Aalto University General Guideline on Credit Transfer at

<https://into.aalto.fi/display/enregulations/Aalto+University+General+Guideline+on+Credit+Transfer>

### **3.11 Evaluation and Grading**

The methods used for evaluating learning at the Aalto University School of Science are e.g. the following:

#### **Examination**

The most common evaluation method is a written examination. In addition to the traditional written examination, other exams, such as a pre-exam, a take-home exam, an oral exam, a web exam, a material-based exam and a multiple-choice exam may be used. On some courses, the testing may consist of two or more examinations. More information on examination can be found in Chapter 3.5.

#### **Peer Evaluation**

Peer evaluation may be included in any evaluation method used. It means that the students evaluate each other's learning outcomes or performance.

#### **Self-Evaluation**

A student or a group of students evaluate their own learning outcomes or performance.

#### **Other Evaluation Methods**

The teaching methods mentioned, such as portfolio, learning diary, demonstration, exercises, written tasks and project assignments can also be used to partially evaluate the course performance.

#### **Grading**

Grading is based on evaluation. The teacher in charge of the course shall evaluate the student's work. According to the degree regulations, the teacher is obliged to publish the list of grades students, and, if possible, the main criteria of assessment, on the notice board within one month of the date of the examination, or, with good reason, organise within one month of the examination the information mentioned above in some other way. Exam results must also be published in Noppa -portal. An extension to this timetable may be granted only in special circumstances.

In the lower and higher university degrees, including the Master's thesis, the grades used are excellent (5), very good (4), good (3), very satisfactory (2), and satisfactory (1). Courses can also be assessed as pass/fail. The maturity test included in the theses is assessed as pass/fail.

If the course consists of individual partial completions, the grade is the weighted average of the partial completions. According to the degree regulations, the student is entitled to know the evaluation criteria applied to passing a course. He or she shall be guaranteed the opportunity to examine the written or otherwise stored grading of the course. Correction of grades is discussed in Chapter 3.8

### **3.12 Feedback**

Feedback usually refers to the information students or teachers receive on their performance. Feedback provides information about the performance outcome and it can be used in evaluating whether the set goals have been met. Feedback can be used as a tool for developing both the students' and teachers' activities. Learning to give and receive feedback is part of studying.

Student feedback is used as a tool to develop teaching and course content. It is important to give constructive feedback in order to assist the teachers to discover targets for development and assess how the course has been perceived by the students.

#### **Course Feedback**

Feedback can be collected before the course, during the course and after the course in oral or written format. The Degree Programme in Industrial Engineering and Management and Degree Programme in Engineering Physics and Mathematics use the feedback system in WebOodi, whereas the feedback forms of Degree Programme in Computer Science and Engineering can be found at: <https://into.aalto.fi/display/entik/Course+Feedback>. Feedback forms are opened just before the teaching period ends and they are closed after the examination period. Students are encouraged to give feedback on every course they take part in. Feedback is collected also from all the graduates.

## 4. TUTORING AND STUDY COUNSELLING

This chapter contains information about tutoring, study planning and study counselling at different stages of the studies. Information about orientation, academic issues and counselling can be found in the Survival Guide, which is available at the Student Services office (CS-building, room A225) and at: <https://into.aalto.fi/display/enmastersci/For+new+degree+students>

### 4.1 Tutoring

Each student studying for a higher university degree has a nominated teacher tutor, who is either an academic coordinator of the programme or professor on the major. The purpose of tutoring is to guide the student during his/her studies. Each student has a personal tutor meeting once per academic year. The purpose of the personal meeting is to review the student's progress and discuss his/her studies in the light of the student's study plan. The tutor and the student evaluate the student's possibilities to complete his/her studies within the set target time frame.

### 4.2 Study Plan

Planning one's studies is an important part of studying. Each student goes through different choices from the very beginning of the studies to graduation. This route towards the degree should be as realistic and systematic as possible. As a tool for planning the studies, Aalto University uses a personal study plan.

#### **Official Personal Study Plan (HOPS)**

The official or confirmed personal study plan (HOPS) allows choices to be made on a modular level with the exception of personally agreed entities, e.g. studies abroad as the content of the C-module. Of the personally agreed entities, a course-level description of the entity, approved by the professor (professor's signature is required), must be attached to the study plan.

HOPS must be completed in the beginning of the studies. A student can have only one HOPS at a time. If a student wishes to make changes to his/her personal study plan, s/he has to apply for the changes and have the study plan re-examined. New HOPS replaces the old one and the old one expires. Changing one's study plan must be considered carefully.

The study plan is a binding agreement on both parties: the student and the School of Science. It grants the student with a right to study according to the confirmed personal study plan but, at the same time, obliges the student to follow his/her study plan.

#### **Unofficial Study Plan**

Students should also prepare an unofficial, detailed course-level study plan including a schedule. The purpose of the unofficial plan is to familiarise students with the degree structure and to clarify the student's personal goals. The unofficial study plan is a tool for detailed study planning and it helps a student to divide the amount of work evenly for each semester. Using the unofficial study plan the student can also monitor the credit accumulation and ensure that the degree requirements are met.

### **4.3 Degree Programme Office**

In questions related e.g. to study counselling, graduation and grouping of studies the students can contact the Degree Programme Office, Master's programme coordinator and Study Advisors. Please see the contact information in Chapter 2.2 or in Into:

Degree Programme in Computer Science and Engineering:  
<https://into.aalto.fi/display/entik/Contact+information>

Degree Programme in Engineering Physics and Mathematics:  
<https://into.aalto.fi/display/entfm/Contact+information>

Degree Programme in Industrial Engineering and Management  
<https://into.aalto.fi/display/entuo/Contact+information>

## 5. STRUCTURE AND AIM OF HIGHER UNIVERSITY DEGREE

The Finnish universities have a two-cycle degree structure. The students take first a Bachelor's degree, and continue then their studies into a Master's degree.

Students get credits (cr) according to the amount of work required. The average number of credits demanded in one academic year of studies, 60 credits, is equivalent to 1 600 hours of work.

The lower university degree, Bachelor's degree, requires studies in the extent of 180 ECTS credits. As a full-time student, it is possible to take the lower university degree in three academic years. The higher university degree, Master's degree, requires studies in the extent of 120 ECTS credits. As a full-time student, it is possible to take the higher university degree in two academic years.

The degrees awarded at Aalto University School of Science are Bachelor of Science in Technology degree (lower university degree) and Master of Science in Technology degree (higher university degree). The education leading to the lower and higher university degree is planned and organised as degree programmes in various areas of expertise in the technical sciences.

### 5.1 Aim of Higher University Degree

Studies leading to the Master of Science degree shall provide the student with:

- good overall knowledge of the major subject of the degree programme;
- knowledge and skills needed to apply scientific knowledge and scientific methods, and capability to lifelong, flexible learning;
- knowledge and skills to understand the problems of his or her own field, from the point of view of the user, of technical and social organisations, and of the environment;
- knowledge and skills to operate as an expert and developer of the field in working life;
- good language and communication skills, as well as
- knowledge and skills needed for scientific postgraduate education.

The education shall be based on scientific research and professional practices. The lower university degree requires studies in the extent of 180 ECTS credits.

### 5.2 Structure of Higher University Degree

The studies leading to the Master of Science degree consist of:

- three modules, at least one of which shall be an advanced module (level 3) in one of the major subjects of the student's own degree programme;
- studies of methodological principles (9-11 credits);
- elective studies (at least 20 credits), and
- Master's thesis (30 credits).

The higher university degree requires studies in the extent of 120 ECTS credits.

In most of the Master's programmes offered by the school, the structure of the higher university degree is as follows:

Elective Studies W <b>20 cr</b>	Metho- dological Principles M <b>9-11 cr</b>	Master's Thesis D <b>30 cr</b>
Intermediate Module A2/ Advanced Module A3 <b>18-22 cr</b>	Advanced Module A3 <b>18-22 cr</b>	Special Module C <b>18-22 cr</b>

In the Master's Programme in Strategy, the structure of the higher university degree is as follows:

Elective Studies W <b>20 cr</b>	Metho- dological Principles M <b>9-11 cr</b>	Master's Thesis D <b>30 cr</b>
Advanced Module A3 <b>18-22 cr</b>	Special Module C <b>18-22 cr</b>	Special Module C <b>18-22 cr</b>

In Master's programmes, the modules to be completed are determined in the study programme and they are confirmed in the personal study plan (HOPS). For more information on the personal study plan, see chapter 4.2.



### **Advanced and Special Modules**

A Master's programme is based on focused subject studies which form the Intermediate, Advanced and Special Modules. In the Master's programmes of the Degree Programme in Industrial Engineering and Management, the contents of one of the Special Modules depend on the student's background.

The student's major subject is determined by the Master's programme he/she studies in. There is no minor subject in the Master's programmes.

Students commit to follow the study programme of their Master's programme by signing the official study plan (HOPS). Any deviation from the study programme must be checked first with the degree programme office.

### **Methodological Principles**

The purpose of the Methodological Principles module (9-11 cr) is to support writing one's Master's thesis. In some Master's programmes, the courses to be included in the methodological principles module are determined beforehand while in others, the student can choose courses from the methodological principles list.

### **Master's Thesis**

Master's thesis shall be written on a topic related to the major and agreed upon together with the student and the professor whose field of specialty includes the topic. Further information on Master's thesis can be found in Chapter 11.

### **Elective studies**

Students are free to choose courses for their Elective studies module (20 cr). In some Master's programmes certain courses are recommended (e.g. IT Services). Elective studies module can also include practical training (see Chapter 14). The language studies are included in the Elective Studies module.

**Obligatory foreign language courses/tests.** According to the Degree Regulations a student shall demonstrate written and oral skills in at least one foreign language included in the curriculum and needed for practicing his/her profession. Language proficiency is demonstrated by passing a course or courses in the foreign language provided by the Language Centre. If a student has demonstrated his/her language proficiency by completing foreign language courses already for the Finnish B.Sc or other lower university or polytechnic degree, he/she does not need to demonstrate it again for the Master's degree.

The required amount of foreign language studies is 3 credits.

For more information about the language courses, see Chapter 14 or the Language Centre website: <http://kielikeskus.tkk.fi/en/studying/degree/>.

## 6. MASTER'S PROGRAMMES IN DEGREE PROGRAMME IN COMPUTER SCIENCE AND ENGINEERING

### 6.1 Master's Programme in Foundations of Advanced Computing

Degree Programme in Computer Science and Engineering

Degree: Master of Science in Technology – M.Sc. (Tech) 120 ECTS

Major: Foundations of Advanced Computing (SCI3014)

Director of the programme:

Prof. Kaisa Nyberg

Professors of the major:

T-79 Prof. Keijo Heljanko

T-79 Assistant prof. Petteri Kaski

T-79 Prof. Kaisa Nyberg

T-79 Prof. Pekka Orponen

T-79 Prof. Erik Aurell

T-79 Associate prof. Stavros Tripakis

T-61 Associate prof. Aristides Gionis

N.N.

Academic coordinator:

<https://into.aalto.fi/display/enfadco/>

#### **Objectives of the programme**

The global computing infrastructure of the future will be founded on a complex and extensively distributed network of heterogeneous subsystems of varying degrees of autonomy. The emergence of this structure will lead to fundamentally new practices in how computing systems and services are designed, developed, implemented, and applied. Students in the Master's Programme in Foundations of Advanced Computing (FAdCo) will receive a solid and versatile methodological education preparing them for a career in exploiting and advancing these exciting new computing technologies.

The Master's Programme in Foundations of Advanced Computing consists of six study modules:

T231-2	Intermediate Module in Foundations of Advanced Computing	20 cr
T231-3	Advanced Module in Theoretical Computer Science	20 cr
T232-C	Special Module in Foundations of Advanced Computing	20 cr
T901-M	Methodological Principles	10 cr
T901-W	Elective Studies	20 cr
T901-D	Master's Thesis	30 cr

**T231-2 Intermediate Module in Foundations of Advanced Computing A2 (20 cr)**

**Professors in charge of the module:** Prof. Heljanko, Prof. Kaski, Prof. Nyberg, Prof. Orponen, Prof. Tripakis, Prof. Gionis

**Description of the module:** This module provides the student with fundamental conceptual tools for the modelling, design and analysis of advanced computing systems.

Code	Course	Cr	Period
T-79.4101	Discrete Models and Search	5	III-IV
T-79.4202	Principles of Algorithmic Techniques	5	I-II
T-79.4302	Parallel and Distributed Systems	5	I-II
T-79.4502	Cryptography and Data Security	5	I-II
	<b>Total</b>	<b>20</b>	

**T231-3 Advanced Module in Theoretical Computer Science A3 (20 cr)**

**Professors in charge of the module:** Prof. Heljanko, Prof. Kaski, Prof. Nyberg, Prof. Orponen, Prof. Aurell, Prof. Tripakis, Prof. Gionis

**Description of the module:** In this module the student is exposed to the four focus areas of the programme: computational logic, computational complexity, distributed computation, and cryptology.

Code	Course	Cr	Period
T-79.5104	Advanced Course in Computational Logic	5	I-II
T-61.5060	Algorithmic Methods of Data Mining	5	II
T-79.5501	Cryptology	5	III-IV
T-79.5103	Computational Complexity Theory	5	III-IV
	<b>Total</b>	<b>20</b>	

One of the A3 courses can be replaced by the course T-79.5001 Student Project in Theoretical Computer Science (5 cr).

**T232-C Special Module in Foundations of Advanced Computing C (20 cr)**

**Professors in charge of the module:** Prof. Heljanko, Prof. Kaski, Prof. Nyberg, Prof. Orponen, Prof. Aurell, Prof. Tripakis, Prof. Gionis

**Description of the module:** In this module the student specializes in one or two of the focus areas of the programme: computational logic, computational complexity, distributed computation, and cryptology. The content is agreed with the supervising professor. The studies typically consist of a list of elective courses from the list below, but may also include studies on application areas or studies abroad.

Code	Course	Cr	Period
Courses may include e.g.			
T-79.5105	Answer Set Programming	5	I-II

T-79.5205	Combinatorics	5	III-IV
T-79.5207	Advanced Course in Algorithms	5	III-IV
T-79.5308	Scalable Cloud Computing	5	I-II
	<b>Total</b>	<b>20</b>	

### Methodological Principles (10 cr)

Code	Course	Cr	Period
<b>Choose at least one of the following courses:</b>			
T-61.5010	Information Visualization	5	III
T-61.3050	Machine Learning: Basic Principles	5	I
<b>To complete 10 credits, select courses from the common methodological studies list.</b>			
	<b>Total</b>	<b>10</b>	

### Elective Studies (20 cr)

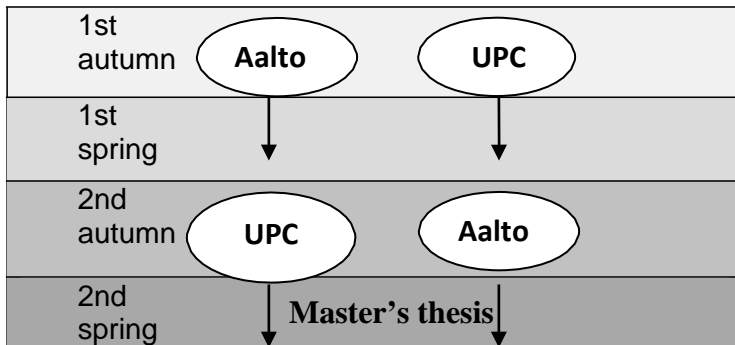
Code	Course	Cr
<b>Compulsory courses (3 cr):</b>		
Kie-98.xxxx/ LC-xxxx	Foreign language courses	3
<b>Any language courses that fulfill the requirements for obligatory foreign language courses: a total of 3 ECTS credits including both oral and written skills.</b>		
<b>Select any courses to complete 20 credits for the Elective studies module. The following courses are recommended:</b>		
Kie-98.7012	Courses not part of another module	
Kie-98.7011	Finnish 1A	2
Kie-98.7012	Finnish 1B	2
Kie-98.7021	Finnish 2A	2
Kie-98.7022	Finnish 2B	2
Harj-0.xxxx	Practical training	2-6
	<b>Total</b>	<b>20</b>

### Master's Thesis (30 cr)

### ***Cluster Dual Degree in Master's Programme in Foundations of Advanced Computing***

In Cluster dual degree studies, the student completes part of the Master's programme studies in the partner university. Master's Programme in Foundations of Advanced Computing has a dual degree agreement with Technical University of Catalonia (UPC) in Spain.

In the Cluster dual degree programme, the second autumn semester or the second year of the Master's programme studies is completed at the partner university. The Master's thesis is supervised by both universities and the student graduates from both universities.



Application process to the Cluster dual degree programme has two phases. First the student applies to the Master's programme. After the first semester of studies at the home university (Aalto or UPC), the student applies to the Cluster dual degree programme. Students are admitted to the programme based on their academic results, prerequisite requirements, motivation and language skills. The application deadline is February 28 annually.

For further information on the Cluster dual degree studies, contact the Study coordinator of the programme.

## 6.2 Master's Programme in Machine Learning and Data Mining

Degree Programme in Computer Science and Engineering

Degree: Master of Science in Technology – M.Sc. (Tech) 120 ECTS

Major: Machine Learning and Data Mining (SCI3015)

Director of the programme: Professor Erkki Oja  
 Professors of the major: T-61 Prof. Erkki Oja  
 T-61 Prof. Samuel Kaski  
 T-61 Prof. Assistant prof. Harri Lähdesmäki  
 T-61 Prof. Juho Rousu  
 T-61 Prof. Aristides Gionis  
 T-115 Prof. Olli Simula  
 T-120 Prof. Juha Karhunen  
 T-122 Prof. Heikki Mannila  
 Academic coordinator: Dr. Markus Koskela

<https://into.aalto.fi/display/enmac/>

### **Objectives of the programme**

The programme gives a strong basic understanding of modern computational data analysis and modelling methodologies. It builds on the strong research of two centres of excellence, appointed by the Academy of Finland, in machine learning and data mining. These methods are applicable and needed in a wide variety of fields ranging from process industry to mobile communications. Recent spearhead application areas include bioinformatics, computational linguistics and natural language processing, and multimodal interfaces. The programme provides an excellent basis for doctoral studies as well as industrial research and development work. The offered courses are a focused part of the major subject Computer and Information Science.

**The Master's Programme in Machine Learning and Data Mining consists of six study modules:**

<b>T271-2</b>	<b>Intermediate Module in Machine Learning and Data Mining</b>	<b>20 cr</b>
<b>T271-3</b>	<b>Advanced Module in Computer and Information Science</b>	<b>20 cr</b>
<b>T279-C</b>	<b>Special Module in Computer and Information Science</b>	<b>20 cr</b>
<b>T901-M</b>	<b>Methodological Principles</b>	<b>10 cr</b>
<b>T901-W</b>	<b>Elective Studies</b>	<b>20 cr</b>
<b>T901-D</b>	<b>Master's Thesis</b>	<b>30 cr</b>

### **T271-2 Intermediate Module in Machine Learning and Data Mining A2 (20 cr)**

**Professor in charge of the module:** Prof. Erkki Oja

**Description of the module:** The Intermediate Module in Machine Learning and Data Mining gives the knowledge required in further studies and applications of machine learning and data mining.

<b>Code</b>	<b>Course</b>	<b>Cr</b>	<b>Period</b>
<b>Compulsory courses:</b>			
T-61.3050	Machine Learning: Basic Principles	5	I
T-61.5130	Machine Learning and Neural Networks	5	II

T-61.5140	Machine Learning: Advanced Probabilistic Methods	5	III-IV
T-61.5060	Algorithmic Methods of Data Mining	5	II
	<b>Total</b>	<b>20</b>	

### **T271-3 Advanced Module in Computer and Information Science A3 (20 cr)**

**Professor in charge of the module:** Prof. Erkki Oja

**Description of the module:** The advanced module of the Computer and Information Science provides in-depth knowledge of the various areas of the major. In addition to the lectured courses, the student can choose seminar courses with yearly varying content on current research topics. The module gives the student the necessary skills for post-graduate studies as well as for demanding tasks in research and development: analysis and modelling of signals and complex data sets, and ability to take advantage of the current research results in practical applications.

<b>Code</b>	<b>Course</b>	<b>Cr</b>	<b>Period</b>
<b>Compulsory course:</b>			
T-61.5910	Research Project in Computer and Information Science	5-10	I-II
<b>Select some to complete 20 cr:</b>			
T-61.5070	Computer Vision	5	III-IV
S-89.5150	Speech Recognition	5	II
T-61.6010	Special Course in Computer and Information Science I	3-10	I-II
T-61.6020	Special Course in Computer and Information Science II	3-10	III-IV
T-61.6030	Special Course in Computer and Information Science III	3-10	III-IV
T-61.6040	Special Course in Computer and Information Science IV	3-10	I-II
T-61.6050	Special Course in Computer and Information Science V	3-10	I-II
T-61.6060	Special Course in Computer and Information Science VI	3-10	III-IV
	<b>Total</b>	<b>20</b>	

### **T279-C Special Module in Computer and Information Science C (20 cr)**

**Professor in charge of the module:** Prof. Erkki Oja

**Description of the module:** The advanced special module of the Computer and Information Science provides the students of the programme a possibility to gain in-depth knowledge in some areas of the Computer and Information Science. The contents of the module are agreed individually with a professor. May include studies on application areas or studies abroad.

<b>Code</b>	<b>Course</b>	<b>Cr</b>	<b>Period</b>
<b>Possible courses include:</b>			
T-61.5020	Statistical Natural Language Processing	5	III-IV
T-61.5050	High-Throughput Bioinformatics	5-7	III-IV
T-61.5070	Computer Vision	5	III-IV
T-61.5080	Signal Processing in Neuroinformatics	5	I-II

T-61.5090	Image Analysis in Neuroinformatics	5	III-IV
S-89.5150	Speech Recognition	5	II
T-61.6xxx	Special Courses (see above)	3-10	I-II, III-IV
<b>Total</b>		<b>20</b>	

### Methodological Principles (10 cr)

The objective of the methodological principles module is to support the Master's thesis work.

Code	Course	Cr	Period
<b>Compulsory course:</b>			
T-61.5010	Information Visualization	5	III
<b>Select one of the following courses:</b>			
T-79.4101	Discrete Models and Search	5	III-IV
T-79.4302	Parallel and Distributed Systems	5	I-II
T-79.4502	Cryptography and Data Security	5	I-II
T-79.5103	Computational Complexity Theory	5	III-IV
<b>Total</b>		<b>10</b>	

### Elective Studies (20 cr)

Elective studies module gives an opportunity to familiarize oneself with any other field at the whole university, including languages.

