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V-2023-0948 3.2.3**Entity responsible for supervision and questions**  
The School of Electrical Engineering and Computer Science

## General syllabus for education at third-cycle level in the subject **Electrical Engineering**

This regulatory document has been decided (E-2012-2331) pursuant to chapter 6 sections 26-27 of the Higher Education Ordinance. The regulatory document has been decided by the President and is valid with effect from 2024-02-06. The regulatory document regulates the main content of the education, requirements for special qualifications and the other regulations that are needed. The School of Electrical Engineering and Computer Science is responsible for review and questions about the governing document.

### 1 Content of the education

#### 1.1 The name of the subject in Swedish and in English translation

Elektro- och systemteknik (Electrical Engineering).

#### 1.2 Subject description

Electrical engineering ranges, in a broad sense, from research related to the science of electricity, including hardware design, to more theoretical topics. Disciplines include control engineering, communication and information theory, data-driven information processing, power engineering, electromagnetism, fusion plasma physics, space and plasma physics, micro- and nanosystems engineering, signal processing, and sound and image processing.

#### 1.3 Specialisations

- The doctoral programme has six specialisations
- Electromagnetic engineering
- Electric power and energy systems
- Information and signal processing
- Microsystems
- Plasma physics
- Decision and control systems

These are described in greater detail below

**Electromagnetic engineering:** This specialisation includes classical electromagnetic field theory and its applications, including antenna and microwave technology, based on analytical, numerical and experimental methods.

**Electric power and energy systems:** This specialisation includes electricity markets, integration of renewable electricity in power systems, the dynamics, operations and control of power systems, power electronics and its applications to power systems, electrical machines and drives and their applications in electrical transport, sustainable communications and control systems.

**Information and signal processing:** This specialisation includes the theory and application of various forms of information processing and transfer, based on information theory, communication theory, signal processing, machine learning, estimation, detection, and optimisation theory.

**Microsystems:** This specialisation includes micro- and nano-electromechanical systems and their application in medicine, life sciences, information and communications technologies, security, transport and aerospace.

**Plasma physics:** This specialisation includes theory, data analysis and simulations in fusion physics, space physics and general plasma fusion physics.

**Decision and control systems:** This specialisation includes the theory of and applications for different forms of control and modelling, based on control theory, optimisation theory, machine learning, system identification and estimation.

#### 1.4 Organisation of the education

The programme follows KTH's Guideline on Third-Cycle Studies and the Admission Regulations at KTH. Courses are decided on an individual basis, in consultation with the supervisor, and included in the individual study plan. During their studies, doctoral students must participate in and contribute to scientific activity at the school/KTH by participating in seminars and, in most cases, by holding one seminar per year on their thesis work. Doctoral students are normally requested to devote a certain amount of time (maximum 20 per cent of full-time) to teaching or other institutional duties. Such efforts must be included in the individual study plan and are a basis for extending the duration of the programme.

##### 1.4.1 Activities for fulfilment of outcomes for the education according to the Higher Education Ordinance (HF)

This section applies to all programme specialisations.

Below are described activities for the doctoral student's fulfilment of the learning outcomes for third-cycle education according to the Higher Education Ordinance (HF) and KTH's goals. The individual study plan specifies the activities for each individual doctoral student.

##### *Learning outcomes: Knowledge and understanding*

For the Degree of Doctor the doctoral student shall:

- Demonstrate broad knowledge and a systematic understanding of the research field as well as advanced and up-to-date specialist knowledge in a limited area of this field.

This outcome is achieved through the thesis work and through the doctoral student's participation in research seminars and completing a number of electrical engineering courses within and outside the area of specialisation.

- Demonstrate familiarity with research methodology in general and the methods of the specific field of research in particular.

This outcome can be achieved by completing the compulsory course Introduction to the Philosophy of Science and Research Methodology - short course, as well as through additional activities such as reading, discussing and presenting research articles in the research domain.

For a Degree of Licentiate, the doctoral student shall:

- Demonstrate knowledge and understanding in the field of research including current specialist knowledge in a limited area of this field as well as specialised knowledge of research methodology in general and the methods of the specific field in particular.

This outcome can be achieved with the thesis work, by reading, discussing and presenting research papers in the research domain, and through the doctoral student's participation in research seminars and the completion of a number of electrical engineering courses within and outside the area of specialisation.

