



# Information and Communication Technology

## Study plan for third-cycle subject

*The subject plan was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring 11.*

## Subject title

Information and Communication Technology (Informations- och kommunikationsteknik)

## Subject description and programme outcomes

### Scientific field

#### 1.1 Scientific field

Information and communication technology can be divided into three parts: Communication: Services & Infrastructure, Electronic Systems and Micro and Nano Electronics.

The study in the subject Communication: Services & Infrastructure includes the interface between Services and Software respective to Infrastructure for calculation, storing and communication. A specialisation should be made within one of the fields Software and Service Systems, Distributed and Parallel Software and Computer Systems and Network Technology including both fixed and wireless and mobile communication. Both theory, design, implementation and evaluation of these systems are relevant.

Studies in the subject Electronic Systems include among other things design and analysis of electronic systems, computer systems and other systems that include electronics and/or computers and theories and methods for design, implementation and analysis of these. The subject can include the study of hardware and software, together or each in its own right.

The topic Micro and Nano Electronics is defined as the study of the physical and technological problems that occur in the context of interaction between electromagnetic fields and materials in the solid state. Of interest is also the technology for the production of these materials as well as components and circuits produced thereof and their function.

## 1.2 Specialisations

The specialisations are:

1. Communication: Services & Infrastructure/Communication: Services & Infrastructure (CSI)
2. Electronic Systems (ES)
3. Micro and Nano Electronics/MNF

The specialisations represented within the third-cycle subject area have joint parts, while they have specialised parts both when it comes to theory, method and application.

Doctoral students in the subject Information and Communication Technology should be given an extensive training in research methodology and acquire a good analytical ability. Active participation in national and international research networks within the knowledge field is strived for.

The aim with the education is that the doctoral students should become independent, excellent researchers. The research student should after completed studies be able to:

- describe and explain theories and empirical results within his/her specialised field
- formulate concrete research issues within the subject area Information and Communication Technology
- use scientific methods and provide new knowledge through own scientific studies
- analyse and evaluate critically applied methods and results from own and others'scientific studies
- present and discuss research results in the scientific community
- present research in an pedagogical manner outside the science community in education contexts
- assess ethical aspects around research within the subject area Information and Communication Technology and act from these and
- identify needs of new knowledge and have knowledge of how to initiate and lead research.

The education should also aim towards that the doctoral student after completed studies should be able to:

- participate in interdisciplinary cooperations within the problem area and
- analyse the role of research in the development of society.

## Description of possible specialisation

1. Specialisation in Communication: Services & Infrastructure
2. Specialisation in Electronic Systems
3. Specialisation in Micro and Nano Electronics

Specification of how the programme outcomes are to be achieved

## Specialisation in Communication: Services & Infrastructure

### Description of the specialisation

The study in the subject Communication: Services & Infrastructure includes the interface between Services and Software respective to infrastructure for calculation, storing and communication. A specialisation should be made within one of the fields Software and Service Systems, Distributed and Parallel Software and Computer Systems and Network Technologies including both fixed and wireless and mobile communication. Both theory, design, implementation and evaluation of these systems are relevant.

Courses within the following areas are recommended for doctoral students in Communication: Services & Infrastructures:

Dimensioning and performance analysis of communication systems

Architectures and protocols for communication systems

Communication related services and service platforms

Information & Communication theory

Wireless systems

Distributed Systems

Logic, Automata Theory, Complexity Theory, Artificial Intelligence

Data Security

## Human Machine Interaction

Tele Economy (cost and business models, regulation).

Courses from other areas as well as complementary courses (e.g. project management, teaching and learning and presentation techniques) may be included depending on the focus of the essay or thesis.

## Current research

Research within Communication Systems includes theory, design, implementation and evaluation of communication systems and communication services. In particular, fixed and wireless nets are treated, applications, systems for networks and service management, communications protocols and architectures for communication systems but also economic and regulative aspects on communication system. The research also includes the following fields:

Data Security, Human Machine Interaction and Applied Artificial Intelligence.

## Programme structure

The education for third-cycle studies consists of a course module and a thesis module. Course modules consist of lectures, literature studies and problem-solving activities, including active participation in seminars and conferences. Courses can be studied within the school or in collaboration with other national and international research departments.