Code	Course	Cr
<b>Compulsory courses (3 cr):</b>		
Kie-98.xxxx/ LC-xxxx	Foreign language courses	3
<b>Any language courses that fulfill the requirements for obligatory foreign language courses: a total of 3 ECTS credits including both oral and written skills.</b>		
<b>Select courses to complete 20 credits for the Elective studies module.</b>		
<b>The following courses are recommended:</b>		
Kie-98.7011	Finnish 1A	2
Kie-98.7012	Finnish 1B	2
Kie-98.7021	Finnish 2A	2
Kie-98.7022	Finnish 2B	2
Harj-0.xxxx	Practical training	2-6
<b>Total</b>		<b>20</b>

### Master's thesis (30 cr)



### ***Cluster Dual Degrees in Master's Programme in Machine Learning and Data Mining***

#### **Aalto University School of Science**

Department of Information and Computer Science

#### **Master's Programme in Machine Learning and Data Mining**

<https://into.aalto.fi/display/enmac/>

#### **Responsible academic persons:**

Professor Samuel Kaski ([samuel.kaski@aalto.fi](mailto:samuel.kaski@aalto.fi))

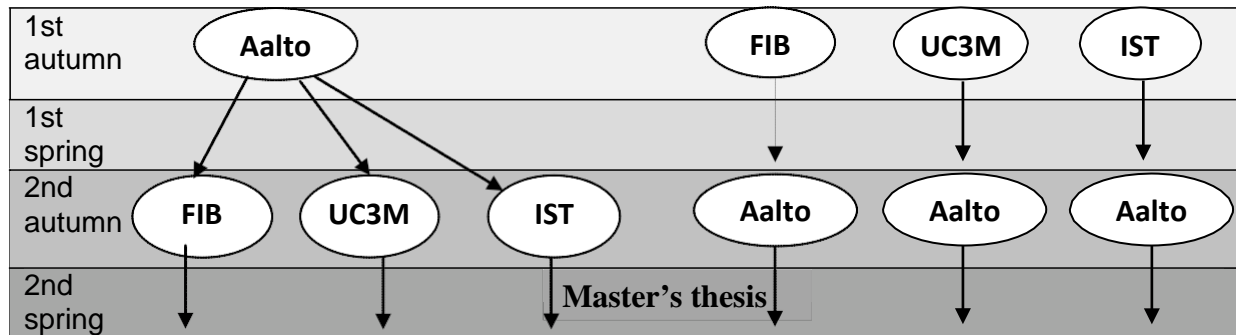
Associate professor Harri Lähdesmäki ([harri.lahdesmaki@aalto.fi](mailto:harri.lahdesmaki@aalto.fi))

Coordinator: Dr. Markus Koskela ([markus.koskela@aalto.fi](mailto:markus.koskela@aalto.fi))

In Cluster dual degree studies, the student completes part of the Master's programme studies in the partner university. Master's Programme in Machine Learning and Data Mining has four dual degree partner universities:

- Technical University of Catalonia (UPC), Barcelona School of Informatics (FIB), Spain
- University of Carlos III (UC3M), Spain
- Technical University of Lisbon, School of Engineering (IST), Portugal

In the Cluster dual degree programme, the second autumn semester or the second year of the Master's programme is completed at the partner university. The Master's thesis is supervised by both universities and the student graduates from both universities.



Application process to the Cluster dual degree programme has two phases. First the student applies to the Master's programme. After the first semester of studies at the home university (Aalto, UPC-FIB, UC3M or IST), the student applies to the Cluster dual degree programme. Students are admitted to the programme based on their academic results, prerequisite requirements, motivation and language skills. The application deadline is 28 February annually.

For further information on Cluster dual degree, contact the Study coordinator of the programme.

### **6.3 Master's Programme in Mobile Computing - Services and Security**

**Degree Programme in Computer Science and Engineering**

**Degree: Master of Science in Technology – M.Sc. (Tech) 120 ECTS**

**Major: Mobile Computing - Services and Security (T3010)**

**Director of the programme:** Professor Antti Ylä-Jääski  
**Professors of the major:** T-110 Prof. Antti Ylä-Jääski  
 T-110 Prof. Tuomas Aura  
 T-110 Prof. Jukka K. Nurminen

<https://into.aalto.fi/display/enmob/>

#### **Objectives of the programme**

The Finnish information and communications technologies industry and Aalto University School of Science (Aalto) are global leaders in research and education in mobile computing technologies. This two year full-time Master's programme extends the students' computer science skills towards the mobile computing area. The programme provides both practical skills and theoretical insights into computer networking, network application and service development, information security, and mobile networking. The graduates will have a broad knowledge of mobile computing technologies and they are able to design and develop their own solutions for the mobile Internet.

The technical foundation of the Mobile Computing programme covers Internet and networking technologies. The advanced studies focus on application and service development including service management issues like mobility, quality of service, energy efficiency, and charging. Special attention is paid to information security, which is a critical issue when developing and deploying services on public networks. Throughout the programme, students apply their theoretical knowledge in hands-on exercises and implementation projects. Students also learn to read the latest research literature and technical documentation, and to write and present technical ideas.

The Mobile Computing programme graduates are employed in Finland and internationally in both industry and academia. They are able to take on diverse roles including expert positions, product development, research, and management. In addition to the international telecommunications industry, there is an increasing demand for the graduates from small and medium software companies that develop network-based applications and services. The programme also provides a solid basis for doctoral studies and an academic career.

As learning outcomes, you will be able to apply 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. You will also be able to apply common security mechanisms in software systems and communications networks taking into account their design principles and limitations, to perform threat analysis and security requirements specification, and to design and implement secure information systems. As general engineering skills, you will be able to read and write technical documents, follow the latest scientific research and present technical ideas clearly to other experts.

The Master's Programme in Mobile Computing – Services and Security (120 cr) consists of six study modules:

<b>T402-3</b>	<b>Advanced Module in Technical Information Security</b>	<b>20 cr</b>
<b>T401-3</b>	<b>Advanced Module in Network Services and Applications</b>	<b>20 cr</b>
<b>T403-C</b>	<b>Special Module in Computer Science</b>	<b>20 cr</b>
<b>T901-M</b>	<b>Methodological Principles</b>	<b>10 cr</b>
<b>T901-W</b>	<b>Elective Studies</b>	<b>20 cr</b>
<b>T901-D</b>	<b>Master's Thesis</b>	<b>30 cr</b>

#### **T402-3 Advanced Module in Technical Information Security (20 cr)**

**Professor in charge of the module:** Tuomas Aura

**Description of the module:** This module covers broadly the technical aspects of information security including computer security models and technologies, cryptography, and network security. The module provides both theoretical knowledge and practical skills for analyzing and developing secure systems.

<b>Code</b>	<b>Course</b>	<b>Cr</b>	<b>Period</b>
<b>Compulsory courses:</b>			
T-110.4206	Information Security Technology	3	I
T-110.5210	Cryptosystems	5	I-II
<b>Choose one of the following:</b>			
T-110.5291	Seminar on Network Security	5	I-II
T-110.5191	Seminar on Internetworking	5	III-IV
Optional courses: select as many as needed to complete the module. See the list of optional courses below.			
<b>Total</b>		<b>20</b>	

#### **T401-3 Advanced Module in Network Services and Applications (20 cr)**

**Professors in charge of the module:** Antti Ylä-Jääski and Jukka K. Nurminen

**Description of the module:** This module covers the technologies and development of network-based services and applications. It provides both practical skills and theoretical knowledge with emphasis on system architecture and business models. The content includes state-of-the art protocols, systems, and architectures. Practical experience is gained in laboratory assignments.

<b>Code</b>	<b>Course</b>	<b>Cr</b>	<b>Period</b>
<b>Compulsory courses:</b>			
T-109.4300	Network Services Business Models	3	III-IV
T-110.5111	Computer Networks II – Advanced Features	5	I-II
T-110.5102	Laboratory works in networking and security	5-10	I-II
Optional courses: select as many as needed to complete the module. See the list of optional courses below.			
<b>Total</b>		<b>20</b>	

#### **T403-C Special Module in Computer Science C (20 cr) or studies abroad (to be agreed with the professor of the major)**

**Professors in charge of the module:** Antti Ylä-Jääski, Tuomas Aura and Jukka K. Nurminen

**Description of the module:** This module is programming oriented and includes a software development project and a course in data communications software. The students learn a broad range of techniques for the development of networked systems. The module can also be replaced with studies abroad based on prior agreement with the professor of the major.

Code	Course	Cr	Period
<b>Compulsory courses:</b>			
T-110.5140	Network Application Frameworks	5	III-IV
T-110.7111	Internet Technologies for Mobile Computing	4	III-IV
<b>Choose one of the following courses:</b>			
T-76.4115	Software Development Project I	5	II-V
T-110.6101	Special Assignment in Networking and Security	5	I-II
Optional courses: select as many as needed to complete the module. See the list of optional courses below.			
<b>Total</b>		<b>20</b>	

**Optional courses for the Advanced Module in Technical Information Security, Advanced Module in Network Services and Applications, Special Module in Computer Science and Elective Studies module:**

*	Code	Course	ECTS	Period
	T-106.5300	Embedded Systems	5	III-IV
	T-106.5600	Concurrent Programming	5	I-II
x	T-110.4206	Information Security Technology	3	I
	T-110.5102	Laboratory works in networking and security	5-10	I-II
x	T-110.5111	Computer Networks II – Advanced Features	5	I-II
	T-110.5121	Mobile Cloud Computing	5	I-II
	T-110.5130	Mobile Systems Programming	5	III-IV
x	T-110.5140	Network Application Frameworks	5	III-IV
	T-110.5150	Applications and Services in Internet	5	I-II
	T-110.5191	Seminar on Internetworking	5	III-IV
	T-110.5220	Information Security and Usability	3	III-IV
	T-110.5241	Network Security	5	II-III
	T-110.5291	Seminar on Network Security	5	I-II
	T-110.6000	Internet and Computing Forum	2	III-IV
	T-110.6101	Special assignment in networking and security	1-10	I-II, III-IV
	T-110.6120	Special Course in Data Communication Software	2-10	I-II, III-IV
x	T-110.6130	Systems Engineering in Data Communications Software	2-10	I-II
	T-110.6220	Special Course in Network Security	2-10	I-II, III-IV

x	T-110.7111	Internet Technologies for Mobile Computing	2-10	III-IV
	T-110.7190	Research Seminar on Data Communications Software	2-10	
x	T-76.4115	Software Development Project I	3-8	II-V
	T-79.5501	Cryptology	5	III-IV
	S-38.3001	Telecommunications Forum	2	

\*Compulsory course that can be chosen as optional only in Cluster dual degree programmes

### T901-M Methodological Principles (10 cr)

Code	Course	Cr	Period
<b>Compulsory:</b>			
T-110.6130	Systems Engineering in Data Communications Software	5	I-II
<b>Select one course to complete 10 cr:</b>			
T-61.5010	Information Visualization	5	III
T-61.3050	Machine Learning: Basic Principles	5	I
T-79.4101	Discrete Models and Search	5	III-IV
T-79.4302	Parallel and Distributed Systems	5	I-II
T-79.5103	Computational Complexity Theory	5	III-IV
<b>Total</b>		<b>10</b>	

### T901-W Elective Studies (20 cr)

Code	Course	Cr
<b>Compulsory courses (3 cr):</b>		
Kie-98.xxxx/ LC-xxxx	Foreign language courses*	3
<b>*Any language courses that fulfil the requirements for obligatory foreign language courses: a total of 3 ECTS credits including both oral and written skills.</b>		
<b>Select courses to complete 20 credits for the Elective studies module.</b>		
<b>The following courses are recommended:</b>		
T-76.5115	Software Development Project II	6-8
Kie-98.7011	Finnish 1A	2
Kie-98.7012	Finnish 1B	2
Kie-98.7021	Finnish 2A	2
Kie-98.7022	Finnish 2B	2
T-xx.xxxx	Practical training	2-6
<b>Total</b>		<b>20</b>

**Master's thesis (30 cr)**

In the master's thesis project, the students apply their knowledge to solve an advanced technical or scientific problem. The thesis topics are related to networking, services and security, and they enable the students to develop specialized skills in the analysis, modeling, simulation, design, implementation and management of mobile computing systems. Most thesis projects are done in the local industry as a member of an R&D team. Academically oriented students can also find thesis topics from university research projects.

**Timetable for the programme**

In addition to the courses below, optional studies must be taken so that the total amount of credits obtained is about 30 credits per term, total 60 credits per academic year.

<b>1<sup>st</sup> autumn</b>		
<b>Code</b>	<b>Course</b>	<b>Cr</b>
<b>Compulsory courses:</b>		
T-110.4206	Information Security Technology	3
T-110.5102	Laboratory Works in Networking and Security	5-10
T-110.5210	Cryptosystems	5
T-110.6130	Systems Engineering in Data Communications Software	5
LC-xxxx	Foreign language	3

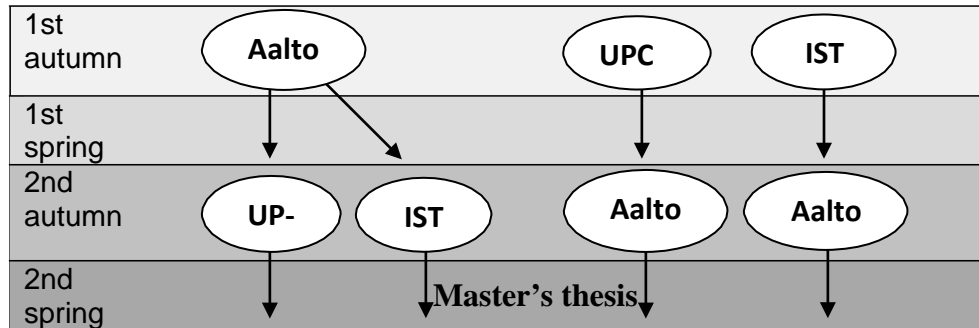
<b>1<sup>st</sup> spring</b>		
<b>Code</b>	<b>Course</b>	<b>Cr</b>
<b>Compulsory courses:</b>		
T-109.4300	Network Services Business Models	3
T-110.5140	Network Application Frameworks	5
T-110.5191	Seminar on Internetworking (or T-110.5291 in 2 <sup>nd</sup> autumn)	5
T-110.7111	Internet Technologies for Mobile Computing	4
T-xxx.xxxx	Methodology course (or in the 2 <sup>nd</sup> autumn)	(5)

<b>2<sup>nd</sup> autumn</b>		
<b>Code</b>	<b>Course</b>	<b>Cr</b>
<b>Compulsory courses:</b>		
T-110.5111	Computer Networks II – Advanced Features	5
T-110.5291	Seminar on Network Security (or T-110.5191 in 1 <sup>st</sup> spring)	(5)
T-76.4115	Software Development Project I	continue
	OR	
T-110.6101	Special Assignment in Networking and Security	5
T-xxx.xxxx	Methodology course (or in the 1 <sup>st</sup> spring)	5
<b>2<sup>nd</sup> spring</b>		
<b>Code</b>	<b>Course</b>	<b>Cr</b>
<b>Compulsory courses:</b>		
T-76.4115	Software Development Project I (continues)	5
T-110.D	Master's thesis	30

**Cluster Dual Degrees in  
Master's Programme in Mobile Computing – Services and Security**

In Cluster dual degree studies, the student completes part of the Master's programme studies in the partner university. Master's Programme in Mobile Computing has two dual degree partner universities: Technical University of Catalonia (UPC) in Spain and Technical University of Lisbon, School of Engineering (IST) in Portugal.

In the Cluster dual degree programme, the second autumn semester or the second year of the Master's programme is completed at the partner university. The Master's thesis is supervised by both universities and the student graduates from both universities.



Application process to the Cluster dual degree programme has two phases. First the student applies to the Master's programme. After the first semester of studies at the home university (Aalto, UPC or IST), the student applies to the Cluster dual degree programme. Students are admitted to the programme based on their academic results, prerequisite requirements, motivation and language skills. The application deadline is 28 February annually.

## 6.4 Master's Programme in Service Design and Engineering

Degree Programme in Computer Science and Engineering

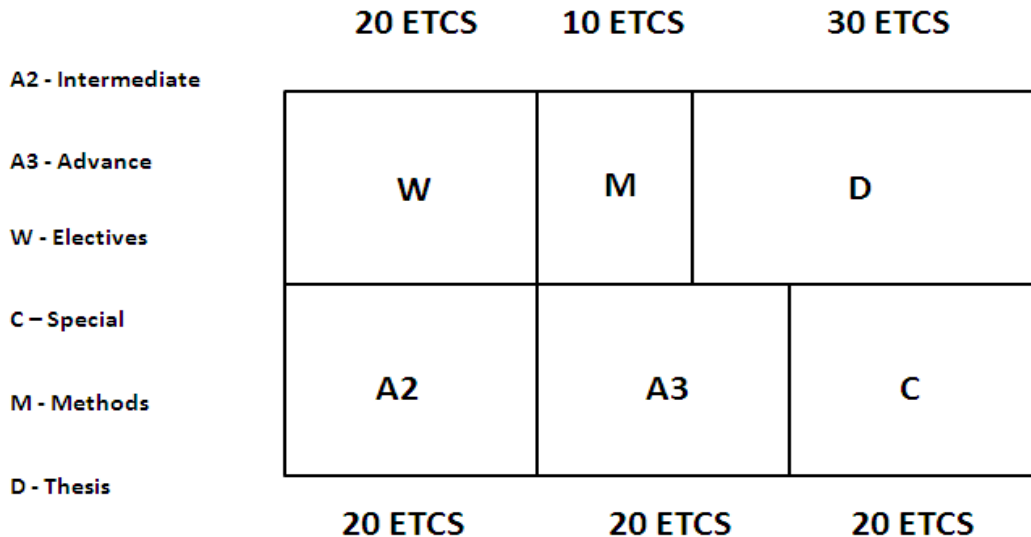
Degree: Master of Science in Technology - M.Sc. (Tech) 120 ECTS

Major: Service Design and Engineering (IL3005)

Director of the programme: Professor Heikki Saikkonen  
 Professors of the major: Professor Heikki Saikkonen  
 Professor (pro tem) Marjo Kauppinen  
 Academic coordinator: Håkan Mitts  
 More information: <https://into.aalto.fi/display/ensde/>

### General program structure:

The Master's Programme in Service Design and Engineering (SDE) consists of six study modules A2, A3, C, W, M and D, total of 120 ECTS (European Credit Transfer and Accumulation System). Students must complete all listed courses in the modules as part of master degree.



Picture 1: Module structure of SDE program

T233-2	<b>A2 - Intermediate Module in Service Design and Engineering</b>	<b>20 cr</b>
	- Service and information science foundations	
T234-3	<b>A3 - Advanced Module in Service Design and Engineering</b>	<b>20 cr</b>
	- Service technologies track	
	- Service systems track	
T235-C	<b>C- Special Module in Service Design and Engineering</b>	<b>20 cr</b>
	- Digital Innovation Venture Experience	
T901-M	<b>M - Methodological Principles</b>	<b>10 cr</b>
T901-W	<b>W - Elective Studies</b>	<b>20 cr</b>
	- min. 3 ECTS of mandatory foreign language	
T901-W	<b>D - Master's Thesis</b>	<b>30 cr</b>

The Aalto Service Design and Engineering (SDE) Master's Program is an interdisciplinary approach to computer science and engineering, information system management and digital services graduate education. The SDE program focuses on the development of digital and soft-



ware services from user centric perspectives, to meet the needs of networked businesses. Students cover the foundations of service systems and platforms both from technical and business perspectives. The program is a very intensive two (2) year full-time commitment.

Courses focus on service concept research, strategic foresight, service development, software engineering, open innovation, business modeling, implementation strategies, lifecycle architectures, and governance models. All students will be engaged in a real-life “case” or “new start-up” projects in business camps or projects. These courses require the students to analyze real user and business stakeholder needs, implement business needs by programming new solutions, and manage these new systems in authentic situations.

Service innovation and entrepreneurship are important parts of the curriculum. The SDE program cooperates with the Aalto Ventures Program (AVP) in order to provide students with world-class innovation and entrepreneurial skills. Students can include the AVP minor in their study program. For details on the AVP minor, see <http://avp.aalto.fi/teaching/aalto-ventures-program-minor/>.

The SDE program provides a good foundation also for a scientific research career. The research methodology studies on paper writing, publishing, and the M.Sc. thesis are a solid track to highly valued graduate, development, consulting, or research position in industry and academic institutions.

SDE students graduate to highly competitive information technology roles in international and local organizations both in the business and technology roles. Typical job titles can be etc. Service Development Engineer/Consultant, Systems Engineer, Business Development Manager, Service Manager, Account Manager, Product/Service Manager, Enterprise Architect, Chief Service Officer (CSO) or Chief Technology Officer (CTO). There are several cases where SDE students have founded successful new ventures, business or non-profit organizations from the content of program.

### **T233-2 Intermediate Module in Service Design and Engineering A2 (20 ECTS)**

**Professors in charge of the module:** Prof. Saikkonen and Prof. Kauppinen

**Description of the module:** The A2 module is an introduction to service science and digital services technologies. The module provides the foundation for innovative design of IT-based services. It is common to all SDE students.

Code	Course	ECTS	Period	Year
<b>Compulsory courses:</b>				
TU-22.1309	Aalto Introduction to Services	5	I	1
T-86.5310	ICT Enabled Service Business and Innovation	5	I-II	1
T-76.5150	Software Architectures	5	III-IV	1
<b>Choice of:</b>				
TU-22.1335	Service Innovation and New Service Development	5	I-II	2
Student choice of service design courses		5		
<b>Total</b>		<b>20</b>		

**T901-M Methodological Principles M (10 ECTS)****Professors in charge of the module:** Prof. Saikkonen and Prof. Kauppinen

**Description of the module:** The M-module is collaborative research module with courses on research foundation. The seminars are focusing in research methods and master thesis research or project related academic topics presented and approved by specialization track professor.

Code	Course	ECTS	Period	Year
<b>Compulsory courses:</b>				
T-86.5200	Service research seminar P	5	I – V	1
<b>Choice of:</b>				
T-76.5050	Methods for SW Engineering and Business Research P	5	I - II	2
Student choice of common methodological studies list.		5		
<b>Total</b>		<b>10</b>		

**T235-C Special Module in Service Design and Engineering C (20 ECTS)****Professors in charge of the module:** Prof. Saikkonen

**Description of the module:** Special module in digital service based on the conceive, design, implement and operate (CDIO) model consists of four courses. The objective of this module is to teach students to work in expert teams on challenging digital and information services related technology and business innovation questions, problems, cases and Capstone projects. This module is intended to provide a culminating graduate experience that allows a student to demonstrate their technological innovation and entrepreneurial proficiency in several of the learning outcomes that are set forth by the program.

Code	Course	ECTS	Period	Year
T-106.5261	Master's Studio in Service Design and Engineering	6	I – II	1
T-106.5750	Aalto Service Camp	6	V	1
T-86.5415	Digital Service Insight and Innovation I	6	I – IV	1
T-86.5416	Digital Service Insight and Innovation II	2	I – III	2
<b>Total</b>		<b>20</b>		

**T234-3 Advanced Module in Service Design and Engineering A3 (20 ECTS) tracks**

Students must complete one of the preselected combinations of courses (full track) as part of master's degree studies. The track must be confirmed in the students personal study plan and approved by the academic coordinator of the programme.

In the Service Technologies track, students learn how to design and implement IT-based services. The focus of the track is on web-based services with both desktop and mobile client sys-

tems. The student can focus on either server side or client-facing aspects of service development.

SDE specialization in “Service technologies track” (20 ECTS) from prof. Saikkonen.

Code	Course	ECTS	Period	Year
<b>Compulsory courses:</b>				
T-79.5308	Scalable Cloud Computing	5	I-II	2
CSE-C3210	Web Software Development	5	II-III	1
<b>Choice of:</b>				
T-110.4206	Information Security Technology	3	I	2
T-110.5121	Mobile Cloud Computing	5	I-II	2
T-121.5300	User Interface Construction	3-4	II	2
T-110.5130	Mobile Systems Programming	5	III-IV	1
Student choice: approved by specialization track professor				
<b>Total</b>		<b>20</b>		

In the Service Systems track, the student will learn how to innovate, define, purchase, operate and manage ICT-based service systems.

SDE specialization in “Service systems track” (20 ECTS) from prof. Kauppinen.