The education for third-cycle studies are carry out under the guidance of a principal supervisor together with one or several assistant supervisors in accordance with an individual study plan that has been accepted by the person responsible for research education. The student's individual study plan should be adapted to the prior knowledge and to the specialisation of the thesis. The doctoral student's progress should be assessed at least once a year in connection with a review of the individual study plan that should be made by the student and his/her main supervisor.

Before completing a licentiate thesis or doctoral thesis, an internal review of the manuscript should be done by a specially appointed censor. The doctoral student should also participate in national and international conferences within the knowledge field.

## Compulsory and recommended courses

A degree of Licentiate consists of a course module of at least 30 credits and a thesis module of at least 60 credits, so that the sum amounts to 120 credits. The exact balance between course module and thesis module should be established in the individual study plan. Of the total course module at least half should be for third-cycle studies.

A degree of Doctor consists of a course module of at least 60 credits and a thesis module of at least 120 credits which in all should give 240 credits. The exact balance between course module and thesis module should be established in the individual study plan. Of the total course module at least 60 percents should be for third-cycle studies.

The course module for both degree of Licentiate and Degree of Doctor consists of compulsory and optional courses. The courses should be taken in accordance with an agreement between the student and his/her main supervisor, stated in an individual study plan.

Compulsory courses should be carried out equivalent to 7.5 credits for Degree of Licentiate and Degree of Doctor. The compulsory course and its credit are the following: - Theory of Science and Research Methodology, 7.5 credits (provided this knowledge is not present from the second cycle studies)

Courses can, by agreement with principal supervisors, be included from earlier education. At credit transfers, regulations in KTH's Degree Ordinance for the higher education qualifications should be observed for third-cycle studies. At Degree of Doctor at least 60 % and at the Degree of Licentiate at least 50 % of the total course module should be for third-cycle studies. Further according to the Degree Ordinance courses for first-cycle studies within the disciplinary domain Technology may not be included in doctor and Degree of Licentiate. From education for first-cycle studies and second cycle up to 240 credits no courses may be included.. No courses that are required for specific entry requirements to the education for third-cycle studies may be included.

Additional parts of courses that supervisors and students jointly deem important for the essay or the thesis may also be included in the course module of the Degrees of Licentiate or Doctor. Such credited activities can be individual literature courses, qualified actions in the research activity of the department or other qualified scientifically related activities. Because such activities should may be included, agreement in advance is required between principal supervisors and students with credits that are established in the individual study plan.

Courses in teaching and learning in higher education are a requirement, if teaching within first cycle and second cycle are to take place during the period of education.

## Thesis

The essay or the thesis is a compulsory part of the education for third-cycle studies. This part of the education aims at developing the student's ability to give independent contributions to research and cooperating to scientific studies within and outside his/her own subject. The essay/the thesis should contain new research results that the student has developed alone or in collaboration with others. The main scientific results should satisfy the quality requirements for publication in internationally recognised journals using a peer review system. The doctoral student's contributions to texts included in the essay/the thesis that have several authors should be distinguishable.

A licentiate thesis should contain an application of existing scientific knowledge within a new field that the student has developed via theoretical or empirical research. It should also contain an overview of earlier research within the chosen subject area. Irrespective of whether the licentiate thesis is presented as a monograph or as a joinder of scientific articles, it should be of such quality that it is judged to constitute ground for at least two normal articles that can be published in internationally respected magazines utilising a peer review system.

A thesis for the Degree of Doctor should contain new theoretical or empirical research results within the chosen subject area that the student has developed via theoretical or empirical research. It should

also contain an overview of earlier research within the chosen subject area. Irrespective of whether the doctoral thesis is presented as a monograph or as a joinder of scientific articles it should be of such quality that it is assessed to constitute ground for at least four normal articles that can be published in internationally respected magazines utilising a peer review system.

# Specialisation in Electronic Systems

## Description of the specialisation

Studies in the subject Electronic Systems include among other things Design and Analysis of Electronic Systems, Computer Systems and other systems that include electronics and/or computers and theories and methods for design, implementation and analysis of these. The subject can include the study of hardware and software, together or each in its own right.

## Current research

Research within electronic systems includes parts of the main fields of study Electrical Engineering and Computer Science. KTH carries out research within such subareas of Electronics and Computer Systems that are particularly relevant to Information and Communication Technology, such as Radio Electronics, Circuit Theory, Electronics, Electronic Construction Methods, Construction of Electronic Systems, Digital Technology, Embedded Systems, Compiler Technology, Computer Architecture, Parallel and Distributed Computer Systems, Performance Analysis of Computer Systems, Real Time Systems and Programming Languages, Software, Algorithms and theory of such systems.

## Programme structure

The education for third-cycle studies consists of a course module and a thesis module. Course modules consist of lectures, literature studies and problem-solving activities, including active participation in seminars and conferences. Courses can be studied within the school or in collaboration with other national and international research departments.

The education for third-cycle studies are carried out under the guidance of a principal supervisor together with one or several assistant supervisors in accordance with an individual study plan that has been approved by the person responsible for research education. The student's individual study plan should be adapted to the prior knowledge and to the specialisation of the thesis. The progress of the doctoral student should be assessed at least once a year in connection with audit of the individual study plan that should be made by the student and the principal supervisor.

Before completing of licentiate thesis or doctoral thesis, an internal review of manuscripts should take place with a particularly appointed censor. The doctoral student should also participate in national and international conferences within the knowledge field.

# Compulsory and recommended courses

A degree of Licentiate consists of a course module of at least 30 credits and a thesis module of at least 60 credits, so that the sum amounts to 120 credits. The exact balance between course module and thesis module should be established in the individual study plan. Of the total course module at least half should be for third-cycle studies.

The degree of Doctor consists of a course module of at least 60 credits and a thesis module of at least 120 credits which in all should give 240 credits. The exact balance between course module and thesis module should be established in the individual study plan. Of the total course module at least 60 percents should be for third-cycle studies.

The course module for both degrees of Licentiate and Doctor consists of compulsory and optional courses. The courses should be taken in accordance with an agreement between the student and his /her main supervisor, stated in the individual study plan.

Compulsory courses corresponding to 7.5 credits should be carried out for the Degree of Licentiate and the Degree of Doctor. The compulsory course and its credit are the following:

- Theory of Science and Research Methodology, 7.5 credits (if this knowledge is not present from the education in the second cycle)

Courses from earlier education can, by agreement with the principal supervisor, be included. At credit transfers, regulations in KTH's Degree Ordinance for the higher education qualifications should be observed for third cycle studies. In a Degree of Doctor at least 60 % and in the Degree of Licentiate at least 50 % of the total course module should be for third cycle studies. Further, according to the Degree Ordinance courses for first-cycle studies within the disciplinary domain Technology may not be included in the degrees Doctor and Licentiate. For education for first-cycle studies and second cycle up to 240 credits, no inclusion may occur. Courses that are required for specific entry requirements to the education for third-cycle studies may not be included.

Additional parts of the course as the supervisor and the student jointly deem important for the essay /thesis may also be included in the course module of Licentiate respective to Degree of Doctor. Such activities can be individual literature courses, qualified actions in the research activity of the department, or other qualified scientifically connected activities. In order for such activities to be included, an agreement in advance is required between the principal supervisor and the student with credits that are stated in the individual study plan.

Courses in teaching and learning in higher education are a requirement, if teaching within first cycle and second cycle should take place during the education period.

Courses within the following areas are recommended for doctoral students in Electronic Systems:

Formal Design Techniques Digital Systems Engineering Theory of Distributed Systems Concurrent Programming Semantics for Programming Languages Systems Modelling Systems ASIC Design Communication Systems

# Thesis

The essay / thesis is a compulsory part of the education for third cycle studies. This part of the education aims at developing the student's ability to give independent contributions to research and cooperating to scientific studies within and outside his/her own subject. The essay/the thesis should contain new research results that the student has developed alone or in collaboration with others. The main scientific results should satisfy the quality requirements for publication in internationally recognised journals with peer review systems. The doctoral student's contributions to texts that have several authors, and are included in the essay/the thesis should be distinguished.