Code	Course	ECTS	Period	Year
<b>Compulsory courses:</b>				
T-86.5141	Enterprise Systems Architecture	4	I	2
T-76.5612	Software Project Management P	3	III	1
T-76.5615	Requirements Engineering P	3	III	1
<b>Choice of:</b>				
T-86.5180	IT Governance P	4	II	2
T-76.5762	Legal Aspects of Service Management P	3	II	2
T-128.2500	Management of a Software Venture P	6	I-II	2
T-121.5850	Individual Course on Usability	3	I-II	2
S-38.3062	Modelling Human Behaviour P	3	III	2
Student choice: approved by specialization track professor				
<b>Total</b>		<b>20</b>		

### Elective Studies in Service Design and Engineering W (20 ECTS)

Code	Course	ECTS	Period	Year
<b>Compulsory Course (3 cr):</b>				
Kie-98.xxxx/ LC-xxxx	Foreign language courses*	3	I-II, III-IV	1

Select any Aalto courses to complete 20 credits for the Elective studies module. The following course is recommended:

Kie-98.1320	Writing for Master's Students, w	3-5		
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The Aalto Venture Program is the entrepreneurial program at the Aalto University. The AVP is open for Aalto students. SDE students can include the AVP curriculum in their studies by taking the AVP as part of the elective studies. To make AVP part of your studies, follow the AVP guidelines. The courses below are specifically recommended for SDE students.

CSE-E4751	Introduction to IT Business and Venturing	2	I-II	1
T-128.2500	Management of a Software Venture P	6	I-II	1
CSE-E5753	Technology Entrepreneurship Seminar	4	IV	1
CSE-E5754	Growth and Internationalization of Technology SMEs	4	V	1
<b>Total</b>		<b>20</b>		

\*Student will have to earn at least three credits for foreign language courses in order to demonstrate **oral (o)** and **written (w)** proficiency in a foreign language. Finnish and Swedish are not considered as foreign languages. List of courses that fulfill the requirement can be found at the www-page of the Language Centre.

SDE program recommends students to include practical training (max 6 ECTS) from internships. Students are also highly recommended to take courses from the other track or courses offered by Aalto Ventures Programme (AVP) as electives.

### Master's Thesis D (30 ECTS)

	ECTS	Period	Year
Thesis in the area of the A3 specialization track	30	III – IV	2

## **6.5 Master's Programme in Bioinformatics**

**Degree Programme in Computer Science and Engineering**

**Degree: Master of Science in Technology – M.Sc. (Tech) 120 ECTS**

**Major: Bioinformatics (T3012)**

**Professors in charge:**

**T-61 Prof. Juho Rousu**

**T-61 Assistant prof. Harri Lähdesmäki (on leave of absence)**

**T-61 Prof. Samuel Kaski (on leave of absence)**

**Academic Coordinator at Aalto: Elena Czeizler**

<http://www.cs.helsinki.fi/en/mbi/>

### **Bioinformatics as a Discipline**

Bioinformatics is a new field of science that seeks answers to the questions of life, raised by biology and medicine, with computational means. It is possible to study the infective potential of a virus by modelling its three-dimensional surface structure. The function of genes can be uncovered by a computational study of DNA sequences. The utilization of renewable resources for example biofuel production can be improved by metabolic modelling. Machine learning can be used to seek cellular mechanisms of cancer from gene expression and metabolomics data.

Analysis of measurement data is of vital importance in modern research in biology and medicine. Understanding such data requires both robust statistical modelling and methods which are computationally feasible.

In general terms, bioinformatics is computer-aided collecting, processing and analysing of biological and medical information. Mathematics, statistics and computer science methods provide the foundation of bioinformatics, but it is necessary to have a thorough understanding of both the application area and methods. Thus, a bioinformatician often acts as an important mediator between the methodological and biological sciences.

Aalto University School of Science and the University of Helsinki (HY) offer excellent opportunities for bioinformatics studies. Research in bioinformatics at the institutions is of the highest quality in Europe. The universities have extensive contacts to universities and research institutes abroad. This guarantees a wide range of options for student exchange and post-graduate studies.

### **Organization**

The Master's Programme in Bioinformatics (MBI) is organized jointly by the University of Helsinki and Aalto University School of Science. At the University of Helsinki, member faculties are the Faculties of Science, Medicine and Biological and Environmental Sciences. At Aalto University School of Science, the programme is organized by the Degree Programme in Computer Science and Engineering and the Department of Information and Computer Science.

The teaching is given by people working on the cutting edge of bioinformatics research. For instance, people from three research units chosen to be Centres of Excellence by the Academy of Finland have a central role in the development and implementation of the programme.

## **Degree**

The basic degree offered by the MBI programme is Master of Science (in HY: MSc, filosofian maisteri; in Aalto: MSc (Tech), diplomi-insinööri), with bioinformatics as the major subject. The scope of the degree is 120 credits, and requires a suitable Bachelor's level degree as a pre-requisite.

The intended time to complete the degree is two years. The detailed structure of the MSc degree is described in the section on degree requirements.

## **Degree requirements 2013 - 2015**

Students who have obtained the right to study in the Master's Programme in Bioinformatics in 2013 in Aalto University School of Science will follow these requirements.

The Master's Programme in Bioinformatics consists of six study modules:

<b>T420-2</b>	<b>Intermediate Module in Bioinformatics A2</b>	<b>20 cr</b>
<b>T422-3</b>	<b>Advanced Module in Computational Modeling and Data Analysis for Systems Biology A3</b>	<b>20 cr</b>
<b>T421-C/</b>	<b>Special Module in Biology for Bioinformatics C <i>or</i></b>	<b>20 cr</b>
<b>T279-C</b>	<b>Special Module in Computer and Information Science C</b>	
<b>T901-M</b>	<b>Methodological Principles</b>	<b>10 cr</b>
<b>T901-W</b>	<b>Elective Studies</b>	<b>20 cr</b>
<b>T901-D</b>	<b>Master's Thesis</b>	<b>30 cr</b>

The courses in the study modules are listed below, the non-Aalto course codes are the course codes of the University of Helsinki.

### **T420-2 Intermediate Module in Bioinformatics A2 (20 cr)**

**Professors in charge (Aalto):** Prof. Rousu, prof. Lähdesmäki, and prof. S. Kaski

**Description of the module:** The module contains bioinformatics courses in the Aalto University and the University of Helsinki. The aim of the module is to introduce the student to the key research questions and methods in bioinformatics.

Code	Course	Cr	Period
57748	Genetic analysis and molecular evolution	4-6	I
T-61.5120	Computational Genomics	4-7	
Choose from the updated list on the web to get the total of 20 cr. The following courses are recommended:			
582670	Algorithms for bioinformatics Special	4	IV
T-61.6070	Course in Bioinformatics I Phylogenetic	3-10	
57729	Inference and Data-Analysis Seminar	4-10	
5831XXX	Total	3	
		20	

**T422-3 Advanced Module in Computational Modeling and Data Analysis for Systems Biology A3 (20 cr)**

**Professors in charge (Aalto):** Prof. Rousu, prof. Lähdesmäki, and prof. S. Kaski

**Description of the module:** The module consists of advanced studies in bioinformatics. The aim of the module is to provide an advanced understanding of the computational, modeling, and data mining methods for understanding biological and medical systems, analyzing large datasets measured from them, and solving biomedical problems.

Code	Course	Cr	Period
<b>At least 10 cr from the following:</b>			
T-61.3050	Machine Learning: Basic Principles	5	I
T-61.5050	High-Throughput Bioinformatics	5	III-IV
T-61.5110	Modelling Biological Networks	5	II
<b>Choose from the following list to get the total 20 cr:</b>			
T-61.5140	Machine Learning: Advanced Probabilistic Methods	5	III-IV
T-61.5010	Information Visualization	5	III
T-61.6070	Special Course in Bioinformatics I	3-10	IV
T-61.6080	Special Course in Bioinformatics II	3-10	I-II
T-61.60xx	Special Course in Computer and Information Science I-VI	3-10	
<b>Total</b>		<b>20</b>	

**T421-C Special Module in Biology for Bioinformatics C (20 cr)**

**Professors in charge (Aalto):** Prof. Rousu, prof. Lähdesmäki, and prof. S. Kaski

**Description of the module:** The module consists of biological courses tailored to provide the necessary biological background for studying bioinformatics. The courses are given at the University of Helsinki. The aim of the module is to provide an understanding of the current research questions in biology and to offer a hands-on experience in studying those questions.

Code	Course	Cr
<b>Recommended courses:</b>		
399672	Biology for Methodological Scientists, modules I-IV	8
399673	Measurement Techniques for Bioinformatics	6
<b>Choose from the updated list on the web to get the total of 20 cr. The following courses are recommended:</b>		
52714	Human Genetics	3
52912	Genomes	3

529014	Epigenetics		3
		<b>Total</b>	<b>20</b>

### **T279-C Special Module in Computer and Information Science C (20 cr)**

Content to be agreed individually with the professors in charge.

### **Methodological Principles (10 cr)**

To complete 10 credits, select courses from the common methodological studies list.

### **Elective studies (20 cr)**

Code	Course	Cr	Period
<b>Compulsory courses:</b>			
Kie-98.xxxx/ LC-xxxx	Foreign language courses*	3	I-II
*Any language courses that fulfill the requirements for obligatory foreign language courses: a total of 3 ECTS credits including both oral and written skills.			
<b>Select any Aalto courses to complete 20 credits for the Elective studies module. The following courses are recommended:</b>			
Kie-98.7011	Finnish 1A	2	
Kie-98.7012	Finnish 1B	2	
	<b>Total</b>	<b>20</b>	

### **T901-D Master's thesis D (30 cr)**

The Master's thesis is the final thesis done independently by the student for the MSc degree. The extent of the thesis is 30 credits. In the Master's Programme in Bioinformatics, the Master's thesis is written during the second year of studies.

In addition to the written thesis, students are expected to complete maturity test and give their Master's thesis presentation.



## 6.6 Master's Programme in ICT Innovation

### Degree Programme in Computer Science and Engineering

**Degree:** Master of Science in Technology – M.Sc. (Tech) 120 ECTS

**Majors:** Digital Media Technology (SCI3023)  
Distributed Systems and Services (SCI3021)  
Embedded Systems (SCI3024)  
Human-Computer Interaction and Design (SCI3020)  
Service Design and Engineering (SCI3022)

**Minor:** Innovation and Entrepreneurship Minor (SCI3100)

**EIT ICT Labs Master School** <http://eitictlabs.masterschool.eu/>

**EIT ICT Labs co-location centre, Helsinki Node, visiting address:** Otaniementie 19 B, Espoo <http://eit.ictlabs.eu/ict-labs/nodes-co-location-centres/helsinki/>

**Programme website at Aalto** <https://into.aalto.fi/display/eneitictinno/>

**Study Coordinator:** Aino Lyytikäinen

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). Backed by the ICT Labs of the European Institute of Innovation and Technology (EIT), students who study during the programme at Aalto University will receive a double degree from both Aalto University and one of the partner universities. Within the ICT Innovation programme, Aalto University offers five tracks in different fields of innovation.

### **Admission criteria**

A degree equivalent to a Bachelors degree of 180 ECTS credits. Please note that 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 <http://eitictlabs.masterschool.eu/>.

### **Mobility of Students**

The programme features mandatory mobility of students including a mentoring programme and internships at one of EIT ICT Labs partner organisations. A joint curriculum is defined for the programme and it involves always two universities. The first year home university is called entry point where students follow a first-year curriculum and I&E courses. The second year host university is called exit point. For the second year the exit point partners will provide a particular specialisation with a number of specialisation courses.

### **The Master's Programme in ICT Innovation (120 ECTS) consists of following studies:**

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

### **Innovation & Entrepreneurship Minor (30 ECTS)**

T470-3 Innovation & Entrepreneurship Minor

The Aalto I&E minor 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 first year 2013-2014 and summer 2014:**

CSE-E4751 Introduction to IT Business and Venturing 2 ECTS T-128.2500 Management of Software Venture 3-8 ECTS

T-128.5780 Individual Study in Software Business (BDL) 2 ECTS T-106.5750 Aalto Service Camp (BDL) 6 ECTS

T-106.5320 ICT Innovation Summer School 4 ECTS

**Select one of the following I&E courses:**

CSE-E5753 Technology Entrepreneurship Seminar 4 ECTS

CSE-E5754 Growth and Internationalization of Technology SMEs 4 ECTS

**Compulsory I&E course during the second year 2013-2014:**

T-106.5330 ICT Innovation I&E Minor Thesis 6 ECTS

**Partner universities:**

AALTO:	Aalto University School of Science, Espoo Finland
BME:	Budapest University of Technology and Economics, Budapest Hungary
UCL:	University College London, London UK
ELTE:	Eötvös Loránd University, Budapest Hungary
KTH:	Royal Institute of Technology, Stockholm Sweden
TU Berlin:	Technische Universität Berlin, Berlin Germany
TU Delft:	Delft University of Technology, Delft The Netherlands
TU/e:	University of Twente, Twente The Netherlands
UNITN:	University of Trento, Trento Italy
U of Turku:	University of Turku, Turku Finland
UPS:	Université Paris-Sud, Paris France
U Rennes 1:	University of Rennes 1, Rennes France
Åbo Akademi	Åbo Akademi University, Turku Finland

Further information on curriculum at partner universities during the first and the second year of studies can be found at <http://eitictlabs.masterschool.eu/>.

**1 Digital Media Technology**

<b>Professors of the major:</b>	T-111	Prof. Petri Vuorimaa (on leave of absence)
	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
	T-75	Prof. Pirkko Oittinen

**Entry points:**

AALTO, KTH and TU Delft

**Exit points with specializations:**

AALTO: Hypermedia (not in 2013)  
 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.

**First year at AALTO**

T420-3 Advanced Module in Digital Media Technology

**First autumn 2013****Compulsory courses (28 ECTS)**

ME-C3100 Computer Graphics 5 ECTS  
 S-38.2188 Communication Networks 5 ECTS S-72xxxx Signals and Systems 5 ECTS  
 CSE-E4751 Introduction to IT Business and Venturing 2 ECTS  
 T-128.2500 Management of Software Venture 6 ECTS  
 T-128.5780 Individual Study in Software Business (BDL) 2 ECTS  
 LC-xxxx Foreign language course that fulfills compulsory degree requirement for obligatory foreign language: a total of 3 ECTS including both oral and written skills

**First spring 2014****Compulsory courses (4 ECTS)**

T-111.4360 Design of WWW Services 4 ECTS  
 T-61.5010 Information Visualization 5 ECTS  
 -106.5750 Aalto Service Camp (BDL) 3-8 ECTS  
 T-106.5320 ICT Innovation Summer School 4 ECTS

**Select one of the following courses:**

CSE-E5753 Technology Entrepreneurship Seminar 4 ECTS  
 CSE-E5754 Growth and Internationalization of Technology SMEs 4 ECTS

Select 7 ECTS of **Elective courses** over two semesters

**Electives (7 ECTS)**

T-61.3050 Machine Learning: Basic Principles 5 ECTS (autumn) S-72.2205 Digital Transmission Methods 4 ECTS (autumn)  
 T-75.5600 Special Assignment in WWW and Knowledge Technology 2-8 ECTS (autumn + spring)

T-106.4300 Web Software Development 4 ECTS (autumn + spring) T-110.5121 Mobile Cloud Computing 5 ECTS (autumn)  
 T-110.5150 Applications and Services in Internet 5 ECTS (autumn) T-121.5300 User Interface Construction 3-4 ECTS (autumn)

Total 60 ECTS

### **Second year at AALTO (not in 2013)**

T423-3 Advanced Module in Hypermedia

## ***2 Distributed Systems and Services***

<b>Professors of the major:</b>	<b>T-110</b>	<b>Prof. Jukka K. Nurminen</b>
	<b>T-110</b>	<b>Prof. Tuomas Aura</b>
	<b>T-110</b>	<b>Prof. Antti Ylä-Jääski</b>
	<b>T-110</b>	<b>Prof. Keijo Heljanko</b>

### **Entry points:**

- AALTO, TU Berlin and U Rennes 1

### **Exit points with specializations:**

- AALTO: Mobile Services
- KTH: Data Intensive Computing
- TU Berlin: Cloud operation
- UPS: Distributed Information Management
- U Rennes 1: Cloud Infrastructures

### **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 that 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**

T430-3 Advanced Module in Distributed Systems and Services

#### **First autumn 2013**

##### **Compulsory courses (31 ECTS)**

T-79.5308 Scalable Cloud Computing 5 ECTS

T-110.5111 Computer Networks II – Advanced Features 5 ECTS T-110.5121 Mobile Cloud Computing 5 ECTS

T-110.6130 Systems Engineering in Data Communications Software 5 ECTS CSE-E4751 Introduction to IT Business and Venturing 2 ECTS

T-128.2500 Management of Software Venture 6 ECTS

LC-xxxx course that fulfills compulsory degree requirement for obligatory foreign language: a total of 3 ECTS including both oral and written skills

#### **First spring 2014**

##### **Compulsory courses (29 ECTS)**

T-110.5140 Network Application Frameworks 5 ECTS

T-110.5241 Network Security 5 ECTS (or T-110.5191 Seminar on Internetworking 5 ECTS in autumn)

T-128.5780 Individual Study in Software Business (BDL) 2 ECTS

T-106.5750 Aalto Service Camp (BDL) 6 ECTS

T-106.5320 ICT Innovation Summer School 4 ECTS

##### **Select one of the following courses:**

CSE-E5753 Technology Entrepreneurship Seminar 4 ECTS

CSE-E5754 Growth and Internationalization of Technology SMEs

Select 3 ECTS of **Elective courses** over two semesters

##### **Electives**

T-79.4302 Parallel and Distributed Systems 5 ECTS (autumn) T-79.5308 Scalable Cloud Computing 5 ECTS (autumn)

T-110.5102 Laboratory Works in Networking and Security 5-10 ECTS (autumn) T-110.5241 Network Security 5 ECTS (autumn)

T-110.5150 Applications and Services in Internet 5 ECTS (autumn)

T-110.6101 Special Assignment in Networking and Security (autumn + spring)

T-110.6120 Special Course in Data Communications Software 2-10 ECTS (autumn + spring)

T-110.6220 Special Course in Network Information Security 2-10 ECTS (autumn + spring)

T-110.5130 Mobile Systems Programming 5 ECTS (spring)

T-110.7111 Internet Technologies for Mobile Computing 4 ECTS (spring)

Total 60 ECTS

### **Second year at AALTO**

#### **AALTO specialization – Mobile Services**

### T434-3 Advanced Module in Mobile Services

Description: 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 2013

##### Compulsory courses (24 ECTS)

T-79.5308 Scalable Cloud Computing 5 ECTS T-110.5121 Mobile Cloud Computing 5 ECTS

T-110.5191 Seminar on Internetworking 5 ECTS or T-110.5241 Network Security 5 ECTS

LC-xxxx course that fulfills compulsory degree requirement for obligatory foreign language: a total of 3 ECTS including both oral and written skills.

##### Elective Courses (6 ECTS)

T-79.4302 Parallel and Distributed Systems 5 ECTS

T-110.5102 Laboratory Works in Networking and Security 5-10 ECTS T-110.5241 Network Security 5 ECTS

T-110-5150 Applications and Services in Internet 5 ECTS T-110.5130 Mobile Systems Programming 5 ECTS

T-110.7111 Internet Technologies for Mobile Computing 2-10 ECTS

T-110.6000 Internet and Computing Forum 2 ECTS

Total 30 ECTS

#### Second spring 2014

Master's thesis 30 ECTS

Total 60 ECTS

### 3 Embedded Systems

Professors 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
- AALTO: Mobile Cyber-Physical Systems
- TU Berlin: Embedded Multicore Processing
- UNITN: Real-Time Embedded Systems
- TU/e: Embedded Networking
- Åbo Akademi and U. of Turku: 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**

T440-3 Advanced Module in Mobile Cyber-Physical Systems

#### **Second autumn 2013**

##### **Compulsory courses**

CSE-C3210 Web Software Development 5 ECTS

T-106.5840 Seminar on embedded systems 3-10 ECTS T-106.5740 Embedded systems project 5-10 ECTS

T-106.5330 ICT Innovation I&E Minor Thesis 6 ECTS

LC-xxxx Foreign language course that fulfills compulsory degree requirement for obligatory foreign language: a total of 3 ECTS including both oral and written skills

##### **Elective courses**

T-61.5100 Digital Image Processing 5 ECTS S-89.5150 Speech Recognition 5 ECTS

T-111.5350 Multimedia programming 4 ECTS

T-121.5300 User Interface Construction 3-4 ECTS

Total 30 ECTS

#### **Second spring 2014**

Master's thesis 30 ECTS

Total 60 ECTS

### ***4 Human-Computer Interaction and Design***

<b>Professors of the major:</b>	<b>T-121</b>	<b>Prof. Marko Nieminen</b>
	<b>T-111</b>	<b>Prof. Tapio Takala</b>
	<b>T-61</b>	<b>Prof. Samuel Kaski</b>
<b>Academic coordinator:</b>		<b>Mika P. Nieminen</b>

##### **Entry points:**

- AALTO, KTH and Université Paris-Sud

##### **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
- TU/e: Intelligent systems
- UCL: Cognitive interaction

### **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**

T450-3 Advanced Module in Human-Computer Interaction and Design

#### **First autumn 2013**

<b>Compulsory courses</b>		<b>ECTS</b>
LC-xxxx	Compulsory Language Course(s)*	3
T-61.3050	Machine Learning: Basic Principles	5
T-121.5151	Methods for User-centred Product Development	3
T-121.5300	User Interface Construction	3
ME-E4200	Experimental User Interfaces**	5
CSE-E4751	Introduction to IT Business and Venturing	2
T-128.2500	Management of a Software Venture	6
Total		27

\*LC-xxxx Foreign language course that fulfills compulsory degree requirement for obligatory foreign language: a total of 3 ECTS including both oral and written skills.

\*\* Either in autumn on spring semester.



**First spring 2014**

<b>Compulsory courses</b>		<b>ECTS</b>
T-121.5350	Strategic User-Centred Design	9
T-121.5450	Interaction Design and Evaluation	8
T-128.5780	Individual Study in Software Business (BDL)	2
T-106.5750	Aalto Service Camp (BDL)	6
T-106.5320	ICT Innovation Summer School	4
<b>Select one of the following courses:</b>		
CSE-E5753	Technology Entrepreneurship Seminar	4
CSE-E5754	Growth and Internationalization of Technology SMEs	4
Total		33

**Total 60 ECTS****Second year at AALTO****AALTO specialization – User Modeling for advanced human-computer interaction**

T454-3 Advanced Module in User Modeling for Advanced Human-computer Interaction

**Second autumn 2013**

<b>Compulsory courses</b>		<b>ECTS</b>
T-61.3050	Machine Learning: Basic Principles (If basics done in KTH or UPS select more electives)	5
T-61.3040	Statistical Signal Modeling	5
T-106.5330	ICT Innovation I&E Minor Thesis	6
LC-xxxx	Compulsory Language Course(s)	3*
Total		19

\*LC-xxxx Foreign language course that fulfills compulsory degree requirement for obligatory foreign language: a total of 3 ECTS including both oral and written skills

**Select 11 ECTS of elective courses.**

<b>Elective courses</b>		<b>ECTS</b>
T-61.5100	Digital Image Processing	5
T-61.5130	Machine Learning and Neural Networks	5
S-89.5150	Speech Recognition	5
T-61.6090	Special Course in Language Technology	5
T-121.5850	Individual Course on Usability	1

ME-E4200	Experimental User Interfaces	5
Total		30

**Second spring 2014**  
Master's thesis 30 ECTS

**Total 60 ECTS**

### ***5 Service Design and Engineering***

**Professors of the major: Prof. Heikki Saikkonen (T-106)**  
**Academic coordinator: Håkan Mitts**

#### **Entry points:**

- AALTO and TU/e

#### **Exit points and specializations:**

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

At Aalto, the EIT SDE and the home SDE program will run in parallel. In this way student in both programs will benefit from maximum exposure from to each other and will be encouraged to co-operate across program boundaries.