A licentiate thesis should contain an application of existing scientific knowledge within a new field that the student has developed via theoretical or empirical research. It should also contain an overview of earlier research within the chosen subject area. Irrespective of whether the licentiate thesis is presented as a monograph or as a joinder of scientific articles it should be of such quality that it is assessed to constitute ground for at least two normal articles that can be published in internationally respected magazines with peer review systems.

A thesis for Degree of Doctor should contain new theoretical or empirical research results within the chosen subject area that the student has developed via theoretical or empirical research. It should also contain an overview of earlier research within the chosen subject area. Irrespective of whether the doctoral thesis is presented as a monograph or as a joinder of scientific articles it should be of such quality that it is assessed to constitute ground for at least four normal articles that can be published in internationally respected magazines with peer review systems. .

## Specialisation in Micro and Nano Electronics

### Description of the specialisation

The subject Micro and Nano Electronics is defined as the study of the physical and technological problems that occur in connection with the interaction between electromagnetic fields and materials in the solid state. Of interest is also the technology for the production of these materials both as components and circuits produced thereof and their function.

### Current research

Research within Micro and Nano Electronics includes parts of the main topics Physics and Electrical Engineering. At KTH, research is carried out within subareas of Micro Electronics and Applied Physics that are particularly relevant to Information and Communication Technology, such as Semiconductor Materials, Integrated Components, Circuits, Photonic Components, Radio Electronics, Circuit Theory, Electronics and Electronic Construction.



## Programme structure

The education for third-cycle studies consists of a course module and a thesis component. Course modules consist of lectures, literature studies and problem-solving activities, including active participation in seminars and conferences. Courses can be studied within the school or in collaboration with other national and international research departments.

The education for third-cycle studies are carried out under the guidance of a principal supervisor together with one or several assistant supervisors in accordance with an individual study plan that has been approved by the person responsible for the research education. The student's individual study plan should be adapted to the prior knowledge and to the specialisation of the thesis. The Doctoral student's progress should be assessed at least once a year in connection with the audit of the individual study plan that should be made by students and principal supervisors.

Before completing of a licentiate thesis or a doctoral thesis an internal prescreening of manuscripts should take place with a particularly appointed censor.. The doctoral student should also participate in national and international conferences within the knowledge field.

## Compulsory and recommended courses

A degree of Licentiate consists of a course module containing at least 30 credits and a thesis module containing at least 60 credits, so that the sum amounts to 120 credits. The exact balance between course module and thesis module should be established in the individual study plan. Of the total course module at least half should be for third-cycle studies.

A degree of Doctor consists of a course module containing at least 60 credits and a thesis module containing at least 120 credits which in all should give 240 credits. The exact balance between course module and thesis module should be established in the individual study plan. Of the total course module at least 60 percents should be for third-cycle studies.

The course module for both the degree of Licentiate and the degree of Doctor consists of compulsory and optional courses. The courses should be taken in accordance with an agreement between the student and his/her main supervisor, following an individual study plan.

Compulsory courses should be carried out equivalent to 7.5 credits for the degree of Licentiate and the degree of Doctor. The compulsory course and its credit are the following:  
- Theory of Science and Research Methodology, 7.5 credits (provided this knowledge is not covered by the student's education for second-cycle studies)

Courses from earlier education can be included, by agreement with the principal supervisor. At credit transfers, regulations in KTH's Degree Ordinance for the higher education qualifications should be observed for third-cycle studies. For a Degree of Doctor at least 60 % and for a Degree of Licentiate at least 50 % of the total course module should be for third-cycle studies. Further obtains according to the Degree Ordinance courses for first-cycle studies within the disciplinary domain

technology not be included in doctor and Degree of Licentiate. For education from the first-cycle and second cycle up to 240 credits no inclusion may occur. Obtained including not make courses that are required for specific entry requirements to the education for third-cycle studies.

Additional parts of the course as supervisors and students joint assess important for essay-/the thesis may also be included in the course module of licentiate- respective Degree of Doctor. Such activities can be individual literature courses, qualified actions in the research activity of the department, or other qualified scientifically connected activities. In order for such activities to be included, an agreement in advance is required between the principal supervisor and the student with credits that are established in the individual study plan.

Courses in teaching and learning in higher education are a requirement, if teaching within first cycle and second cycle should take place during the period of education.