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 2013-2014 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**

T234-3 Advanced Module in Service Design and Engineering

#### **First autumn 2013**

##### **Compulsory courses**

TU-22.1309 Aalto Introduction to Services 2 ECTS  
T-86.5141 Enterprise Architectures 4 ECTS  
T-86.5310 ICT Enabled Service Business and Innovation 5 ECTS  
CSE-C3210 Web Software Development 5 ECTS  
CSE-E4751 Introduction to IT Business and Venturing 2 ECTS  
T-128.2500 Management of Software Venture 6 ECTS

LC-xxxx Foreign language course that fulfills compulsory degree requirement for obligatory foreign language: a total of 3 ECTS including both oral and written skills\*

Select 4 ECTS of **Elective courses** over two semesters.

### **First spring 2014**

#### **Compulsory courses**

T-76.5612 Software Project Management 3 ECTS

T-61.5010 Information visualization 5 ECTS

T-76.5150 Software Architectures 5 ECTS

T-128.5780 Individual Study in Software Business 2 ECTS (BDL) T-106.5750 Aalto Service Camp 6 ECTS (BDL)

T-106.5320 ICT Innovation Summer School 4 ECTS

#### **Select one of the following courses:**

CSE-E5753 Technology Entrepreneurship Seminar 4 ECTS

CSE-E5754 Growth and Internationalization of Technology SMEs 4 ECTS

Alternatively select courses for at least 4 ECTS from the Aalto Ventures Programme courses in the category 2 Knowledge & Skills (see <http://avp.aalto.fi/teaching/aalto-ventures-program-minor/> for a full listing of the eligible courses)

#### **Elective courses**

T-106.5261 Master's Studio in Service Design and Engineering 5-10 ECTS (autumn) All courses offered by the Aalto Venture Program

Other relevant courses on agreement with the academic coordinator.

### **Total 60 ECTS**

### **Second year at AALTO**

#### **AALTO specialization – Mobile Service Systems**

T460-3 Advanced Module in 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 2014**

#### **Compulsory courses**

LC-xxxx Foreign language course 3 ECTS\*

T-106.5330 ICT Innovation I&E Thesis P 6 ECTS

CSE-E6250 Digital Service Design, Course with Varying Content 1-10 ECTS (service design methods)\*\*

**Recommended courses (Mobile/Smart Spaces)**

T-110.5121 Mobile Cloud Computing 5 ECTS

CSE-E6250 Digital Service Design, Course with Varying Content 1-10 ECTS (smart spaces)\*\*

**Elective courses**

As agreed in personal study plan to fulfill credit requirement

\* The students will be informed of the exact course at the beginning of the Fall semester.

\*\*course with varying content, details available at the beginning of the Fall term

Total 30 ECTS

**Second spring 2015**

Master's thesis 30 ECTS

Total 60 ECTS

## 6.7 Methodological Studies

A student must include 10 credits of methodological studies in his/her degree. The purpose of the Methodological Principles module (10 cr) is to support writing one's Master's thesis. Below is a list of recommended methodological studies in Degree Programme in Computer Science and Engineering. Please check Programme specific instructions from the Master's Programme section.

### T901-M Methodological principles 10 cr

CODE	COURSE	CREDITS	PERIOD
<a href="#">A-36.3326</a>	Tutkimusmetodologia L	5	I-II
<a href="#">AS-74.3114**</a>	Tietokonemallintaminen L	5	III-IV
<a href="#">AS-74.4191**</a>	Monimuuttujaregression menetelmät L	4	I-II
<a href="#">Kon-0.4710</a>	Suomen teollistumisen historia L	3	III-IV
<a href="#">Kon-0.4720</a>	Tekniikan tutkimuksen ja opetuksen historia L	3	III-IV
<a href="#">Kon-0.4730</a>	Tekniikan kulttuurihistoria L	3	III-IV
<a href="#">Kon-41.4005**</a>	Kokeelliset menetelmät	5	III-IV
MS-A0401/2/9	Diskreetin matematiikan perusteet	5	III-IV
<a href="#">Mat-2.2105</a>	Optimoinnin perusteet	3	III-IV
<a href="#">Mat-2.3170</a>	Simulointi L	5	III-IV
<a href="#">Mat-1.3015**</a>	Tieteen filosofia I & II L	5	I-II
<a href="#">Mat-1.3016**</a>	Tieteen historia I & II L	5	I-II
<a href="#">Mat-1.3621**</a>	Tilastollinen päättely L	5	I-II
<a href="#">Mat-2.1197</a>	Filosofia ja systeemiajattelu L V*	3	III-IV
<a href="#">Mat-2.2103</a>	Koesuunnittelu ja tilastolliset mallit	5	III-IV
MS-C2104	Tilastollisen analyysin perusteet	5	III-IV
<a href="#">Mat-2.3117</a>	Riskianalyysi L	5	III-IV
<a href="#">S-38.3184*</a>	Network Traffic Measurements and Analysis P	5	IV
<a href="#">T-61.3040*</a>	Statistical Signal Modeling	5	I-II
<a href="#">T-61.3050*</a>	Machine Learning: Basic Principles	5	I
<a href="#">T-61.5010*</a>	Information Visualization P	5	III
<a href="#">T-76.5050*</a>	Methods for Software Engineering Research P V	3-5	I-II
<a href="#">TU-0.2000*</a>	Industrial Management Research Methods	5	I-II
<a href="#">Kie-98.1320*</a>	Writing for Master's Students	3-5	I-II, III-IV
<a href="#">Kie-98.1330*</a>	Presenting Doctoral Research	3-5	I-II, III-IV
<a href="#">Kie-98.1310*</a>	Introduction to Academic Communication for Master's Programs in English	3	I-II, III-IV
Kie-98.7102	Tieteellinen kirjoittaminen DI - ja arkkitehtiopiskelijoille	3	I, III
<a href="#">Eri-0.6100</a>	Diplomityöntekijän työkalut	3	I, II, III, IV
<a href="#">Vie-98.1226</a>	Väittelytaito	2	I, II, III, IV
<a href="#">T-75.4950</a>	Havaitsemisen kokeellinen tutkiminen	5	III-IV
<a href="#">T-79.4101*</a>	Discrete Models and Search	5	III-IV
<a href="#">T-79.4302*</a>	Parallel and Distributed Systems	5	I-II
<a href="#">T-79.4502*</a>	Cryptography and Data Security	5	I-II
<a href="#">T-79.5103*</a>	Computational Complexity Theory P	5	III-IV
<a href="#">T-106.4000**</a>	Ohjelmistotekniikan laboratoriotyöt	3-8	III-IV
<a href="#">T-106.4100**</a>	Algoritmien suunnittelu ja analyysi	5	II

<a href="#">T-106.5600*</a>	Concurrent Programming L	5	I-II
<a href="#">T-110.6130*</a>	Systems Engineering in Data Communications Software P	2-10	I-II

\* Language of Instruction: English

\*\* Language of Instruction: Primarily Finnish. The assessed work may be completed in English upon request.

**Other courses:**

Språkalliansen <http://www.sprakalliansen.fi/>

Vetenskapligt skrivande (2 sp)

Contact person: Planning Officer Johanna Söderholm, [johanna.soderholm@aalto.fi](mailto:johanna.soderholm@aalto.fi)

## 7. MASTER'S DEGREE PROGRAMME IN SECURITY AND MOBILE COMPUTING (NordSecMob)

**Degree: Master of Science (Technology) 120 ECTS, Security and Mobile Computing**  
**Major: Security and Mobile Computing T3011**

**Professors:** Prof. Antti Ylä-Jääski  
 Prof. Tuomas Aura  
 Prof. Jukka K. Nurminen

**Study coordinator:** Anna Stina Sinisalo

<http://nordsecmob.aalto.fi/>

### **Objectives of the Programme**

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.

NordSecMob - Master's Programme in Security and Mobile Computing is one of the European top-quality Masters Courses selected by the European Commission Erasmus Mundus Programme. Erasmus Mundus, which is a co-operation and mobility programme, both promotes the European Union as a centre of excellence in higher education around the world and supports European top-quality Masters Courses. Erasmus Mundus programmes offer culturally enriching higher education opportunities for both European and Non-European students. Students from any country can apply to the NordSecMob - Master's Programme in Security and

Mobile Computing. Non-European students have the opportunity to apply for the Erasmus Mundus scholarships. The European students selected to the NordSecMob programme can apply for the Erasmus Mundus or Nordplus scholarships for the duration of their studies at the host university. 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.

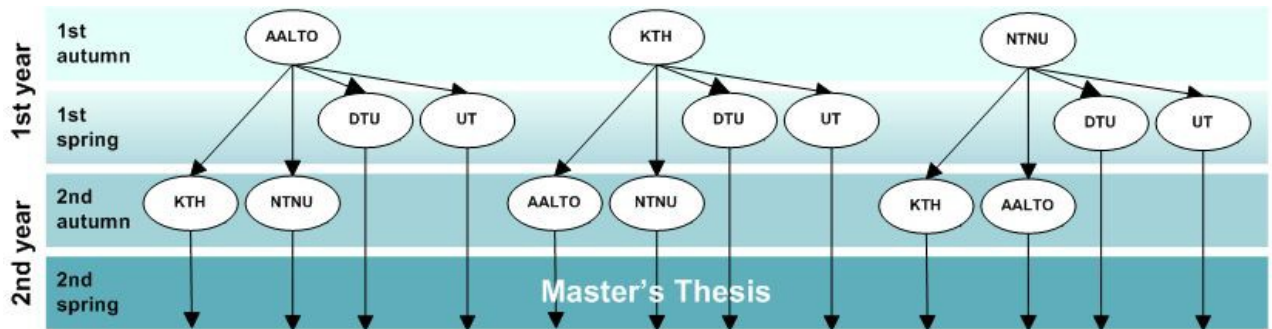
The language of instruction of the programme is English. The applicants must have an excellent command of English. For further information on admission and application deadline, please see <http://nordsecmob.aalto.fi/>.

### **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 specialisation:

- **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).

### **Structure and Content of the Study Programme**

**AALTO: Technical Information Security and Network Services**

**KTH: Communications Systems Design**

**NTNU: Information Security**

**DTU: Reliable Software Systems**

**UT: Mathematical Foundations of Cryptography**

### **AALTO: Technical Information Security and Network Services**

Professors in charge: Professor Antti Ylä-Jääski, Professor Tuomas Aura, Professor Jukka K. Nurminen

T410-3 Advanced Module in Security and Mobile Computing

T411-3 Advanced Module in Security and Mobile Computing

T412-C Special Module in Security and Mobile Computing

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 2013**

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 (23-26 ECTS)**

T-110.4206 Information Security Technology 3 ECTS

T-110.5111 Computer Networks II – Advanced Features 5 ECTS

T-110.5210 Cryptosystems 5 ECTS

T-110.6130 Systems Engineering in Data Communications Software 5 ECTS

T-110.5102 Laboratory Works in Networking and Security 5 ECTS

LC-98.xxxx English course: compulsory degree requirement, both oral and written requirements 3 ECTS

### **Optional courses for the autumn term**

T-110.5241 Network Security (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 31 ECTS (students on DTU/UT track)

Total 28-33 ECTS (students on other tracks)

### **First spring 2014**

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 (17 ECTS)**

T-109.4300 Network Services Business Models 3 ECTS

T-110.5140 Network Application Frameworks 5 ECTS

T-110.5191 Seminar on Internetworking 5 ECTS

T-110.7111 Internet Technologies for Mobile Computing 4 ECTS

**Optional and elective courses for the spring term**

T-110.5130 Mobile Systems Programming 5 ECTS  
 T-110.5220 Information Security and Usability 3 ECTS  
 T-110.6101 Special Assignment in Networking and Security 2-10 ECTS  
 T-110.6000 Internet and Computing Forum 2 ECTS  
 T-110.6120 Special Course in Data Communications Software 2-10 ECTS  
 T-110.6220 Special Course in Network Security 2-10 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 2 ECTS

Total 27-32 ECTS (Total for the whole academic year should add up to 60 ECTS)

**AALTO as host University (second year students)**

**Second autumn 2013**

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 (16-18 ECTS)**

T-110.5111 Computer Networks II – Advanced Features 5 ECTS  
 T-110.5291 Seminar on Network Security 5 ECTS  
 T-110.6130 Systems Engineering in Data Communications Software 3-5 ECTS  
 LC-98.xxxx English course: compulsory degree requirement, both oral and written requirements 3 ECTS

**Optional and elective courses**

T-110.5102 Laboratory Works in Networking and Security 5/10 ECTS  
 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  
 T-110.6101 Special Assignment in Networking and Security 2-10 ECTS  
 T-110.6120 Special Course in Data Communications Software 2-10 ECTS  
 T-110.6220 Special Course in Network Security 2-10 ECTS  
 T-79.5308 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

**KTH: Communications Systems Design**

Professor in charge: Markus Hidell

**T200-3 KTH Advanced Module in Security and Mobile Computing / Communications Systems Design****KTH as home university (first year students)****First autumn 2013**

**Focus:** Communication security, including advanced topics in networking and security, theory and laboratory exercises.

During the first semester, students will develop in-depth knowledge in the fundamental areas of communication systems and networks. Students will be able to critically evaluate current and new protocol designs for internetworking, routing, and network security. They will also learn to describe functionality and design principles of network devices and systems, and will be able to design, set up and operate TCP/IP networks and services. Students will also understand the fundamental components and techniques for building secure networks, be able to critically evaluate new and existing protocols for authentication, authorization, and integrity, describe network security threats and attacks, and be able to evaluate and how systems are designed to protect against such attacks.

During this semester, students will also gain theoretical insight and practical skills required to plan, implement, analyse and report a scientific experiment in the area of communication systems.

**Compulsory courses**

IK2215 Advanced Internetworking 7.5 ECTS

II2202 Research Methodology and Scientific Writing 7.5 ECTS

IK2206 Internet Security and Privacy 7.5 ECTS

**Choose one of the following:**

IK1501 Communication Systems 7.5 ECTS or

ID2212 Network Programming with Java 7.5 ECTS or

II2300 Product Realization Processes I 7.5 ECTS

Total 30 ECTS

**First spring 2014**

**Focus:** Advanced operator-related topics, including network management, technology management, mobile services and networks.

The spring semester offers rich opportunities for students to specialize in the area of secure and mobile computing, by selecting a mix of elective courses. Through elective courses, the students will be able to:

- Understand, compare and contrast architectures for mobile and wireless networks, and different types of mobility.
- Design, implement and test applications for small, mobile devices.
- Describe and discuss methods and systems for switched wireless and wired networks.
- Design, configure and manage local area networks (wireless and Ethernet).
- Apply queueing theory methodology for solving practical dimensioning problems for communication systems and networks.

**Compulsory courses**

IK2217 Advanced Internetworking II 7.5 ECTS

**Optional and elective courses**

ID2216 Developing Mobile Applications 7.5 ECTS

IK2555 Wireless and Mobile Network Architectures 7.5 ECTS

IK1611 Dimensioning of Communication Systems 7.5 ECTS

IK2214 Telecom Policy and Regulatory Principles 7.5 ECTS

IK2213 Network Services and Internet-Based Applications 7.5 ECTS

IK2000 Security Architectures for Open Distributed Systems 7.5 ECTS

IK2002 Security in Mobile and Wireless Networks 7.5 ECTS

II2302 Sensor Based Systems 7.5 ECTS

II2500 Product Realization Processes II 7.5 ECTS

IO2654 Optical Networking 7.5 ECTS

IK2200 Communication Systems Design Project 15 ECTS

IK1611 Dimensioning of Communication Systems 7.5 ECTS

ME2062 Technology-Based Entrepreneurship 7.5 ECTS

Total minimum 30 ECTS

**KTH as host university (second year students)****Second autumn 2013**

**Focus:** Problem-oriented, project-driven learning in teams addressing real-life problems in the communication systems area, with external project owners optionally in parallel with business management/creation.

The autumn semester for second year students is devoted to courses that are problem-oriented in nature. In these courses, through work that is self-directed and project-based, students learn to apply skills earned from the first year in order to address real-world problems that come from external project owners. The students learn to analyse and research a problem area, to plan and perform the work as a project team, and to disseminate the results through presentations and exhibitions. The overall goal is that students should acquire the skills to design, build and operate communication applications, services and networks in innovative ways.

**Compulsory courses**

IK2200 Communication Systems Design Project 15 ECTS (Can be substituted by any of IK2207-IK2209)

**Optional and elective courses**

IK2207-09 ICT and Communication Systems Design 15-30 ECTS

IK2554 Practical Voice Over IP (VoIP) 7.5 ECTS

EP2300 Management of Networks and Networked Systems 7.5 ECTS

ID2212 Network Programming with Java 7.5 ECTS

IK2001 Security in Java environments and Electronic Commerce 7.5 ECTS

IK2207 Communication Systems Design Project 18 ECTS

IK2208 Communication Systems Design Project 24 ECTS

IK2209 Communication Systems Design Project 30 ECTS

IK2510 Wireless Networks 7.5 ECTS

IK2219 Performance Evaluation for Network Engineering 7.5 ECTS

IK2514 Wireless infrastructure deployment & economics 7.5 ECTS  
 IK2511 Project in Wireless Networks 7.5 ECTS  
 EP2400 Network Algorithms 7.5 ECTS  
 IS2500 RFID Systems 7.5 ECTS

Total minimum 30 ECTS

### **NTNU: Information Security**

Professor in charge: Danilo Gligoroski

## **T100-3 NTNU Advanced Module in Security and Mobile Computing / Information Security**

### **NTNU as home university (first year students)**

#### **First autumn 2013**

**Focus:** Basic networking courses, dependability, performance and simulation, basic cryptography.

Students will gain basic knowledge in classical cryptography and public key cryptography. They will also learn about fundamental and necessary components, functions and principles needed to build mobile and fixed access and transport networks. Additionally they will learn the principles on software security and how to develop more secure software systems. Via concrete examples taken from computing and communication (ICT) systems the students will gain knowledge how to perform discrete event simulation, and how to use the probability theory and Markov models as tools for modeling, analysis, measurements and dimensioning of computing and communication systems with respect to dependability and performance. They will also gain a clear understanding of the various mechanisms used in the Internet protocols, their strengths and weaknesses, and possible alternatives. They will be able to engineer small networks including configuration of the network nodes and to do performance measurements and Internet traffic analysis.

TTM4110 Dependability and Performance with Discrete Event Simulation 7.5 ECTS  
 TTM 4150 Internet Network Architecture 7.5 ECTS  
 TMA4155 Cryptography, Introduction 7.5 ECTS

#### **Electives (7.5 ECTS)**

TTM4105 Access and Transport Networks 7.5 ECTS  
 TDT4237 Software Security 7.5 ECTS

Total minimum 30 ECTS

Norwegian Course (offered for NSM students if there are available places in the course)

#### **First spring 2014**

**Focus:** Communication security, including basic topics in networking and security, theory and laboratory exercises and topics on technology management, business management/creation, mobility and mobility management.

The students will deepen their knowledge and will get practical skills in information security technologies. Depending of their choice of courses, students will gain knowledge of methodology for engineering distributed real-time systems, a basic knowledge of ASN.1, CCS, UML,

MSC and SDL, and will be able to specify and simulate systems using these languages and corresponding tools.

The students will get the ability to design and manage systems, based on information and communication technologies (ICT), to meet availability, reliability and safety requirements. Furthermore, they will get a firm conceptual insight into important dependability aspects of hardware, software and networks as well as knowledge for management of network resources and services in communication networks. (i.e. installation, deployment, adaptation, operation and removal/de-installation).

The student will get knowledge about the different functions required to establish a multimedia phone call/session with mobility and with personal context dependent behaviors and how they are realized in PSTN, IN, GSM, and IMS, incl. using SIP.

The students will also get knowledge on the logical separation between signaling network and transport network (control plane and user plane) and on how mobility can be handled at different layers.

TTM4135 Information Security 7,5 ECTS

**Electives (22,5 ECTS):**

TTM4115 Engineering of Distributed Real time systems 7.5 ECTS

TM4120 Dependable Systems 7.5 ECTS

TTM4128 Network and Service Management 7.5 ECTS

TTM4130 Service Intelligence and Mobility 7.5 ECTS

Total minimum 30 ECTS

**NTNU as host university (second year students)**

**Second autumn 2013**

**Focus:** Advanced topics in networking and security with a minor thesis on a specialization topic, security management.

The students will gain knowledge of, and best practice skills for information security technology and methods in distributed systems providing services for mobile users and users of wireless networks. They will learn how to acquire specialized knowledge in a specific area of information security by applying scientific methods for gaining knowledge of principles, methods, protocols, algorithms and contemporary tools for securing information in distributed systems and telecommunication networks. The students will also learn how to work independently with a project, present a project plan with milestones, report partial results on a regular basis, and write a project report in accordance with accepted standards. Students will get a specialized knowledge about problems and solutions relevant for the information security area.

TTM4531 Networks and services – Information Security, Specialization Project 15 ECTS

TTM4536 Networks and services – Information Security, Specialization Course 7,5 ECTS

TTM4137 Wireless Security 7,5 ECTS

Total 30 ECTS

**DTU: Reliable Software Systems**

Professor in charge: Flemming Stassen

### **T301-3 DTU Advanced Module in Security and Mobile Computing / Reliable Software Systems**

At DTU, the focus is on Safe and Secure IT-Systems: - methods, tools and techniques for design, implementation, and validation of safe and secure IT-systems, - covering Network Technology (privacy and intrusion detection) as well as Language Based Technology (program analysis, operational semantics, process calculi, and software validation).

The DTU study programme consists of the following elements:

- \* Mandatory courses corresponding to 22.5 ECTS
- \* Optional courses corresponding to at least 22.5 ECTS
- \* Electives corresponding to at most 15 ECTS

#### **DTU as host university (first year students)**

##### **First spring 2014**

Students work on specialized aspects of security and mobility, and deepen their knowledge of both theoretic foundations and practical approaches. They enhance their skills of how to model and analyse systems, and learn how to critically judge both existing techniques as well as new ones. Students gain the ability to engineer and manage robust and safe systems using these techniques, and are enabled to analyse system requirements, and to argue why a system fulfills these. Furthermore, they gain deep understanding of how a mobile application operates in a network system, and how this influences the overall system.

##### **Mandatory**

02244 Language Based Security 7,5 ECTS

02241 Robust Software Systems 5 ECTS

##### **Optionals**

01405 Error-Correcting Codes I 5 ECTS

02220 Distributed Systems 10 ECTS

02141 Computer Science Modeling 10 ECTS

02142 Semantics and Inference Systems 5 ECTS

02224 Real-Time Systems 7,5 ECTS

02233 Network Security 5 ECTS

02238 Biometric Systems 5 ECTS (June)

#### **DTU as host university (second year students)**

##### **Second autumn 2013**

The students gain knowledge of theoretical foundations of modeling and analysing security and robustness properties of information systems. Students acquire specialized skills in security and mobility, learn how to analyse a given problem and to select the right approach. The problems come from fundamental areas for security of mobile information systems, guaranteeing a broad understanding of the problem facets. Often, a combination of theoretical foundations and practical solutions is required for solving the problems. The students learn how to reach a goal as part of a group, how to organize a group in order to do so, and how to communicate project work and results in form of reports or articles.



**Mandatory**

02242 Program Analysis 7.5 ECTS

02298 Analysis Techniques 2.5 ECTS

**Optionals**

01426 Cryptology II 5 ECTS

02156 Formal Logical Systems 5 ECTS

02232 Applied Cryptography 5 ECTS

02267 Software Development of Web Services 5 ECTS

Free choice of courses from DTU study handbook, up to 15 ECTS

**Note:**

a) Courses 02141 and 02142 are mutually exclusive alternatives.

b) Course 01400 is not applicable with previous course 01257.

**UT: Mathematical Foundations of Cryptography**

Professor in charge: Dominique Unruh

**T400-3 UT Advanced Module in Security and Mobile Computing / Mathematical Foundations of Cryptography**

The focus of the studies at Tartu is on strong theoretical foundations on cryptography, and on the construction and analysis of secure protocols. The electives allow a deeper study of related mathematical subjects, or possible application areas of security in computer science and IT.