Courses within the following areas are recommended for doctoral students in Micro and Nano Electronics:

Solid State Physics Characterization Techniques for Micro Electronics and Photonics Optics  
Microwave Engineering Fibre Optic Communication Photonics Electrical Analytical Methods and  
Test Structures Power Semiconductor Components

## Thesis

The essay/the thesis is a compulsory part of the education for third-cycle studies. This part of the education aims at developing the student's ability to give independent contributions to research and cooperating to scientific studies within and outside his/her own subject. The essay/the thesis should contain new research results that the student has developed alone or in collaboration with others. The main scientific results should satisfy the quality requirements for publication in internationally recognised journals with referee systems. The doctoral student's contributions to texts that have several authors included in the essay/the thesis should be distinguishable.

A licentiate thesis should contain an application of existing scientific knowledge within a new field that the student has developed via theoretical or empirical research. It should also contain an overview of earlier research within the chosen subject area. Irrespective of whether the licentiate thesis is presented as a monograph or as a joinder of scientific articles it should be of such quality that it is assessed to be able to constitute ground for at least two normal articles that can be published in internationally recognized magazines with a peer review system.

A thesis for Degree of Doctor should contain new theoretical or empirical research results within the chosen subject area that the student has developed via theoretical or empirical research. It should also contain an overview of earlier research within the chosen subject area. Irrespective of whether the doctoral thesis is presented as a monograph or as a joinder of scientific articles, it should be of such quality that it is assessed to constitute ground for at least four normal articles that can be published in internationally respected magazines utilising a peer review system.

# Entry requirements and selection

## General and special admission requirements and prior knowledge

General entry requirements for education for third-cycle studies consist of

- qualification awarded for second-cycle studies, or
- completed course requirements about at least 240 credits of which at least 60 credits should be for second-cycle studies or
- equivalent knowledge acquired in another way within or outside the country.

As requirements of specific entry requirements apply according to Higher Education Ordinance 7 chapter section 40 the requirement that are set because doctoral student should be able to absorb education. The requirements may intend:

- knowledge from higher education or the equivalent education,
- special professional or vocational experience, and
- necessary language skills or other conditions that are determined by the education.

For requirements of specific entry requirements at KTH, see

Admission regulations for education for third-cycle studies

Doctoral students are expected to be able to read and write scientific English and to be able to speak English fluently.

## Selection rules and procedures

Admission to education for third-cycle studies is decided by the dean of the school after preparation by the director of studies or the equivalent and where appropriate by the person responsible for the research education (at assessment of qualifications).

Apart from that the applicant has been tested to be eligible, it is the grade of maturity and ability to independently assess and critically analyse that is placed underlying selections. Of great interest in this assessment is earlier study results in courses of specialisation in academic first-cycle and second-cycle courses and study programmes or independently performed scientific work. To obtain a comprehensive decision-making basis, the applicants are interviewed by the director of studies or the equivalent together with the intended supervisor. Contact is normally taken with teachers at the

education that the applicant has earlier gone through. Selection among applicants to education for third-cycle studies are made by the dean of school in consultation with a director of studies or the equivalent and the intended principal supervisor in connection with the admission office.

## The programme's degrees and examinations

### Degree of Licentiate and Degree of Doctor (PhD)

#### **Degree of Licentiate and Degree of Doctor (PhD)**

The degree of Licentiate consists of a course module of at least 30 credits and a thesis module containing at least 60 credits so that the sum amounts to 120 credits. The degree of Licentiate consists of a course module of at least 30 credits and a thesis module containing at least 60 credits so that the sum amounts to 120 credits. The essay should be submitted and defended in accordance with KTH's general regulations.

A degree of Doctor consists of a course module containing at least 60 credits and a thesis module containing at least 120 credits so that the sum amounts to 240 credits. The exact balance between course module and thesis module should be established in the individual study plan. The thesis should be submitted and defended in accordance with KTH's general regulations. Courses and thesis work that are included in the Licentiate degree may also be included in the PhD degree.

### The programme's examinations

In courses for third-cycle studies a written examination should be included. In certain cases, this can be substituted by an oral test. The design of the examination should in an individual case be such that examiner can convince himself that the student has acquired the whole course content.

Belongs to: KTH ICT

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