**UT as host university (first year students)****First spring 2014**

Through the courses given at UT, students will comprehend the mathematical and complexity-theoretical foundations of secret- and public-key cryptography, as well as the meaning of security and analysis methods for cryptographic protocols. Students acquire knowledge of the foundations of complexity theory, the construction, working and attack principles of the most important contemporary and historic cryptographic algorithms and protocols, different security goals of protocols and primitives and relationships between them, the principles of reducing the security of one construction to the security of another one. The graduates will be able to recall that knowledge in a mathematically rigorous manner. They will also be able to recognize whether an argument provides a proof that a system satisfies some security property.

**Compulsory (15 ECTS)**

MTAT.07.025 Topics of mathematics in cryptology 3 ECTS

MTAT.07.002 Cryptology I 6 ECTS

MTAT.07.017 Applied cryptography 6 ECTS

**Elective and guided choice courses (15 ECTS, see below)**

Total 30 ECTS

**UT as host university (second year students)****Second autumn 2014**

During the semester in UT, the student will get to know the mathematical foundations of secret- and public-key cryptography, as well as the meaning of security and analysis methods for cryptographic protocols. The knowledge can be applied to argue about the security or insecurity of

existing cryptographic primitives and protocols, as well as to design new protocols or to propose new primitives that are at least as secure as some existing ones.

**Compulsory (15 ECTS):**

MTAT.07.014 Cryptographic protocols 6 ECTS

MTAT.07.004 Complexity theory 6 ECTS

MTAT.07.019 Research Seminar in Cryptography 3 ECTS

**Elective and guided choice courses (15 ECTS, see below)**

Total 30 ECTS

**List of electives for the spring and autumn:**

MTAT.03.238 Advanced Algorithmics 6 ECTS (spring)

MTAT.08.011 Basics of Grid and Cloud Computing 6 ECTS (spring)

MTAT.07.015 Secure Programming Techniques 3 ECTS (spring)

MTAT.07.016 Secure Programming Techniques -- project work 3 ECTS (spring)

MTAT.03.247 Principles of Secure Software Design -- project work 3 ECTS (spring)

MTAT.03.246 Principles of Secure Software Design 3 ECTS (spring)

MTAT.05.080 Graphs 6 ECTS (not every year) (spring)

MTAT.05.082 Introduction to Coding Theory (spring, 6 ECTS)

MTAT.07.019 Research Seminar in Cryptography 3 ECTS (autumn, spring)

MTAT.07.020 Special Assignment in Cryptography 3 ECTS (autumn, spring)

MTAT.07.003 Cryptology II 6 ECTS (autumn)

MTAT.08.009 Distributed Systems 6 ECTS (autumn)

MTAT.08.022 Concurrent Programming Languages 6 ECTS (autumn)

MTAT.05.005 Combinatorics 6 ECTS (not every year) (autumn)

MTAT.03.183 Data Mining 6 ECTS (autumn)

MTAT.03.190 Text Algorithms (not every year) 6 ECTS (autumn)

MTAT.03.229 Enterprise System Integration 6 ECTS (autumn)

MTAT.08.010 Scientific Computing (not every year) 6 ECTS (autumn)

MTAT.08.020 Parallel Computing 6 ECTS (autumn)

MTAT.07.024 Quantum Cryptography (6 ECTS) (not every year) (autumn)

MTAT.05.117 Randomness in Computer Science (autumn, 6 ECTS)

MTAT.03.286 Advanced Methods in Algorithms (autumn, 6 ECTS)

MTAT.05.103 Logic Programming (not every year) 6 ECTS (autumn, in Estonian)

One at least master-level seminar of some other research group at Dept. of Math and CS 3 ECTS

FLKE.03.110 Estonian for Beginners I (For International Students, Based on English), Level 0 > A1, 6 ECTS

Guided choice: select 6 ECTS (over two semesters) from any courses offered by the university to be agreed with the local coordinator

Estonian language course - extra, not part of the curriculum.

Total minimum 60 ECTS

## 8. MASTER'S DEGREE PROGRAMME IN COMPUTATIONAL AND SYSTEMS BIOLOGY (euSYSBIO)

**Degree:** Master of Science (Technology), M.Sc. (Tech) 120 credits

**Major:** Computational Systems Biology (IL3013)

**Description:** The aim is to familiarize the student with current research problems in biology systems and medicine, and to provide fundamental knowledge on state-of-art computational methods for analyzing them.

**Professors in charge of the major:**

**T-61 Professor Juho Rousu**

**T-61 Assistant professor Harri**

**Lähdesmäki (on leave of absence)**

**T-61 Professor Samuel Kaski (on leave of absence)**

**Elena Czeizler**

**Academic coordinator:**

<http://www.kth.se/eusysbio>

<https://into.aalto.fi/display/enesb/>

The euSYSBIO Consortium comprises three leading European Technical Universities: KTH-Royal Institute of Technology (Stockholm, Sweden), Aalto University School of Science (Espoo, Finland) and Instituto Superior Técnico (IST), one of the Schools of the Technical University of Lisbon (Lisbon, Portugal).

### **Admission criteria**

A degree equivalent to a Bachelors degree of 180 ECTS credits, with credits in the following subjects: multivariate calculus, linear algebra and computer science including programming. 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 <http://www.kth.se/eusysbio>.

### **Objectives of the Programme**

Systems biology is defined as the study of the interactions between the components of a biological system, and how these interactions give rise to the function and behavior of that system. Thus, by definition, systems biology is a highly interdisciplinary field that necessarily needs expertise from biology, biotechnology, and statistical and computational modeling. The aim of euSYSBIO programme is to train professionals who can cope with the expected future demands of a systems biology specialist. Due to the rapid progress within the field, learning to use the current tools and methods for handling data in bioinformatics applications is not yet enough. New measurement techniques are being developed, giving rise to new forms of data, with ever-increasing quantities. The euSYSBIO programme gives the students a solid background in methodological sciences and hands-on experience in modern measurement technologies, thus providing the students the means for handling large quantities of data and using the information to make valid biological hypotheses, and then to functionally test them.

euSYSBIO - Master's Degree Programme in Computational and Systems Biology at Aalto University consists of the following study modules:

**T633-3 Advanced Module in Computational Methods for Systems Biology A3**

**T634-3 Advanced Module in Machine Learning for Systems Biology A3**

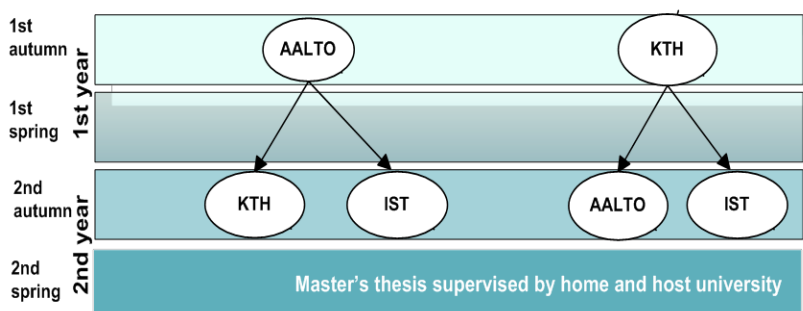
**T421-C Special Module in Biology for Bioinformatics C**

**T901-M Methodological Principles****T901-W Elective studies****T901-D Master's thesis**

Courses taken at partner university (KTH, IST) will be regrouped in the following modules:

**T635-3 KTH Advanced Module in Computational and Systems Biology****T636-3 IST Advanced module in Bioinformatics and Systems Biology****Curriculum**

The euSYSBIO is a two-year programme organized jointly with three European universities. The euSYSBIO programme offers two first-year entry points, one in KTH Royal Institute of Technology (Stockholm, Sweden) and one in Aalto University School of Science (Aalto) Helsinki, Finland.



Both first-year courses have a methodological focus, and are organized by departments of computer and information science at the respective university. The euSYSBIO programme currently offers three second-year courses, one each from KTH and Aalto, and one from IST Instituto Superior Técnico (Lisbon, Portugal). The second-year courses are focused on application areas where the respective universities are particularly strong in research, and include a half-year master degree project. The curriculum offered by KTH is based on KTH's existing International Master's programme, and key new courses contributed by KTH School of Biotechnology. The teaching and supervision of euSYSBIO students at Aalto will be performed at the Aalto, Department of Information and Computer Science, with a special teaching focus on machine learning, statistical modeling and bioinformatics.

Teaching at IST is based on IST's Integrated Master Course Biotechnology (minor in Bioinformatics and Systems Biology). The teaching and supervision of students at IST will be based at the Department of Bioengineering (DBE), with contributions from the Electrical and Computer Engineering and Computer Science Departments, the Institute for Biotechnology and Bioengineering (IBB) at IST, the [Institute for Systems and Computer Engineering \(INESC-ID\)](#) and other Research Institutions of excellence associated to IST. Teaching and Research builds around the fields of Molecular Systems Microbiology, Computational methods in Systems Biology, Biomedical Systems and Biosignals, Biomaterials, Nanobiotechnology and Regenerative Medicine and Biomolecular and Bioprocess Engineering.

Detailed syllabus of all euSYSBIO courses is shown below and will also be available on the euSYSBIO web page at: [www.kth.se/eusysbio](http://www.kth.se/eusysbio)

**First year at Aalto**

**Learning outcome:** The student is familiar with common research problems in biological systems. In interdisciplinary research projects the student will be able to develop and apply modern computational methods in order to solve biological problems.

**Autumn 2013 (33 cr)**

<b>Code</b>	<b>Course</b>	<b>Cr</b>	<b>Period</b>
Becs-114.2510	Computational Systems Biology	5	II
T-61.5120	Computational Genomics	5	I
T-61.5110	Modelling Biological networks	5	II
T-61.3050	Machine learning: Basic Principles	5	I
T-61.6080	Special course in Bioinformatics II	5	I-II
399672*	Biology for Methodological Scientists, module II	2	II
399673*	Measurement Techniques for Bioinformatics, modules I - III	3	
Kie-98.xxxx/ LC-xxxx	English course, compulsory degree requirement, both oral and written requirements	3	I-II
	<b>TOTAL</b>	<b>33</b>	

\*course code with numbers only: the course is organized by University of Helsinki

**Spring 2014 (27cr)**

T-61.5050	High-Throughput Bioinformatics	5	III-IV
T-61.5140	Machine Learning: Advanced Probabilistic Methods	5	III-IV
T-61.5010	Information Visualization	5	III
T-61.6070	Special course in Bioinformatics I	5	IV
399672*	Biology for Methodological Scientists, modules III – IV	4	III-IV
399673*	Measurement Techniques for Bioinformatics, modules IV - VI	3	III-IV
	<b>TOTAL</b>	<b>27</b>	

\*course code with numbers only: the course is organized by University of Helsinki

The scope of first year studies at Aalto is 60 credits. The student will continue the second year studies either at KTH or IST with 30 credits module of courses. Master's thesis (30 cr) is written during the second spring under supervision of both home and host university.

**Second year at Aalto:**  
**Autumn 2013 (30cr)**

<b>Mandatory studies</b>		<b>Cr</b>	<b>Period</b>
T-61.5110	Modelling Biological networks	5	II
T-61.3050	Machine learning: Basic Principles	5	I
T-61.5910	Research Project in Computer and Information Science	5-10	I-II
Kie-98.xxxx/ LC-xxxx	English course, compulsory degree requirement, both oral and written requirements	3	I-II
<b>Elective studies</b>			
T-61.5080	Signal Processing in Neuroinformatics	5	I-II
T-61.6080	Special course in Bioinformatics II	3-7	I-II
T-61.60xx	Special course in Computer and Information Science	3-10	
	<b>TOTAL</b>	<b>30</b>	

**Spring 2014 (30cr)**

Master's thesis is written under supervision of both home and host university.

**EuSYSBIO-curriculum at partner universities****First year at KTH:****Degree: Master of Science (two years) (120 cr)****Degree programme: Systems Biology****T635-3 KTH Advanced Module in Computational and Systems Biology (30/60 cr)****Professor in charge: Professor Erik Aurell and Associate professor Torbjörn Gräslund**

**Description:** The module consists of courses in biology and biotechnology and computations systems biology. The goal of the course is to bring the students to a level where they can perform simple experiments in the lab, design and implement algorithms in bioinformatics and computational neuroscience. The module includes an orientation course on topics of current interests in systems biology.

**Autumn 2013 (29,5 cr)**

<b>Code</b>	<b>Course</b>	<b>Cr</b>
SK2530	Introduction to Biomedicine	6
DD2435	Mathematical Modelling of Biological Systems	9
DD2397	Applied Bioinformatics	7,5
BB1110	Gene Technology and Molecular Biology	7
	<b>TOTAL</b>	<b>29,5</b>

**Spring 2014 (30,5 cr)**

DD2398	Quantitative Systems Biology	7,5
DD2399	Omic Data and Systems Biology	7,5
DD2402	Advanced Individual Course in Computational Biology	6,0
BB2160	Structure Biology	7,5
	Throughout the first year: What is life? The future of biology	2
	<b>TOTAL</b>	<b>30,5</b>

**Second year at KTH:**

<b>Code</b>	<b>Course</b>	<b>Cr</b>
<b>Mandatory courses</b>		
BB2290	Molecular Biomedicine	7,5
BB2510	Proteomics	6
<b>Elective courses</b>		
BB2470	Genetics and Genomics	10
DD2380	Artificial Intelligence	6
SF2940	Probability Theory	7,5
SK2520	Experimental Methods in Molecular Biophysics	8
SI2700	Protein Physics	7,5
BB2280	Molecular Modeling	7,5
DD2403	Advanced Individual Course in Computational Biology II	
	Any other suitable course given in Stockholm if approved by the KTH Programme Director	
	<b>TOTAL</b>	<b>30</b>

Master's thesis (30 cr) is written during the second spring under supervision of both home and host university.

### **Second year at IST:**

**Degree: Mestrado em Biotecnologia (Master in Biotechnology)**

**Degree programme: Biotechnology**

**T636-3 IST Advanced module in Bioinformatics and Systems Biology (30 cr)**

**Professor in charge: Professor Isabel Sá Correia**

**Description:** The objective of the second year of studies at IST is to expose the student to advanced experimental techniques and approaches and advanced computational methods used in Systems Biology. The Project in Systems Biology consists essentially of a program of rotations in Research Laboratories of Research Institutions in the IST campus, associated to euSYSBIO (research fields: Omics analyses and Molecular and Integrative Microbiology, Computational Biology, Biomedical Systems and Biosignals, Biomaterials, Nanobiotechnology and Regenerative Medicine and Biomolecular and Bioprocess Engineering).

<b>Course</b>	<b>Cr</b>
<b>Mandatory courses</b>	
Project in Systems Biology	12
<b>Elective courses</b>	
Functional and Comparative Genomics	6
Molecular Biotechnology	6
Molecular and Cellular Microbiology	6
Medicinal Chemistry	6
Neuroimaging	6
Optimization and Algorithms	6
Machine Learning	6
Algorithms for Discrete Structures	6
Nanotechnology	6
Entrepreneurship in Bioengineering	6
Cell and Tissue Engineering	6
Artificial Intelligence and Decision Systems	6
Any course offered at IST, depending on EuSysBio coordination approval	6
<b>TOTAL</b>	<b>30</b>

Master's thesis (30 cr) is written during the second spring under supervision of both home and host university.

## 9. MASTER'S PROGRAMMES IN DEGREE PROGRAMME IN INDUSTRIAL ENGINEERING AND MANAGEMENT

The domain of industrial engineering and management combines technological, economic and organizational knowledge in order to support value-creating processes and successful business. The required degree studies combine engineering and social sciences and, therefore, demand solid knowledge of mathematics and natural sciences. In addition to a major in one of the sub-disciplines of industrial engineering and management, graduates of the degree programme should obtain good knowledge of one engineering discipline. The engineering expertise is founded on Bachelor's studies and refined at the Master's level.

The Aalto University School of Science offers two Master's programmes in the field of Industrial Engineering and Management: Master's Programme in Service Management and Engineering and Master's Programme in Strategy.

### ***9.1 Master's Programme in Service Management and Engineering***

#### **Objectives of the programme**

In modern economies, services are becoming increasingly important. Service elements are added to products, service-based business models are adopted by manufacturers, and new innovative service concepts and systems are emerging and developing rapidly. The Master's Degree Programme in Service Management and Engineering aims at providing the participants with a solid basic knowledge on the key issues of the field. It focuses on service design and production with the help of information and communication technologies. The programme places emphasis on customer involvement and productive assets; its lectures, design and implementation are designed to promote a systemic and interactive view of services.

#### **Major: IL3007 Service Management and Engineering**

**The Master's Programme in Service Management and Engineering consists of six modules:**

1. TU322-2 Intermediate module Service Management and Engineering A2 (20 cr)
2. TU322-3 Advanced Module Service Management and Engineering A3 (20 cr)
3. TU322-C Special Module Industrial Engineering and Management C (20) cr or TU422-C Special Module in Software Engineering and Services C (20 cr) or TU891-C Special Module in Communications Ecosystems C (20 cr). The required module depends on the student's background knowledge.
4. Scientific principles M (10 cr)
5. Elective studies W (20 cr)
6. Master's thesis D (30 cr)

#### **TU322-2 Service Management and Engineering intermediate module A2 (20 cr)**

**Responsible professors: Jan Holmström (in charge) Paul Lillrank, Eero Eloranta, Matti Vartiainen (on leave during fall semester 2013)**

The objective of the intermediate module is to introduce students to the operational side of service delivery, focusing on the different viewpoints in service delivery systems.



Code	Course	Cr
<b>Compulsory courses:</b>		
TU-22.1309	Aalto Introduction to Services L	5
TU-22.1320	Industrial Service Operations L	5
TU-22.1325	Assignment in Industrial Service Operations	2
TU-91.2046	Managing Innovative Sales L	3
TU-22.1330	Service Purchasing and Supply Management	5
	<b>Total</b>	<b>20</b>

### **TU322-3 Service Management and Engineering, advanced module A3 (20 cr)**

**Responsible professors:** Jan Holmström (in charge), Paul Lillrank, Eero Eloranta, Matti Vartiainen (on leave during fall semester 2013)

The objective of the advanced module is for students to become aware of the state of the art in service innovation and development, and to create the ability of analyzing and designing service systems.

Code	Course	Cr
<b>Compulsory courses:</b>		
TU-22.1335	Service Innovation and New Service Development L	5
TU-53.1112	Human Resources in Service Management and Engineering	5
TU-22.1340	Seminar on Service Management and Engineering	5
	Choose of the following:	
TU-22.1426	Advanced Project-based Management A	5
TU-91.2040	Global Strategic Management	5
	<b>Total</b>	<b>20</b>

Students with insufficient background in industrial engineering and management must complete the following upgrade package of 20 credits:

### **TU322-C Special Module in Industrial Engineering and Management C (20 cr)**

**Responsible professors:** Paul Lillrank, Jan Holmström

The objective of this module is to harmonize the background knowledge of students. It also allows enhancement of knowledge of some specific area of industrial management. Therefore the courses are agreed with professor in charge.

The following list is an example of the courses that a student can suggest to upgrade or advance his/her knowledge of industrial management:

Code	Course	Cr
<b>Compulsory courses: Choose one course from each track (leadership, operations, strategy).</b>		
<b>Select the remaining credits freely from the list of courses below.</b>		
Leadership:		
TU-53.1030	Knowledge and Competence Management	3
TU-53.1360	Cross-cultural Management	3
TU-53.1320	Organizations and Networks	4
Operations:		
TU-22.1115	Design of Production Systems B	4
TU-22.1302	Quality Management	3
Strategy:		
TU-91.1011	Principles of Strategic Management	4
TU-91.2103	Opportunity Prototyping	3 5 5
TU-91.2010	Managerial Economics	
TU-91.2011	International Economics	
<b>Total</b>		<b>20</b>

Students with insufficient technical background must complete a technical package of 20 credits. Two options for technical modules are available to choose from:

**TU422-C Special Module in Software Engineering and Services**  
**Responsible professors: Jan Holmström and Matti Hämäläinen**

The objective is to give the student a sufficient engineering background to understand, use, and develop solutions in the domain of service management and engineering.

Code	Course	C r
<b>Compulsory courses:</b>		
T-76.3601	Introduction to Software Engineering	5
T-76.4602	Software Development Methods	6
T-86.5310	ICT Enabled Service Business and Innovation	6
T-110.4206	Information Security Technology	3
OR		
T-76.5615	Requirements Engineering P	3

	<b>Total</b>	<b>20</b>
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**TU891-C Special Module in Communications Ecosystems C (20 cr)**
**Responsible professors: Henri Schildt, Heikki Hämmäinen**

<b>Code</b>	<b>Course</b>	<b>Cr</b>
<b>Compulsory courses:</b>		
S-38.3061	Communications Ecosystems Analysis	<b>5</b>
S-38.3062	Modeling Human Behavior	<b>5</b>
S-38.3001	Telecommunications Forum	<b>5</b>
	OR	
S-38.3041	Operator Business	<b>5</b>
S-72.1130	Telecommunications Systems	<b>5</b>
	<b>Total</b>	<b>20</b>

**TU901-M Scientific principles M (10 cr)**
**Responsible professor: Eero Eloranta**

<b>Code</b>	<b>Course</b>	<b>Cr</b>
<b>Compulsory courses:</b>		
TU-0.2000	Industrial Management Research Methods	5
TU-22.1345	Special Study in Service Management and Engineering	5
	<b>Total</b>	<b>10</b>

**TU901-W Elective studies W (20 cr)**
**Responsible professor: Eero Eloranta**

<b>Code</b>	<b>Course</b>	<b>Cr</b>
<b>Compulsory courses:</b>		
	Foreign language test/course (including both written and oral skills)	3
<b>Recommended:</b>		
T-106.1004	IT-services on Otaniemi Campus	2
	Practical training max.5 cr	
	The following courses familiarize students with central areas of technology employed in support of industrial services and maintenance operations. They give the student requisite skills to apply available technological tools in the design and development of industrial service operations:	

T-61.5010	Information visualization P	5
AS-84.3125	Estimation and Sensor Fusion Methods P	3
S-113.3141	Design for Reliability	5

### **TU901-D Master's thesis D (30 cr)**

## **9.2 Master's Programme in Strategy**

### **Programme objectives**

The goal of the Master's Programme in Strategy is to train and develop experts in the domain of strategic management, apt to thrive and succeed in today's constantly changing and increasingly complex business environment. This requires excellence in management and technology, but also intercultural and interpersonal sensitivities, behaviors, attitudes as well as international connections and networks.

### **Programme learning objectives**

Students having completed the programme will have:

- the ability to independently apply and further develop frameworks, tools and theories in strategic management;
- the ability to undertake strategy work in a global business environment;
- the intercultural, interpersonal sensitivities, behaviors, attitudes as well as international connections and networks required to work and cooperate successfully across professional and cultural boundaries spanning the globe;
- internalized the significance of lifelong learning and personal development with regard to one's future career.

### **The Master's Programme in Strategy consists of six modules:**

1. TU391-3 Advanced Module in Strategic Management A3 (20 cr)
2. TU391-C Special Module in Strategic Management C (20 cr)
3. TU891-C Special Module in Communications Ecosystems C (20 cr) or TU422-C Special Module in Software Engineering and Services (20 cr) or TU791-C Special Module in Management Studies (20 cr). The required module depends on the student's background knowledge.
4. Scientific principles M (10 cr)
5. Elective studies W (20 cr)
6. Master's thesis D (30 cr)

### **Major: TU3006 Strategic Management**

#### **TU391-3 Advanced Module in Strategic Management A3 (20 cr)**

**Responsible professor: Henri Schildt**

**Note:** this module is only offered to students admitted into the Master's Programme in Strategy. The yearly application deadline is in February.

Local students: There is an opportunity for local students enrolled in the industrial engineering and management (IEM) degree programme to apply to participate in the A3 and C modules offered by the Master's Programme in Strategy. In this case, you are considered an IEM degree student majoring in Strategic Management. The number of participants is restricted. For more information, contact DIEM Student Services.

**The objective of this module** is to provide students with an in-depth knowledge of strategy and strategic management. Courses in the A3-module are offered by Aalto University School of Science and Technology. The compulsory course of the module is an advanced course in strategy. Thereafter, students can focus on selected studies within the field of strategic management to reach 20 credits. The second compulsory course relates to developing the students' global leadership talent through a series of seminars and reflective exercises that span the first year of the Master's programme. In addition to improving the students' interpersonal, interaction, intercultural and future leadership skills, the course also serves to bring social cohesion to the programme, by ensuring that participants meet on a regular basis throughout the Master's programme.

**The A3-module's learning objectives are to form students to have:**

- the ability to independently apply and further develop frameworks, tools and theories in strategic management – with a focus on (a) strategy and/or (b) strategy and venturing;
- begun to develop the intercultural, interpersonal sensitivities, behaviours, attitudes as well as international connections and networks required to work and cooperate successfully across professional and cultural boundaries spanning the globe;
- begun to internalize the significance of lifelong learning and personal development with regard to one's future career excellence potential.

Code	Course	Cr
<b>Compulsory courses:</b>		
TU-91.2047	Strategy & Organizations	5
TU-91.2004	Advanced Strategic Management	5
TU-91.2015	Advanced Case-Seminar in Strategy	3-5
<b>Select from the courses below to reach a total of 20 credits:</b>		
TU-91.2138	Strategies for Growth and Renewal	3
TU-91.2040	Global Strategic Management	5
TU-91.2018	Industry Evolution	5
TU-91.2005	Strategic Management of Technology and Innovation	5
TU-91.2041	Research and Development (R&D) Management	2–4
	<b>Total</b>	<b>20</b>

**TU691-C Special Module in Strategic Management C (20 cr)****Professor in charge: Henri Schildt**

The strategy C-module serves to support the advanced A3 strategy module. Courses in this module are mostly offered by Aalto University School of Economics. There are two options available for you to choose from, by either focusing on strategy and marketing management, or focusing on strategy and the new economy. In addition, the course Developing Global Leadership Talent – year II is offered. In this second year of the course, students deepen and further their knowledge of global leadership.

**The C-module's learning objectives are to form students to have:**

- the ability to independently apply and further develop frameworks, tools and theories in strategic management – with a focus on change management and branding;
- the ability to undertake strategy work in a global business environment;
- mature one's intercultural, interpersonal sensitivities, behaviors, attitudes as well as international connections and networks required to work and cooperate successfully across professional and cultural boundaries spanning the globe;
- internalized the significance of lifelong learning and personal development with regard to one's future career.

Code	Course	Cr
<b>Compulsory courses:</b>		
TU-91.2048	Strategy & Leadership	2
<b>Select courses from one of the tracks below to reach a total of 20 credits:</b>		
<b>(1) Global strategy:</b>		
26E03100	Driving global businesses	6
26E03200	Managing in a global context	6
26E01500	International Business Networks*	6
26E03500	Capstone: Global Business Cases	6
<b>(2) Strategy and marketing management:</b>		
23E53000	Brands in Strategic Marketing	6
23E21050	Marketing Strategy and Firm Performance	6
23E52050	Managing Innovative Sales**	6
27E20000	Models in Marketing	6
23E28000	Consumer Culture	6
<b>3) Strategy and organization:</b>		
21E00013	Capstone: Workshop on Innovating management	6
21E00030	Strategy work	6
21E01050	Management and Strategy Making, book exam	6
37E00200	Strategic Management of Information Technology	6
<b>Totalling</b>		<b>20</b>

\* Course is not offered during academic year 2013-2014.

\*\* Alternatively the students can take TU-91.2046 Managing Innovative Sales (6 cr)

**Technical module 20 cr**

Students with a background in industrial engineering and management (or similar) undertake a technical module totaling 20 credits. Two options for technical modules are available to choose from:

**TU891-C Special Module in Communications Ecosystems C (20 cr)**

**Responsible professors: Henri Schildt, Heikki Hämmäinen**

Code	Course	Cr
<b>Compulsory courses:</b>		
S-38.3061	Communications Ecosystems Analysis	5
S-38.3062	Modeling Human Behavior	5
S-38.3001	Telecommunications Forum	5
<b>OR</b>		
S-38.3041	Operator Business	5
S-72.1130	Telecommunications Systems	5
	<b>Total</b>	<b>20</b>

**TU422-C Special Module in Software Engineering and Services**

**Responsible professors: Jan Holmström and Matti Hämäläinen**

**The objective** is to give the student a sufficient engineering background to understand, use, and develop solutions in the domain of service management and engineering.

Code	Course	Cr
<b>Compulsory courses:</b>		
T-76.3601	Introduction to Software Engineering	5
T-76.4602	Software Development Methods	6
T-86.5310	ICT Enabled Service Business and Innovation	6
T-110.4206	Information Security Technology	3
<b>OR</b>		
T-76.5615	Requirements Engineering P	3
	<b>Total</b>	<b>20</b>

**TU791-C Special Module in Management studies (20 cr)**

**Responsible professor: Henri Schildt**

Students with a technical background (a BSc in engineering or technical domains) will not need to undertake a technical module (as above), but are required to undertake a supplementary management module - the management A2-module. This ensures that the students with a technical background gain sufficient grounding in the management discipline to be able to follow the strategy modules C and A3.

Code	Course	Cr
<b>Compulsory courses:</b>		
TU-91.1011	Principles of Strategic Management	4
TU-91.2500	Marketing	3
TU-22.1114	Design of Production Systems B	4
TU-22.1302	Quality Management	3
TU-91.2043	International Economics	3
TU-53.1030	Knowledge and Competence Management	3
	<b>Total</b>	<b>20</b>

### **TU901-M Scientific principles M (10 cr)**

**Responsible professor: Eero Eloranta**

**The objective** of the scientific principles M-module is to familiarize students with the process of conducting empirical research in the field of strategic management.

Code	Course	Cr
<b>Compulsory courses:</b>		
TU-91.2037	Special study in Strategic Management	5
TU-0.2000	Research Methods in Industrial Management	5
	<b>Total</b>	<b>10</b>

### **TU901-W Elective studies W (20 cr)**

**Responsible professor: Eero Eloranta**

Code	Course	Cr
<b>Compulsory courses:</b>		
	Foreign language test/course (including both written and oral skills)	3
<b>Recommended:</b>		
T-106.1004	IT-services on Otaniemi Campus	2
	Practical training max.5 cr	

### **TU901-D Master's thesis D (30 cr)**



## 10. MASTER'S DEGREE PROGRAMME IN INTERNATIONAL DESIGN BUSINESS MANAGEMENT (IDBM)

The IDBM Master's degree is a 120 credit joint offering between the Aalto University School of Art and Design, School of Economics and Schools of Technology. The program is taught completely in English. The first year of studies consists of set of intensive compulsory study modules and requires full time commitment from the students. The second year of studies allows more individual flexibility.

### Objectives

The overarching learning outcome is seen to be achievable through developing systemic and integrative competences within the two-year programme.

The objective is for learners to gain competence in multiple dimensions and on both strategic and operational levels, to develop enhanced abilities in individuals to recognize and acknowledge value in the tools, practices and mental models of other professions. This is seen to be needed in complex development projects and turbulent operational environments. Achieving systemic competence is seen to require a deep understanding of multidisciplinary in the globalised context, together with well-developed abilities in strategic foresight and agile working methods.

### Learning outcomes and competences

#### In terms of knowledge:

1. Individuals must widely understand and be critically able to approach the knowledge that is needed to undertake new business ventures in global environments.
2. This includes having an understanding and best current knowledge of the systemic nature of global issues and the impact of globalisation; of the multidisciplinary nature of responses needed to address these issues; of the need to possess best knowledge projections of the future through foresight; and the need to understand agile and flexible operational practices.
3. They must furthermore master the professional specialized concepts, applications and knowledge linked to their own business, design or technology background that are relevant to global business development.
4. Additionally they must be able to understand the issues related to the creation and application of new knowledge within and in between domains.

#### In terms of skills:

5. Operating independently and in teams, individuals must be able to arrive at successful cross-cutting solutions within complex, ambiguous and demanding problem settings and environments.
6. Furthermore, individuals must be able to create new knowledge and practices, while applying it in multidisciplinary settings.
7. Individuals must be able to execute demanding tasks in expert and entrepreneurial roles, while also being able to develop new strategic and operational approaches in complex and unforeseeable circumstances.
8. Within global business settings, individuals must be able to manage and lead initiatives and other individuals.
9. While demonstrating abilities to accumulate personal expertise and knowledge, the individual must also possess the ability to evaluate the action of self and of teams/groups and be responsible for the professional development of others.
10. The individual must master excellence in written and oral communication skills within and external to the professional sphere.

**The Master's Programme in International Design Business Management consists of six modules:**

1. TU110-2 Intermediate Module in International Design Business Management A2 (20 cr)
2. TU110-3 Advanced Module in International Design Business Management A3 (20 cr)
3. TU110-C Special Module in International Design Business Management (20 cr)
4. Scientific principles M (10 cr)
5. Elective studies W (20 cr)
6. Master's thesis D (30 cr)

**Major: TU3007 International Design Business Management**

**Responsible professors:** Kalevi Ekman, Matti Vartiainen

**TU110-2 Intermediate Module in International Design Business Management A2 (20 cr)**

**Responsible professors:** Kalevi Ekman, Matti Vartiainen

Code	Course	Cr
<b>Compulsory courses:</b>		
26E04200	Theories in IDBM	5
26E01300	IDBM Project	5
TU-22.1510	IDBM Project	5
id0003	IDBM Project	5
	<b>Total</b>	<b>20</b>

**TU110-3 Advanced Module in International Design Business Management A3 (20 cr)**

**Responsible professors:** Matti Vartiainen, Kalevi Ekman

Code	Course	Cr
<b>Compulsory courses:</b>		
Kon-41.4003	Interdisciplinary Product Development	5
TU-22.1500	Innovation and Project Management	5
	Courses in Schools of Technology that develop core competence of the student in his/her original technical field of study (other than industrial engineering and management).	10
	<b>Total</b>	<b>20</b>

**TU110-C Special Module in International Design Business Management (20 cr)**

**Responsible professors:** Matti Vartiainen, Kalevi Ekman

Code	Course	Cr
<b>Compulsory courses:</b>		
id0001	Design Thinking in Business	5
id0002	Designing Open Innovation	5
26E04400	International Design Business Management IDBM	5
26E04300	Business Modelling and Management	5
	<b>Total</b>	<b>20</b>

**TU901-M Methodological Studies (10 credits)**

Mandatory: TU-0.2000 Industrial Management Research Methods (5 cr)

Select 5 credits from the list below:

\* Language of instruction: English

\*\* Language of instruction: Primarily Finnish. The assessed work may be completed in English upon request.

A-60.3000 *	Introduction to Architectural Research (3 cr) P Introduction to Architectural Research (3 cr) P Introduction to Architectural Research (3 cr) P  <i>Course might be replaced with another one for academic year 2013-2014.</i>
AS-74.3114**	Tietokonemallintaminen (5 op) L Datormodellbygge (5 sp) L Computer Modelling (5 cr) P
AS-74.4191**	Monimuuttujaregression menetelmät (4 op) L Regressionsmetoder med flera variabler (4 sp) L Multivariate Regression Methods (4 cr) P
Kon-41.4005**	Kokeelliset menetelmät (5 op) Experimentella metoder (5 sp) Experimental Methods (5 cr)
Mat-1.3015**	Tieteen filosofia I & II (5 op) L Vetenskapens filosofi I & II (5 sp) L Philosophy of Science I & II (5 cr) P
Mat-1.3016**	Tieteen historia I & II (5 op) L Vetenskapshistoria I & II (5 sp) L History of Science I & II (5 cr) P
Mat-1.3621**	Tilastollinen päättely (5 op) L Statistisk slutledning (5 sp) L Statistical Inference (5 cr) P  <i>Course might be replaced with another one for academic year 2013-2014.</i>
Mat-2.2103**	Koesuunnittelu ja tilastolliset mallit (5 op) Försöksplanering och statistiska modeller (5 sp) Design of Experiments and Statistical Models (5 cr)
Mat-2.2104**	Tilastollisen analyysin perusteet (5 op) Grunderna för statistisk analys (5 sp) Introduction to Statistical Inference (5 cr)
Mat-2.3117**	Riskianalyysi (5 op) L Riskanalys (5 sp) L Risk Analysis (5 cr) P

T-61.3040**	Signaalien tilastollinen mallinnus (5 op) Statistisk modellering av signaler (5 sp) Statistical Signal Modelling (5 cr)
T-61.3050*	Machine Learning: Basic Principles (5 cr) Machine Learning: Basic Principles (5 cr) Machine Learning: Basic Principles (5 cr)
T-61.5010*	Information Visualization (5 cr) P Information Visualization (5 cr) P Information Visualization (5 cr) P
T-76.5050*	Methods for Software Engineering Research (3-5 cr) P V Methods for Software Engineering Research (3-5 cr) P V Methods for Software Engineering Research (3-5 cr) P V
TU-0.2000*	Industrial Management Research Methods (5 cr) Industrial Management Research Methods (5 cr) Industrial Management Research Methods (5 cr)
Kie-98.1320*	Writing for Master's Students (3-5 cr)
Kie-98.1330*	Presenting Doctoral Research (3-5 cr)
Kie-98.1310*	Introduction to Academic Communication for Master's Programs in English (3 cr)

### **TU901-W Electives W 20 credits**

**Responsible professor:** Matti Vartiainen

Foreign language studies (written and oral skills, 3 credits) are included in the Electives-module. Practical training can be included in the electives module. The maximum overall amount of credits the student can obtain for all training periods is 4 credits. If the student has done practical training abroad the overall amount of credits can be 6.

### **TU901-D Master's Thesis D 30 credits**

## 11. MASTER'S PROGRAMMES IN DEGREE PROGRAMME IN ENGINEERING PHYSICS AND MATHEMATICS

### *11.1 Master's Programme in Applied and Engineering Mathematics (N5TeAM)*

**Degree:** Master of Science (Technology)

**Degree programme in Engineering Physics and Mathematics** 120 ECTS

**Major:** Applied and Engineering Mathematics (SCI3016)

**Director of the Programme:** Professor Timo Eirola

**Administrative Coordinator:** Anu Kuusela

[www.n5team.aalto.fi](http://www.n5team.aalto.fi)

**Aalto:**

**Department in charge:** Department of Mathematics and Systems Analysis (T3020)

**Professors:** Timo Eirola (Mat-1), Rolf Stenberg (Mat-5)

**Academic coordinator:** Linda Havola

**Study Coordinator:** Anu Kuusela (anu.kuusela@aalto.fi)

N5TeAM is a two-year Master of Science programme (120 ECTS credits). During the programme the students study at two of the five Nordic partner universities: Aalto University in Finland, Chalmers University of Technology in Sweden, the Technical University of Denmark (DTU), the KTH Royal Institute of Technology in Sweden and the Norwegian University of Science and Technology (NTNU).

Each partner acting as a home university (= starting point, University 1) will provide 60 ECTS as first year study package and for the second year students, the host university (University 2) provides a 30 ECTS package of courses and provides the MSc thesis supervision jointly with the student's home university.

The first year studies are divided into core courses (30-40 credits) and key competences (20-30 credits). The core courses provided by the home university (University 1) cover the following areas:

- Scientific computing
- Stochastics
- Analysis
- Discrete mathematics

**The second year specialisations are the following:**

Scientific Computing and Biocomputing (DTU-KTH, NTNU-KTH)

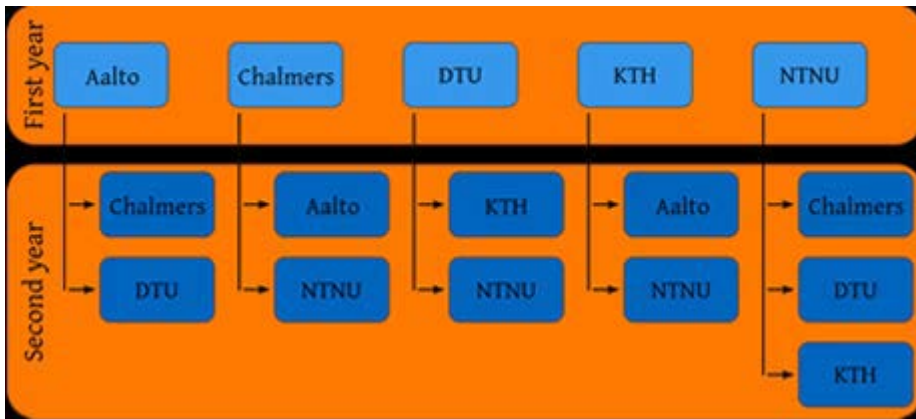
Applied Stochastics and Statistics (Chalmers-NTNU, NTNU-Chalmers)

High Performance and Scientific Computing (KTH-Aalto, Chalmers-Aalto)

Computational Mechanics (Aalto-Chalmers, DTU-NTNU, KTH-NTNU)

Cryptography and Coding Theory (Aalto-DTU, NTNU-DTU)

### Student mobility and study tracks:



### Objectives of the Programme:

The core skills of the graduated students are mathematical modelling of challenging, often multiphysical, problems in engineering and applied science and the ability to choose suitable solution methods and critically evaluate the obtained solutions. To this end the students will be furnished with solid education in mathematics including the theory of ordinary and partial differential equations, probability and statistics, numerical linear algebra, optimization, and discrete mathematics. The students will also achieve qualified knowledge in an area of applied mathematics with active research such as biocomputing, cryptology, stochastics, and computational mechanics and geosciences. Special assignments and thesis work will give experience in research associated with the N5T math departments, their collaborating institutes, and partners in industry. The degree will also give a solid background for PhD studies in applied math and many application fields.

### Learning outcomes:

#### Knowledge and understanding

A master's student with a degree from the N5TeAM programme has:

- qualified and broad knowledge in the field of Applied and Engineering Mathematics including techniques for mathematical modeling, analysis of mathematical models, and simulation
- profound competencies in mathematical and computational disciplines which are applicable in industry, business world, and public administration
- qualified knowledge in a certain area of applied mathematics which comes close to active areas of research and allows for actively taking part in research.

#### Skills and abilities

A master's student with a degree from the N5TeAM programme has the ability to:

- formulate mathematical models, choose suitable methods to investigate these models including the efficient use of computer tools,
- analyze different mathematical models within science and technology and work creatively, systematically and critically
- find strategies for the solution of different types of mathematical models using knowledge about the possibilities and limitations of the different methods and tools,

- communicate effectively with professionals within applied and engineering mathematics as well as with persons working with different scientific-technological applications in an interdisciplinary context,
- communicate effectively with management as well as society at large using written and oral presentations,
- cooperate effectively with colleagues with different cultural backgrounds.

**Ability to make judgements and adopt a standpoint** A master's student with a degree from the N5TeAM programme can:

- critically judge validity and limitations of results obtained from different types of mathematical models,
- identify the need for further knowledge in the field and take responsibility for keeping his/her personal knowledge up to date.

#### **Aalto modules:**

##### **F600-2 Intermediate Module in Applied and Engineering Mathematics**

Professors in charge of the module: Prof. Timo Eirola and prof. Rolf Stenberg

Description of the module: The module gives the essentials for applied mathematics toolbox: mathematical model classes, abstract analysis tools and optimization methods.

##### **F600-3 Advanced Module in Applied and Engineering Mathematics**

Professor in charge of the module: Prof. Timo Eirola and prof. Rolf Stenberg

Description of the module: The module deepens mathematical skills and extends them to application directions and numerical methods.

##### **F600-C Special Module in Applied and Engineering Mathematics**

Professor in charge of the module: Prof. Timo Eirola and prof. Rolf Stenberg

Description of the module: Special courses are chosen to adapt to the aims of specialization

##### **F601-3 NTNU Advanced Module in Applied and Engineering Mathematics**

Professor in charge: Professor Brynjulf Owren

Description of the module: The module is composed of two courses and a written project in the autumn, all giving relevant in-depth background for the master project in mathematical or numerical analysis the Spring. This track builds directly on the 1st year studies from Aalto covering more general mathematical topics.

##### **F602-3 KTH Advanced Module in Applied and Engineering Mathematics**

Professor in charge: Associate professor Michael Hanke

Description of the module:

1. year at KTH: Advanced courses in Mathematics, Statistics, Numerical Methods and Parallel Computation.
2. year at KTH: Advanced courses in Scientific Computing with Biocomputing as Specialization.

##### **F603-3 DTU Advanced Module in Applied and Engineering Mathematics**

Professor in charge: Associate Professor Christian Henriksen

Description of the module: The student learns how to model phenomena relevant for engineering using (partial) differential equation and how to use methods from analysis and geometry to analyze the models. In addition to technical competences, the module also imparts knowledge of business economy, organizational theory, and management.

### **F604-3 CHALMERS Advanced Module in Applied and Engineering Mathematics**

Professor in charge: Professor Johan Jonasson

Description of the module:

1st year at Chalmers: Basics of engineering mathematics. Advanced courses in statistics or pde and computing.

2nd year at Chalmers: Advanced studies in probability and statistics and/or pde and scientific computing.

### **AALTO**

#### **Aalto to Chalmers**

##### **First autumn courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
Mat-1.3460	Principles of Functional Analysis	5
Mat-2.3139	Nonlinear Programming	5
Mat-13652	Finite Difference Methods P	5
MS-C19XX	Geometric Analysis of Differential Equations	5
Mat-1.3350	Partial Differential Equations	10
	<b>TOTAL</b>	<b>30</b>

##### **First spring courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
MS-C1741	Finite Element Method I	5
Mat-1.3601	Introduction to Stochastics	5
Mat-1.3651	Matrix Computations	5
Mat-5.3760	Fluid Mechanics L	5
Mat-1.3626	Computational Methods in Inverse Problem	5
XX- Methodological studies	To be agreed with the professor of major.	2
Kie-98.xxxx	English course: compulsory degree requirement, both oral and written requirements	3
	<b>TOTAL</b>	<b>30</b>

#### **Aalto to DTU**

##### **First autumn courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
Mat-1.3460	Principles of Functional Analysis	5
Mat-2.3139	Nonlinear Programming	5
MS-C19XX	Enumerative combinatorics	5
MC-C19XX	Algebraic Number Theory	5
T-79.4502	Cryptology and Data Security	5
XX- Methodological studies	To be agreed with the professor of major.	2



Kie-98.xxxx	English course: compulsory degree requirement, both oral and written requirements	3
	<b>TOTAL</b>	<b>30</b>

**First spring courses**

Code	Course	CR
MS-C1741	Finite Element Methods I	5
Mat-1.3601	Introduction to Stochastics	5
Mat-1.3651	Matrix Computations	5
MS-C1050	Combinatorics	5
Mat-1.3530	Differential Geometry	5
T-79.5501	Cryptology	5
	<b>TOTAL</b>	<b>30</b>

**Second autumn courses at Aalto**

Code	Course	CR
Kie-98.xxxx	English course: compulsory degree requirement, both oral and written requirements	3
	<b>Choose 27 cr from the following</b>	
Mat-1.3981	N5TeAM Summer School in Applied and Engineering Mathematics	3
Mat-1.2991	Discrete Mathematics	5
Mat-1.3352	Hyperbolic PDEs	5
Mat-1.3422	Wavelet Theory	3
Mat-1.3530	Differential Geometry	5
Mat-1.3603	Mathematical Finance	5
Mat-1.3604	Stationary Processes	5
Mat-1.3626	Computational Methods in Inverse Problems	4-6
Mat-1.3658	Special Course in Numerical Analysis	3-6
Mat-1.3656	Seminar on Numerical Analysis and Computational Science	2
Mat-5.3701	Analytical Mechanics	5
Mat-5.3740	Continuum Mechanics	5
Mat-5.3741	Theory of Elasticity	5
Mat 5.3750	Special Course in Computational Mechanics	5
	Other suitable courses accepted for graduate students	
	<b>TOTAL</b>	<b>30</b>

**CHALMERS:****Chalmers to NTNU****First autumn courses**

Code	Course	CR
TMA401	Functional Analysis	7,5
MVE140	Foundations of Probability	7,5
MVE185	Computer Intensive Statistical Methods (track S)	7,5
MVE190	Linear Statistical Models (track S)	7,5

TMA947	Optimization (track CM)	7,5
TMA265	Numerical Linear Algebra (track CM)	7,5
	<b>TOTAL</b>	<b>30</b>

### First spring courses

Code	Course	CR
MVE160	Mathematical Modelling	7,5
MVE150	Algebra	7,5
TMA881	High-Performance Computing	7,5
MVE155	Statistical Inference (track S)	7,5
TMA322	Partial Differential Equations (track CM)	7,5
	<b>TOTAL</b>	<b>30</b>

### Chalmers to Aalto

#### First autumn courses

Code	Course	CR
MVE140	Foundations of Probability (II)	7,5
TMA401	Functional Analysis (I)	7,5
TMA947	Optimization (II)	7,5
TMA265	Num. Lin. Alg. (I)	7,5
	<b>TOTAL</b>	<b>30</b>

### First spring courses

Code	Course	CR
TMA372	PDE (III)	7,5
TMA881	High Perf. Comp. (IV)	7,5
MVE150	Algebra (III)	7,5
	Elective course	7,5
	<b>TOTAL</b>	<b>30</b>

### From Aalto to Chalmers

#### Second autumn courses

Code	Course	CR
	<b>Choose four of the following courses:</b>	
TMA401	Functional Analysis	7,5
TMA265	Numerical Linear algebra A	7,5
TMA632	Partial Differential Equations, project course	7,5
MVE080	Scientific Visualization	7,5
TMA462	Wavelet Analysis	7,5
KMG060	Systems Biology	7,5
FFR110	Computational Biology 1	7,5
TME225	Mechanics of Fluids	7,5
TME235	Mechanics of Solids	7,5
	<b>TOTAL</b>	<b>30</b>

**From NTNU to Chalmers**  
**Second autumn courses**

Code	Course	CR
	<b>Choose four of the following courses:</b>	
TMS165	Stochastic Calculus	7,5
MVE140	Foundations of Probability	7,5
TMA401	Functional Analysis	7,5
FFR110	Computational Biology	7,5
MVE190	Linear Statistical Models	7,5
MVE220	Financial Risk	7,5
	<b>TOTAL</b>	<b>30</b>

**DTU:**

**DTU to KTH**  
**First autumn courses**

Code	Course	CR
02409	Multivariate Statistics E1A	5
02610	Optimization and Datafitting E2A	5
01415	Computational Discr. Mathematics E3A	5
01418	Introduction to PDE E5A	5
02393	Programming in C++	5
02614	High-performance Computing	5
	<b>TOTAL</b>	<b>30</b>

**First spring courses**

Code	Course	CR
02685	Scientific Computing for Differential Equations F1	10
02616	Large-scale Modeling F3A	5
42490	Technology, Economy, Management and Organization, F5	10
02417	Time Series Analysis F2B	5
	<b>TOTAL</b>	<b>30</b>

**DTU to NTNU**  
**First autumn courses**

Code	Course	CR
02409	Multivariate Statistics E1A	5
02610	Optimization and Data Fitting E2A	5
01617	Dynamical Systems 1 E4A	5
01418	Introduction to PDE E5A	5
01715	Functional Analysis E4B	5
02623	The Finite Element Method for PDEs	5
	<b>TOTAL</b>	<b>30</b>

**First spring courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
01410	Cryptology 1 F2A 5	5
01618	Dynamical Systems 2 F4A 5	5
42490	Technology, Economy, Management and Organization, F5	10
01227	Graph Theory F1B	5
01234	Differential Geometry with Applications F2B	5
	<b>TOTAL</b>	<b>30</b>

**From Aalto to DTU****Second autumn courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
	N5TeAM Summer School in Applied and Engineering Mathematics with follow-up	5
42490	Technology, Economy, Management and Organization E5	10
	<b>Three of the following courses:</b>	
01235	Manifolds and Tensor Analysis E1A	5
01617	Dynamical Systems 1 E4A	5
01257	Advance Modelling	5
xxxxx	Light Weight Cryptology	5
	<b>TOTAL</b>	<b>30</b>

**From NTNU to DTU****Second autumn courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
	N5TeAM Summer School in Applied and Engineering Mathematics with follow-up	5
42490	Technology, Economy, Management and Organization E5	10
	<b>Three of the following four courses:</b>	
01235	Manifolds and Tensor Analysis	5
10336	Fundamental Problems in Fluid Dynamics E1B	5
01715	Functional Analysis E4B	5
xxxxx	Light Weight Cryptology	5
	<b>TOTAL</b>	<b>30</b>

**KTH:****KTH to NTNU****First autumn courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
SF2529	Applied Numerical Methods	7,5
SF2561	Finite Element Methods	7,5
SF2739	Partial Differential Equations	7,5
SF2736	Discrete Mathematics	7,5
DA2205	Philosophy of Science (equivalent)	3
	<b>TOTAL</b>	<b>33</b>

**First spring courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
SF2568	Parallel Computations for Large-Scale Problems	7,5
SF2707	Functional Analysis	7,5
SF2950	Applied Mathematical Statistics	7,5
DA2205	Philosophy of Science (equivalent)	4,5
	<b>TOTAL</b>	<b>27</b>

**KTH to Aalto****First autumn courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
SF2529	Applied Numerical Methods	7,5
SF2739	Partial Differential Equations	7,5
SF2736	Discrete Mathematics	7,5
SF2940	Probability Theory	7,5
DA2205	Philosophy of Science (equivalent)	3
	<b>TOTAL</b>	<b>33</b>

**First spring courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
SF2568	Parallel Computations for Large-Scale Problems	7,5
SF2707	Functional Analysis	7,5
SF2822	Applied Nonlinear Optimization	7,5
DA2205	Philosophy of Science (equivalent)	4,5
	<b>TOTAL</b>	<b>2,5</b>

**Second autumn courses at KTH**

<b>Code</b>	<b>Course</b>	<b>CR</b>
<b>Compulsory</b>		
DA2205	Philosophy of Science	7,5
DN240X	Master Thesis project	30
<b>Recommended</b>		
SK2530	Introduction to Biomedicine	6
DD2435	Mathematical Modelling of Biological Systems	9
<b>Elective</b>		
DD2404	Applied Bioinformatics	7,5
DD2431	Machine Learning	6
BB2300	Computational Chemistry	7,5
BB2440	Bioinformatics and Biostatistics	7
BB2280	Molecular Modeling	7,5
DN2230	Fast Numerical Algorithms for Large-Scale Problems	7,5
DN2295	Project Course in Scientific Computing	7,5
	<b>TOTAL</b>	<b>60</b>

**NTNU:****NTNU to KTH****First autumn courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
TMA4245	Linear Methods	7,5
TMA4195	Mathematical Modeling	7,5
TMA4205	Numerical Linear Algebra	7,5
TMA4220	Num Part Diff Elem	7,5
	<b>TOTAL</b>	<b>30</b>

**First spring courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
TMA4180	Optimization Theory	7,5
TMA4280	Supercomputers, Introduction	7,5
TMA4150	Algebra and Number Theory	7,5
TMA4267	Linear Statistical Models	7,5
	<b>TOTAL</b>	<b>30</b>

**NTNU to Chalmers****First autumn courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
TMA4145	Linear Methods	7,5
TMA4305	Partial Differential Equations (track 1)	7,5
TMA4295	Statistical Inference	7,5
TMA4195	Mathematical Modeling	7,5
TMA4265	Stochastic Processes (track 2)	7,5
	<b>TOTAL</b>	<b>30</b>

**First spring courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
TMA4170	Fourier Analysis	7,5
TMA4180	Optimization	7,5
TMA4150	Algebra and Number Theory	7,5
	One elective course	7,5
	<b>TOTAL</b>	<b>30</b>

**NTNU to DTU****First autumn courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
TMA4195	Mathematical Modeling	7,5
TMA4145	Linear Methods	7,5
TMA4305	Partial Differential Equations	7,5
TMA4265	Stochastic Processes	7,5
	<b>TOTAL</b>	<b>30</b>

**First spring courses**

<b>Code</b>	<b>Course</b>	<b>CR</b>
TMA4150	Algebra and Number Theory	7,5
TMA4185	Coding Theory	7,5
TMA4165	Diff Eq. And Dynamical Systems	7,5
TMA4180	Optimization Theory	7,5
	<b>TOTAL</b>	<b>30</b>

**Second autumn courses at NTNU**

<b>Code</b>	<b>Course</b>	<b>CR</b>
TMA 4500	Written Project	15
	<b>Electives (choose 15 credits)</b>	
TMA4195	Mathematical Modeling	7,5
TMA4205	Numerical Linear Algebra	7,5
TMA4220	Finite Element Methods	7,5
TMA4225	Analysis	7,5
TMA4305	Partial Differential Equations	7,5
TMA4285	Time Series Analysis	7,5
TMA4295	Statistical Inference	7,5
TMA4315	General Linear Models	7,5
	<b>TOTAL</b>	<b>30</b>

## 11.2 Master's Programme in Physics of Advanced Materials

**Degree: Master of Science in Technology, 120 ECTS**

**Major: Physics of Advanced Materials (SCI3017)**

**Director of the Programme: Professor Mikko Alava**

**Professors of the Major: Professors Adam Foster and Sebastiaan Van Dijken**

**Department in charge: Department of Applied Physics**

**Academic coordinator: PhD Emppu Salonen**

<https://into.aalto.fi/display/enphysadv/>

### Objectives of the programme:

☞ The students are furnished with a solid education in the physics of materials from the viewpoint of current research. The emphasis is on either theoretical/computational or experimental aspects. In particular, the programme concentrates on hand-on experience in research in the associated research groups of the Department of Applied Physics and on the campus. The final MSc thesis may also be done on a subject in collaboration with external partners from academic ones to firms working on the development and application of advanced materials. The degree is also gives a solid background in doctoral studies in physics, materials science, and other related fields.

The studies in the programme consist of six modules, for a total of 120 ECTS credits:

1. **A3 Advanced Module in Materials (20 cr)**
2. **A3 Advanced Module in Engineering Physics (20 cr)**
3. **C Special Module (20 cr)**
4. **Methodological Principles (10 cr)**
5. **Elective Studies (credits to obtain the total of 120 cr)**
6. **Master's thesis (30 cr)**

In modules F330-3 and F331-3 each student focuses on either theoretical/computational or experimental research. The study modules are presented in detail below.

### F330-3 Advanced Module in Materials A3 (20 cr)

Professor in charge of the module: Mikko Alava

Of the special assignments, one is to be done during the summer after the 1st year.

Code	Course	CR
Tfy-105.5111	Computational Physics, special assignment	10
Tfy-125.5111	Physics, special assignment	10
Tfy-3.4311	Materials Physics II	5
Tfy-3.4361	Advanced Statistical Physics	5
Tfy-3.4331	Surface Physics	5
Tfy-3.4343	Nanophysics	5
Tfy-125.4313	Microscopy of Nanomaterials	5
Tfy-125.4314	Microscopy of Nanomaterials, laboratory course	5

### F331-3 Advanced Module in Engineering Physics A3 (20 cr)

Professor in charge of the module: Mikko Alava



The module contains studies that provide background in physical sciences. The course selection allows to focus either on a theoretical or experimental track.

Code	Course	CR
Tfy-3.5111	Physics, special assignment	10
Tfy-3.4323	Quantum Physics	5
Tfy-3.4411	Experimental Methods in Physics	5
Tfy-3.4423	Computational Physics	5
S-104.3610	Nanotechnology	5

### **F300-C Special Module in Engineering Physics (20 cr)**

This module may contain courses in mathematics, computer science, and various aspects of materials research. An individual study plan will be made with the supervisor.

### **F901-M Methodological Principles (10 cr)**

The module contains a selection of methodological courses related to the theme of the programme.

Code	Course	CR
Tfy-3.4510	Special Course in Physics	3-10
	<b>or</b>	
Tfy-3.4520	Special Course in Theoretical Physics	3-10
	<b>TOTAL</b>	<b>10</b>

### **F901-W Elective Studies**

Compulsory courses (3 cr): Any Kie-98.xxxx language courses that fulfill the requirements for obligatory foreign language studies for a total of 3 ECTS credits, including both oral and written skills.

In addition, the student can select *any Aalto University courses* to complete 20 ECTS credits. The course choices may contain courses relevant for eventual doctoral studies.

### **F901-D Master's thesis (30 cr)**

The Master's thesis is a written report of a 6-month independent research project on a topic related to the programme. The topic of the thesis is agreed upon by the student and the supervising professor. The work is carried out as full-time research in either one of the groups at the [Department of Applied Physics](#), in a research group collaborating with one of the groups at the department or in an industrial company whose field of operation is related to the programme.

### **Practical training**

In this programme it is not possible to include practical training.

## 12. MASTER'S DEGREE PROGRAMME IN BRAIN AND MIND

**Degree:** Master of Science in Technology - M.Sc. (Tech), 120 ECTS

**Major:** Brain and Mind (SCI3018)

**Director of the programme:** Professor Mikko Sams

**Professors of the major:** Prof Risto Ilmoniemi (Tfy-99)  
 Prof Jouko Lampinen (Becs-114)  
 Assistant Prof Lauri Parkkonen (Tfy-99)  
 Prof Mikko Sams (Becs-114)  
 Prof. Riitta Hari (Tfy-99)  
 Prof. Riitta Salmelin (Tfy-99)  
 Assistant prof. Lauri Nummenmaa (Becs-114)  
 Assoc. prof. Jari Saramäki (Becs-114)

**Academic coordinator:** Dr. Margareta Segerstahl

<https://into.aalto.fi/display/enbrainmind/Homepage>

### **Objectives of the programme**

The goal is to provide talented and highly motivated students with skills and knowledge to conduct research on mechanisms and neural basis of human mind, as reflected in the research at Aalto University. This includes research in cognitive/systems neuroscience, social interaction and networks, as well as computational complex systems methods. The programme emphasizes multidisciplinary understanding of mind from various perspectives, such as neuroscience, computational analysis and modelling, psychology, sociology, physics, and culture. All students will gain a profound understanding of modern systems-level research methodology of the brain, mind, and human cognition, as well as a good command of signal and computational analysis and modelling methods.

### **The content of the Programme**

The duration of the programme is two years. Studies are partly tailored taking into account the students' background education and field of interest. In addition to the necessary fundamental courses, a significant portion of the studies will take place in research groups. Items may be selected from an extensive menu, including lecture courses, laboratory exercises and seminars. An experienced scientist takes care of a small group of students from the beginning of the studies and acts as an advisor and tutor. During their studies, students will rotate between laboratories of the participating departments. Students will do their MSc thesis work primarily in the participating laboratories. Teaching is organized in collaboration with the Master's degree Programme in Neuroscience (MNEURO) of the University of Helsinki.

### **The Brain and Mind programme consists of the following study modules:**

Advanced Module in Social and Affective Cognitive Neuroscience (20 cr)  
 Advanced Module in Neuroscience (20 cr)  
 Advanced Module in Advanced Computational Analysis and Modelling (20 cr)  
 Methodological principles (10 cr)  
 Elective studies (20 cr)  
 Master's thesis (30 cr)

### **BM110-3 Advanced Module in Social and Affective Cognitive Neuroscience (20 cr)**

**Professor in charge of the module:** Mikko Sams

**Description of the module:** The module provides understanding of the basics of modern cognitive psychology, social psychology and sociology. Emphasis is on experimental and computational approach.

Code	Course	Cr
Becs-114.5501	Experimental and Statistical Methods in Biological Sciences I	5
Becs-114.5502	Experimental and Statistical Methods in Biological Sciences II	5
Becs-114.5711	Social and Affective Cognitive Neuroscience	5
Becs-114.5707	Individualized Studies in Cognitive Neuroscience V P*	5

\*Consisting of one or more realizations of the course, depending on their respective amount of credits.

### **BM111-3 Advanced Module in Neuroscience (20 Cr)**

**Professor in charge of the module:** Assistant Prof Lauri Parkkonen

**Description of the module:** The module provides comprehensive understanding of the human nervous system and its basic sensory-motor as well as cognitive functions.

Code	Course	Cr
Becs-114.5701	Cognitive Neuroscience I	5
Tfy-99.3720	Advanced Course of Human Brain Functioning	5
HY920009	Introduction to Neurobiology	5
Becs-114.5808	Individualized Studies in Neuroscience V P*	5

\*Consisting of one or more realizations of the course, depending on their respective amount of credits.

### **BM112-3 Advanced Module in Advanced Computational Analysis and Modelling (20 cr)**

**Professor in charge of the module:** Jouko Lampinen

**Description of the module:** In this module students learn practical methods for statistics and data analysis and basics of advanced computational modelling of complex phenomena.

Code	Course	Cr
Becs-114.1311	Introduction to Bayesian Statistics *	3
Becs-114.5312	Work Course on Bayesian Analysis*	2
Becs-114.4150	Complex Networks V P	5
Becs-114.5120	Individualized Studies in the Laboratories V P**	10

\* If the course or corresponding studies are already included in the Bachelor degree:

Becs-114.2601 Introduction to Bayesian Modelling 5 cr

\*\* Consisting of two or more realizations of the course, depending on their respective amount of credits

**BM901-M Methodological Principles (10 cr)**

**Professors in charge of the module:** Mikko Sams, Risto Ilmoniemi, Jouko Lampinen, Lauri Parkkonen

Code	Course	Cr
Becs-114.5791	Brain Imaging Principles	4
Becs-114.5792	Brain Imaging Practice	6

**BM901-W Elective studies (20 cr)**

Code	Course	Cr
<b>Compulsory courses</b>		
Kie-98.xxxx	Foreign language courses*	3
<b>In addition, students can select any courses to complete 20 credits. The following courses are strongly recommended:</b>		
Kie-98.7011	Finnish IA	2
Kie-98.7012	Finnish IB	2
Kie-98.7009	Get to Know Finland	1

\*any Kie-98.xxxx courses that fulfill the requirements for obligatory foreign language courses, a total of 3 ECTS including both oral and written skills.

**BM901-D Master's Thesis (30 cr)**

The Master's thesis is the final thesis done independently by the student for the MSc degree. Master's thesis is written during the second year of the studies. As a rule, the thesis work will be done in the research groups of BECS and BRU.

## 13. MASTER'S THESIS AND GRADUATION

### 13.1 Master's Thesis

The Master's thesis shall be written on a topic related to one's major and the topic shall be agreed upon together with the student and the teacher whose field of speciality includes the topic.

The Degree Programme Committee confirms the topic and the language of the thesis as well as appoints the supervisor and the thesis advisor for the thesis. The supervisor can also act as the thesis advisor. The supervisor must be a professor of Aalto University School of Science. The thesis advisor must have at least higher university degree.

Confirmation of the topic of the Master's thesis can be applied for when at least 45 credits of the Master's degree have been completed. The topic shall be applied for in writing. The topic of the Master's thesis is valid for one year from the date it has been confirmed. If the thesis is not submitted for evaluation within that time, the topic expires and must be applied for again.

The Master's thesis work also includes a maturity essay and a seminar presentation or an equivalent presentation.

During the Master's thesis process, the supervisor must present the student with an opportunity to report on the progress of the work and to receive feedback from the supervisor. Similarly, the supervisor may request the student to report on the progress of the Master's thesis work.

The Master's Thesis is approved and graded by the Degree Programme Committee on the grounds of the written statement given by the supervisor. In his/her statement the supervisor details the grounds for evaluation and proposes a grade for the thesis. The supervisor shall present his/her written statement on the Master's thesis within one month of the submission of the Master's thesis book. In the Degree Programme in CSE also the thesis advisor must submit his/her statement. If the supervisor acts as the thesis advisor as well, the supervisor shall ask for the thesis statement from someone familiar with the field of research. Approval and grading of the Master's thesis shall be applied for in writing.

The Master's thesis is a public document and as such, shall be displayed in the school library. At least two copies are to be submitted: one for the supervisor and one to the Degree Programme Office. The book submitted to the Degree Programme Office shall be taken to the library after the thesis has been approved by the Degree Programme Committee.

For further and more detailed information on the procedure, please see  
 Degree Programme in CSE <https://into.aalto.fi/display/entik/Master%27s+Thesis>  
 Degree Programme in IEM <https://into.aalto.fi/display/entuo/Master%27s+thesis>  
 Degree Programme in Engineering Physics and Mathematics  
<https://into.aalto.fi/display/entfm/Master%27s+Thesis>

### 13.2 Maturity Essay

The student is required to write a maturity essay related to the topic of the Master's thesis. The maturity essay demonstrates mastery of the thesis subject and language skills (Finnish or

Swedish). If the student has demonstrated language skills already for the Bachelor's degree or other university degree, he/she does not have to demonstrate them in a maturity test for the higher university degree. If the student has been educated in language other than Finnish or Swedish or has been educated abroad, he/she does not have to demonstrate language skills in Finnish or Swedish, only mastery of the thesis subject.

### **13.3 Graduation and Certificates**

When the student has completed all the studies required for the higher university degree he or she can apply for graduation. Graduation must be applied for in writing. The degrees for Master of Science (Technology) are approved by the Dean of Aalto University School of Science.

More information about graduation can be found on the web page at

<https://into.aalto.fi/display/enmastersci/Graduation>

#### **13.3.1 Graduation with Honours**

If the student has shown excellent knowledge in his or her studies, and shown particular maturity and judgement in the Master's thesis, the certificate for the Master of Science in Technology may be awarded with honours. The Dean of Aalto University School of Science decides on the awarding of degrees with honours. A degree with honours may be awarded if the weighted average grade for courses for the degree, not including the Master's thesis, is at least 4.0 and the grade for the Master's thesis is at least 4. If a course is graded pass/fail, it is not counted in the calculation of the average grade. If some of the student's courses have been completed at another university, a degree with honours should not generally be awarded, unless at least half of the degree studies, not including the Master's thesis, are completed at Aalto university.

#### **13.3.2 Graduation Ceremonies**

The Dean of Aalto University School of Science awards the degree certificates in ceremonies which are arranged approximately every other month. The dates of the graduation ceremonies can be found at <https://into.aalto.fi/display/enmastersci/Graduation>.

Students who are unable to attend the ceremony can receive their diplomas from the Student Services of Aalto School of Science during the office hours. Students will be requested to prove their identity. On the basis of an authenticated written request, the diploma can also be sent by registered mail.

### **13.4 Career Services and Alumni Relations**

#### **13.4.1 Career Services**

The Career Services (Otakaari 7 B, 3rd floor) guide the degree students and support them in their transfer into the working life. Building a career begins already from the very first summer or training position and continues through the entire career.

The Career Services give advice on planning personal goals and achieving them, as well as offer tools for job search and selecting the right job. Instructions are given, for example, on how to complete the necessary application documents, how to prepare for an interview and what to consider when signing an employment contract. It is possible to make an appointment to have your CV and other documents reviewed. Students may also receive personal career advice

through making an appointment with the career counsellor. Usual themes at career counselling are occupational expectations, goals, interests, motivational questions, strengths, personal qualities and working and learning style values. Annual career and job fairs introduce various professional fields and career opportunities. Services also include coordinating both domestic and international training posts as well as issuing grants for international training.

More information on the Career Services is available at:

<https://into.aalto.fi/display/encareerweb/Home>

### **13.4.2 Alumni Relations**

The Aalto University alumni include all those who have earned a degree or studied at Aalto University or at its predecessors. In addition, Aalto University alumni include former exchange students of the universities mentioned above. The Alumni Relations Office maintains and promotes the mutually beneficial relationship between the alumni and the University. The alumni network is an important part of the academic and social community of Aalto University and the network includes currently over 75,000 individuals in Finland and around the world. It has an active and established role in the student/enterprise cooperation of the University as well as the development of education and research activities. The alumni activities aim to foster life-time partnership between the University and the alumni. The alumni network also offers opportunities for cross disciplinary networking and supports the alumni in broadening their expertise.

Further information on the Aalto University Alumni, please see <http://www.aalto.fi/en/for/alumni/>

The form to join the Alumni network is available at

<https://alumninet.aalto.fi/portal/public/Default.aspx>

## 14. COURSES ACCEPTED AS OBLIGATORY FOREIGN LANGUAGE COURSES

The following language courses meet the university regulations for foreign language studies in the academic year 2013–2014. Please note, that students must prove their proficiency in both written and oral skills. More information on the language skills requirements can be found in the web pages of the Language Centre

<http://kielikeskus.aalto.fi/en/studying/degree/>

**O:** Oral skills

**W:** Written skills

### English

Kie-98.1114 Communicating Technology (o,w) (3 cr)

Kie-98.1115 Persuasive Communication (o,w) (3 cr)

Kie-98.1310 Introduction to Academic Communication for Master's Programs in English (o,w) (V) V (3 cr)

Kie-98.1320 Writing for Master's Students (w) V (3-5 cr)

Kie-98.1330 Presenting Doctoral Research (o) L V (3-5 cr)

Kie-98.1340 Writing Doctoral Research (w) L V (3-5 cr)

Kie-98.1410 Industrial Communications (o,w) (V) V (3-5 cr)

Kie-98.1420 Project Communication (o,w) V (3-5 cr)

Kie-98.1600 English Reading/Writing Test (w) (1 cr)

Kie-98.1601 English Oral Skills Test (o) (2 cr)

LC-116 Direct Studies in English (o/w) (1-2 cr)

### Spanish

Kie-98.2053 Español 5 (o,w) (3 cr)

Kie-98.2063 Español 6 (o,w) (3 cr)

Kie-98.2094 Tekniikan espanjaa 1 (o,w) (2 cr)

Kie-98.2200 Espanjan luku- ja kirjoituskurssi (w) (2 cr)

Kie-98.2510 Internet Course: Caminando por mundos hispanos 1 (o,w) (2 cr)

Kie-98.2520 Internet Course: Caminando por mundos hispanos 2 (o,w) (2 cr)

### Japanese

Kie-98.3560 Syventäviä japanin kielen opintoja (o,w) (2-4 cr)

LC-3355 Nihongo 5 (o,w) (3 cr)

LC-3366 Nihongo 6 (o,w) (3 cr)

### French

Kie-98.4053 Français 5 (o,w) (3 cr)

Kie-98.4063 Français 6 (o,w) (3 cr)

Kie-98.4090 Français avancé (o,w) (2-4 cr)

Kie-98.4105 Acheter et vendre sa technologie (o,w) (2-4 cr)

Kie-98.4115 Sciences et technologies (o,w) (2-4 cr)

Kie-98.4135 Français pour les stagiaires (o,w) (2-4 cr)

Kie-98.4320 Grammaire française 2 (w) (2 cr)

LC-4234 Français pur les étudiants d'échange (o,w) V (2-4 cr)



**German**

- Kie-98.6053 Deutsch Niveau 5 (o,w) (3 cr)
- Kie-98.6063 Deutsch Niveau 6 (o,w) (3 cr)
- Kie-98.6450 Saksan kielioppia 2 (w) (2 cr)
- Kie-98.6609 Saksan kirjallinen viestintä (w) (2 cr)
- Kie-98.6625 Landeskunde (o,w) (2-4 cr)
- Kie-98.6669 Suullista viestintää (o) (2 cr)
- Kie-98.6670 Saksaa vaihtoon lähteville (o,w) (2 cr)
- Kie-98.6729 Tekniikan saksan tekstikurssi (w) (2-3 cr)
- Kie-98.6730 Technisches Deutsch (o,w) (3 cr)

**Russian**

- LC-8053 Venäjän jatkokurssi 1 (o,w) (3 cr)
- LC-8063 Venäjän jatkokurssi 2 (o,w) (3 cr)
- LC-8073 Työelämän venäjää (o,w) (3 cr)
- LC-8083 Elinkeinoelämän venäjää (o,w) V (3 cr)
- LC-8093 Tekniikan alojen venäjää (o,w) V (3 cr)
- LC-8103 Suullisen ja kirjallisen viestinnän venäjää (o,w) V (3 cr)

## 15. INTERNATIONAL STUDIES

Degree students at the School of Science can complete a part of their degree abroad. Studying abroad is an investment in the future and in oneself. It is also a merit acknowledged by employers. In addition to the academic credits, studying abroad builds character as well as intercultural knowledge together with networking and language skills. Being international is not just about traveling abroad – it's a way of thinking

Aalto University aims to encourage all students to become more international during their studies and grants scholarships for studies abroad. Scholarship is granted to all those students who are accepted in the university's exchange programme for studies abroad and also free mover students, according to the annual budget.

The students in the School of Science can develop their global competence by 1) studying abroad as exchange students, 2) applying to an international double degree programme, 3) conducting practical training abroad, 4) working on their master's thesis abroad, 5) studying on a summer course abroad, 6) staying at home at Aalto University and e.g. applying to an English Master's programmes, becoming a student tutor for international students, learning foreign languages.

### 15.1 Student exchange

Most exchange periods are realized through exchange programmes. Students can also look for a suitable host university independently (free mover exchange). Student exchange can be conducted during graduate or postgraduate studies. The duration of the exchange is either one term (minimum 3 months) or the whole academic year.

#### Student Exchange Programmes at Aalto University:

- NORDTEK/Nordplus – Nordic countries
- Erasmus-programme – Europe
- GE4 –network - Asia, North and Latin America
- Magalhães-network – Latin America
- Bilateral agreements of Aalto University or schools in technology - Asia, Australia, North and Latin America
- Bilateral exchange agreements of School of Science

#### Application times

Student exchange placements and scholarships are normally applied for during the previous academic year. Please always check the application deadlines and applicable exchange destinations at the Into webpages of the School of Science

<https://into.aalto.fi/display/enmastersci/When+to+apply>

In addition to exchange networks, there are other international cooperation networks such as Nordic Five Tech (N5T) and Cluster that students may benefit from when planning to study

abroad. Cooperation networks may grant additional scholarships or arrange special events for the exchange students.

At the moment students in the schools of technology cannot apply to exchange destinations that School of Economics and School of Arts, Design and Architecture offer. Students will be informed about possible exceptions or changes.

To get accepted in an exchange program of Aalto University schools of technology in bilateral exchange destinations, the student needs to have an academic index of 50 in addition to the exchange students' general selection criteria. The index is counted as follows: credits / number of semesters present (without ongoing) x weighted average value.

### **Objectives of studying abroad**

Exchange studies abroad support student's academic studies in Aalto University. The general objectives of studying abroad can be described in short as follows:

- To grow academically, personally and ethically
- To develop higher level of global and intercultural competence
- To become better prepared for any career, particularly international career
- To develop greater fluency of foreign language.

(Source: M. Steinberg in Bolen et al., 2007)

### **The language issue**

As the one aim of student exchange is to practice language skills, Aalto University encourages students to study in the language of the host country during their exchange. Therefore, for some European destinations (France, Germany, Spain, Switzerland) knowledge of the language of the host country or region is required at the time of applying. However, you can still choose also courses that are taught in English and continue your language studies at the destination. When applying to Spanish speaking countries of the bilateral agreements, students need to have studied least two years Spanish.

At the moment, European destinations where one can apply with only English language skills are Baltic countries, Czech Republic, Greece, Hungary, Ireland, Netherlands, Poland, Portugal, Turkey, United Kingdom and in certain single destinations such as European Business School in Germany, Eurecom in France, Politecnico di Milano and Politecnico di Torino in Italy. However, especially when applying to Italy, it is very important to know Italian as well. Also Asian destinations are mostly suitable for studying in English.

### **Erasmus student exchange to Europe**

Each degree programme has its own Erasmus student exchange agreements with European universities. Own agreement means that in the selection of applicants for those exchange places, preference will be given to the students of that degree programme. See the list of partner universities <https://into.aalto.fi/display/enmastersci/Erasmus+destinations>

**Nordice countries, bilateral exchange destinations, GE4 and Magalhães-network**  
<https://into.aalto.fi/display/enmastersci/Student+exchange>

### Bilateral partner universities of the School of Science

The School of Science has signed exchange agreements with partner universities in long-distance destinations. These exchange destinations are intended primarily for our own students and the studies available at the destination university has been noted very suitable for the curricula of the students of School of Science

Country	University	Cooperation field		
		Engineering Physics and Mathematics	Computer Science and Engineering	Industrial Engineering and Management
<b>Brazil</b>	Universidade de São Paulo (USP)	x	x	x
<b>India</b>	Birla Institute of Technology and Science (BITS), Pilani		x	
<b>China</b>	Beijing University of Posts and Telecommunications (BUPT), Beijing		x	
	Southwestern University of Finance and Economics (SWUFE), Chengdu			x
	Tongji University, Shanghai		x	
<b>Japan</b>	Kyoto University of Technology, Kyoto			x
<b>Mexico</b>	Instituto Tecnológico Autónomo de México (ITAM), Mexico City	x	x	x
<b>Taiwan</b>	National Taiwan University of Science and Technology, Taipei	x	x	x

### Free mover exchange

If the Aalto University exchange programmes or partner universities do not correspond to students' plans, one can look for a host university independently and go on exchange as a so-called free mover student. To do this, students are expected to organize the exchange fully by yourself. The host university may require an official language test and tuition fees are usually charged. Further information can be found on the School's Into website <https://into.aalto.fi/display/enmastersci/Free+mover+exchange>

### Transferring Credits

One of the ground rules of student exchange is that students may transfer all the studies completed abroad to their degree at Aalto University. Therefore, all students participating in Aalto University student exchange programmes as well as the students granted an Aalto University scholarship for studying abroad are required to present a personal study plan before their departure. This ensures that student can transfer the credits completed abroad without difficulties to the degree.

Please contact your programme coordinator as soon as you start planning your studies abroad. In a two-year master-programme it is especially important to plan the internationalization period very carefully as the degree schedule can be tight and one has to pay attention for leaving space in a degree for credits from abroad. All the credits completed during your exchange should be included in your degree in Aalto.

## **15.2 International Cooperation Programmes**

In addition to the traditional student exchange programmes, Aalto University has also different international cooperation programmes to offer. In international double degree programmes students study at two collaborating universities and get a degree from both. In practice, completing a double degree programme is like spending one or two semesters as a regular exchange student abroad during Master's degree studies with the advantage of getting two degrees instead of just one. Information on double degree programmes and other options can be found on the School's Into website

<https://into.aalto.fi/display/enmastersci/International+double+degree+programmes>

## **15.3 Practical Training Abroad**

Conducting practical training abroad is besides student exchange a good way to become international and to network to meet the requirements of the labor market. For further information on international training, consult the chapter 16.2.

## **15.4 Master's Thesis Abroad**

Engineering students at School of Science may also decide to work on their Master's thesis abroad. Students can work on their thesis at a university or e.g. in a company or a research center. Students should discuss their plans well in advance with the professor of their major. Aalto University awards scholarships for those students working on their Master's thesis abroad. Students can be awarded the Aalto University scholarship either from the home school at the Aalto University or from Aalto University Career Services.

## **15.5 Summer Courses and Summer Schools Abroad**

There are numerous summer courses and summer schools of different length and on different subjects arranged around the world during the summer. Aalto University can award travel scholarships to students participating in a summer course or a summer school at the partner university. Information on international summer courses and schools as well as scholarships available for them can be found on the School's Into website for Internationalisation and studies abroad.

## **15.6 Studying Abroad - Expenses and Financing**

Studying abroad period does not necessarily cost more than spending the same period in Finland. On the contrary, living in certain countries costs even less than living in Finland. Studying expenses vary extensively depending on the target country and university. In addition to the normal housing and living expenses, the other expenses include the preparation costs for going abroad, travel costs, insurance, course materials and possible tuition fees. Further information on Aalto University scholarships and other sources of funding is available in the Into pages <https://into.aalto.fi/display/enmastersci/Grants+and+application+criteria>

### 15.7 Important contacts and sources of information

As a master student it is especially important to plan the internationalization period very carefully. Following staff members are happy to help you with your plans.	
<b>Exchange studies, Aalto University scholarships for exchange studies, summer courses</b>	At Student Services of School of Science: Planning Officer for International Student Exchange Mari Dagnall (CSE-building, room A226 on 2 <sup>nd</sup> floor, <a href="mailto:firstname.lastname@aalto.fi">firstname.lastname@aalto.fi</a> ) Study Secretary for International Student Exchange Jaakko Kölhi (CSE-building, room A225 on 2 <sup>nd</sup> floor)
<b>International Master's Programmes</b>	Coordinator of the programme in concern
<b>All the questions concerning planning of your international studies</b>	Study planning officer or study secretary of your own degree programme; coordinator of the master programme
<b>Administration of international training and scholarships for international training</b>	Coordinator for International Training Ms Linda Wuoristo Otakaari 7 B (3rd floor) <a href="mailto:career-tech@aalto.fi">career-tech@aalto.fi</a>  Career Services Into website: <a href="https://into.aalto.fi/display/encareer/Internships">https://into.aalto.fi/display/encareer/Internships</a>

#### Remember also:

- *Professors* (they have international connections and they have up-to-date knowledge on the worldwide locations of top research on their research fields)
- *International Studies Info Point of School of Science* (CSE-building, 2<sup>nd</sup> floor next to the lift)
- *Notice Board for international studies* (CSE-building, 2<sup>nd</sup> floor next to the Student Services room)
- *Facebook: Aalto University students go abroad*
- AYY international clubs ( BEST, ESN, Aiesec, AEGEE-Helsinki..)
- *Country specific information*, e.g. Fulbright Center (studies in North America), British Council, Campus France, DAAD

## 16. PRACTICAL TRAINING

The Master's degree may include training which further develops expertise as defined in the degree programme curricula. Optional training is part of the Elective Studies module. Practical training is not compulsory in the Degree Programme in Computer Science and Engineering and Degree Programme in Industrial Engineering and Management.

The object of practical training is to support the student's ability to evaluate and apply the theories taught and to prepare the student for working life. Practical training enables the student to consider various directions in professional career and allows the student to gear the studies into the right direction according to his or her interests. Practical training included in the upper university degree aims to teach the students how to apply their basic theoretical knowledge in solving of practical problems.

A person familiar with the tasks involved in the training shall supervise the training. The amount of credits for practical training is calculated by dividing the number of full working weeks by two.

**In the Degree Programme in Computer Science and Engineering** the maximum overall amount of credits the student can obtain for all training periods is 6 credits. Working in the same training position can amount to 2-4 ECTS. The minimum length of a training period is 4 weeks. If the working tasks have changed fundamentally during the training period, long-term training can be accepted as two periods.

In international training 4 working weeks correspond to 3 credits (half credits are not given). In international training the maximum amount of credits is 6, which corresponds to 8 working weeks. For more detailed instructions on practical training in the Degree Programme in CSE, please see <https://into.aalto.fi/display/entik/Practical+training>.

**In the Degree Programme in Industrial Engineering and Management** the maximum overall amount of credits the student can get from all training periods is 5 credits. If the student has done practical training abroad the overall amount of credits can be 7. However, it is possible to get a maximum of 4 credits from one training period abroad.

For more detailed instructions on practical training in the Degree Programme in IEM, see <https://into.aalto.fi/display/entuo/Practical+training>.

**In the Degree Programme in Engineering Physics and Mathematics** the training cannot be included in the Master's degree studies.

### 16.1 Obtaining Trainee Post

Obtaining a trainee post is part of practical training and students are responsible for it themselves. The Career Services (<https://into.aalto.fi/display/encareer/>) assist the students in locating both domestic and international trainee posts. Information on these posts is provided on the bulletin boards and on the Career Services home pages, as well as on Career Web, which is an internet-based job board for School of Science students and alumni. In addition, placing a personal CV on Career Web for the potential employers to see is recommended. Various company events organized by the Career Services throughout the academic year, are also a good opportunity to find out about the companies' recruiting needs and to introduce oneself.

## **16.2 International Training**

A trainee post can also be obtained from abroad. Conducting the practical training abroad is a very good way to get acquainted with the technology industry in an international environment as well as to network in order to meet the requirements of the labor market. The object of training abroad is to learn to operate in the working environment of another culture and also to improve one's language skills. Working in a multicultural environment and living abroad develop the ability to cope with the requirements of the labor market. In the Degree Programme in Computer Science and Engineering practical training abroad also provides more credits than domestic training (more information on the degree programme web site).

Training is often conducted during the summer. Summer training is an excellent option, if you are interested in going abroad but not during the academic terms. Summer training abroad is a good opportunity also if you cannot find a summer job in Finland.

Trainee placement abroad can be obtained through various trainee programmes or by finding a placement independently. Trainee programmes suitable for the students of the school include among others IAESTE, CERN, and Vulcanus. Also the placements through e.g. CIMO and AIESEC may be suitable for the students of the school. In addition, several companies have their own trainee programmes abroad. Trainee placement can be obtained also independently by e.g. contacting an interesting company abroad. Information on seeking a trainee placement can be found at the Aalto Career Services website. More information and tips on applying for a job abroad as well as examples of job applications in different languages can be found also at the Career Services office. Open trainee posts are announced at the Career Services website.

Aalto University grants travel, trainee and Erasmus scholarships to students for training abroad. Scholarships are granted to students who have progressed adequately in their studies. Scholarship applications with appendices have to be submitted to the Career Services prior to the beginning of the training. Applications, instructions and scholarship amounts can be found at the Career Services website or requested from the trainee advisers of the degree programme.

More information on training abroad can be found at the Career Services website <https://into.aalto.fi/display/encareer/>.



## 17. STUDIES IN OTHER UNIVERSITIES AND AT DIFFERENT SCHOOLS OF AALTO UNIVERSITY

### ***17.1 Cross-disciplinary Studies at Aalto University***

Aalto University provides cross-disciplinary studies and opportunities for degree students to study at different schools of Aalto University. There are four application periods per year for individual internal mobility courses:

- 1–15 May for courses offered in period I
- 15–30 September for courses in period II
- 15–30 November for courses in period III
- 1–15 February for courses in periods IV and V.

Application period for minors is twice a year, 1–15 May and 15–30 September.

Within the field of technology, mobility is more free, and students do not need to apply through internal mobility.

An Aalto course is a course organized by one or more Aalto schools which is open to all students at the university, regardless of their field of study. Any student of Aalto can simply sign up, without needing to apply for a right to study.

### ***17.2 National JOO Agreement***

The purpose of the nationwide, flexible study right (JOO) agreement is to widen the course selection available to students and to promote the completion of degree studies. The agreement provides graduate students with an opportunity to include minors or individual courses from other universities in their studies. All universities in Finland are involved in this agreement. In some receiving universities the application periods are 1–31 October and 1–30 April. In others, applications are processed throughout the year.

### ***17.3 The application process***

The application for both JOO studies and internal mobility is done in the electronic Joopas application system. Before filling in the application, the student must have the studies approved as part of his/her official personal study plan (HOPS). Please contact your degree programme office for further information about the study plan. A copy of the study plan and an unofficial transcript should be enclosed with the application.

The application is first transferred to the person responsible for JOO studies and internal mobility at the student's home school. After the application is endorsed by the home school, it is electronically transferred to the receiving school or university. The final decision on the right to study is made by the school or university arranging the course in question. A JOO student who is granted the right to study receives further instructions from the receiving university. The student enrolls as either an attending or non-attending student at the home school. The Student Union fees are remitted only to the home university's student union.

### **17.4 Further information**

Instructions of the School of Science:

<https://into.aalto.fi/display/enmastersci/Internal+mobility+and+JOO+studies>.

Into site Internal mobility and JOO studies:

<https://into.aalto.fi/display/enmobility/Homepage>

- Courses offered, general principles of internal mobility, instructions on how to apply.

Joopas service:

<https://confluence.csc.fi/display/JOO/In+English+Flexible+Study+Rights>

- The electronic application system, instructions.

## 18. DOCTORAL STUDIES

The postgraduate degrees at Aalto University School of Science after the Master's degree are Licentiate of Science (Technology) and Doctor of Science (Technology). The Licentiate degree is a predoctoral postgraduate degree. The Doctor's degree can be taken directly after the Master's degree without first taking the Licentiate degree.

### **18.1 How to Start Doctoral Studies**

The planning of doctoral studies can be started already before completing the Master's degree. The student interested in postgraduate studies should contact the professor in charge of his/her postgraduate research field to discuss beginning doctoral studies.

The schools of Aalto University implement their doctoral education in the form of doctoral programmes. The Doctoral Programme of the School of Science can be applied for throughout the year with the exception of the research fields of the Department of Industrial Engineering and Management which can only be applied for once a year (application period ends at the end of April).

Information about admission requirements is available at:

<https://into.aalto.fi/display/endoctoralsci/Admission+requirements>

and information on how to apply at: <https://into.aalto.fi/display/endoctoralsci/How+to+apply>.

### **18.2 Doctoral Studies**

A Doctor's degree consists of theoretical studies and research with emphasis on scientific research.

#### **Theoretical Studies**

The theoretical studies included in the Doctor's degree consist of studies of the research field and studies that support the student's research field studies and the research itself. In addition the theoretical studies include studies that prepare the student for doctoral studies. If the theoretical studies have been completed already at the licentiate level, the Doctor's degree only includes a dissertation.

Courses completed before graduation but not included as part of the degree may be accepted as partial fulfillment of the demands of the Doctor's degree, as may similar level courses completed at other universities.

#### **Research**

Doctoral studies concentrate on research. For the Licentiate degree, the Licentiate thesis needs to be completed. For the Doctor's degree, the student needs to write a dissertation and defend it in public.

Further information on doctoral studies is available at: <https://into.aalto.fi/display/endoctoralsci/>.

## 19. LIBRARIES

### Library of Computer Science building

Address: Computer Science Building, 1<sup>st</sup> floor  
 Konemiehentie 2, Otaniemi, Espoo  
 Telephone: +358 50 3716404  
 E-mail: [t-kirjasto@aalto.fi](mailto:t-kirjasto@aalto.fi)  
 Web site: [http://sci.aalto.fi/en/services/library/t\\_as/](http://sci.aalto.fi/en/services/library/t_as/)

### Industrial Engineering and Management Library

Address: TUAS Building, 1<sup>st</sup> floor  
 Otaniementie 17, Otaniemi, Espoo  
 Telephone: +358 (0)9 470 22846  
 E-mail: [tuta-library@tkk.fi](mailto:tuta-library@tkk.fi)  
 Web site: <http://sci.aalto.fi/en/services/library/tuta/>

### Library of Mathematics and Systems Analysis

Address: Otakaari 1 M, 3rd floor, room U360A  
 Telephone: +358 (0)9 470 23099  
 E-mail: [ms-kirjast\(at\)aalto.fi](mailto:ms-kirjast(at)aalto.fi)  
 Web site: <http://sci.aalto.fi/en/services/library/ms/>

### Aalto University Otaniemi Campus Library

Address: Otaniementie 9, Espoo  
 Telephone: +358 50 316 1011  
 E-mail: [kirjasto-otaniemi@aalto.fi](mailto:kirjasto-otaniemi@aalto.fi)  
 Opening hours:  
 MON–FRI 9.00–21.00  
 SAT 9.00–16.00