*Learning outcome: Competence and skills*

For the Degree of Doctor the doctoral student shall:

- Demonstrate the capacity for scholarly analysis and synthesis as well as to review and assess new and complex phenomena, issues and situations autonomously and critically.

This outcome can be achieved by completing the compulsory course Philosophy of Science and Research Methodology - short course, as well as through participation in research and in research seminars, including presentation of one's own results and reviewing the research of others, e.g., through peer review of results.

- Demonstrate the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively, and to plan and use appropriate methods to undertake research and other qualified tasks within predetermined time frames and to review and evaluate such work.

This outcome can be achieved by completing the compulsory course Philosophy of Science and Research Methodology - short course, as well as by the supervisor gradually delegating to the doctoral student a greater role in proposing research questions and planning and carrying out research activities, and through participation in peer review.

- Demonstrate through a dissertation the ability to make a significant contribution to the formation of knowledge through his or her own research.

This outcome can be achieved by completing the compulsory course Introduction to Scientific Writing, as well as by writing a thesis.

- Demonstrate the ability in both national and international contexts to present and discuss research and research findings authoritatively in speech and writing and in dialogue with the academic community and society in general.

This outcome can be achieved by completing the compulsory course Basic Communication and Teaching, as well as the course Introduction to Scientific Writing

- Demonstrate the ability to identify the need for further knowledge.

This outcome can be achieved by completing the compulsory course Basic Communication and Teaching.

- Demonstrate the capacity to contribute to social development and support the learning of others both through research and education and in some other qualified professional capacity.

This outcome can be achieved by completing the compulsory course: The Sustainable Scientist, and by the doctoral student participating in some form of teaching, e.g., as a teaching assistant, laboratory assistant or external-workplace supervisor. If participation in educational activities is made impossible by the form of funding (e.g., scholarship), the doctoral student is encouraged to engage in guest lectures, external-employment supervision and/or participation in activities to attract young people and minorities to technical education.

For a Degree of Licentiate, the doctoral student shall:

- Demonstrate the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively, and to plan and use appropriate methods to undertake a limited piece of research and other qualified tasks within predetermined time frames in order to contribute to the formation of knowledge as well as to evaluate this work.

This outcome can be achieved by completing the compulsory course: Philosophy of Science and Research Methodology - short course, as well as through participation in research and in research seminars, including presentation of one's own results, by reviewing the research of others, e.g., through peer review of results, and by writing a licentiate thesis.

- Demonstrate ability in both national and international contexts to present, discuss research, and research findings in speech and writing and in dialogue with the academic community and society in general.

This outcome can be achieved by completing the compulsory course Basic Communication and Teaching, as well as by presenting one's own results at research seminars and conferences.

- Demonstrate the skills required to participate autonomously in research and development work and to work autonomously in some other qualified capacity.

This outcome can be achieved by completing the compulsory course Philosophy of Science and Research Methodology - short course, as well as through one's own research and writing.

*Learning outcomes: Judgement and approach*

For the Degree of Doctor the doctoral student shall:

- Demonstrate intellectual autonomy and disciplinary rectitude as well as the ability to make assessments of research ethics.

This outcome can be achieved by completing the compulsory course: The Sustainable Scientist and by participating in peer reviews as well as in discussions with supervisors and within the research group.

- Demonstrate specialised insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used.

This outcome can be achieved by completing the compulsory course: The Sustainable Scientist and by discussing these aspects of one's own research domain in seminars and in one's thesis.

For a Degree of Licentiate, the doctoral student shall:

- Demonstrate the ability to make assessments of ethical aspects of his or her own research.

This outcome can be achieved through completion of the compulsory course The Sustainable Scientist, and by participating in continuous discussions with supervisors and within research groups about one's own research.

- Demonstrate insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used.

This outcome can be achieved by completing the compulsory course: Philosophy of Science and Research Methodology - short course, and through participation in continuous discussions within one's own research group.

- Demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning.

This outcome is achieved by the doctoral student independently reading the necessary research literature to solve problems and relate solutions to previous research.

#### *KTH's outcome in sustainable development*

For both the Degree of Licentiate and the Degree of Doctor, the doctoral student shall:

- Demonstrate with knowledge and skills the ability to be able to contribute to sustainable societal development towards an equal, inclusive and climate-neutral society.

For the Degree of Licentiate, this outcome is achieved through participation in continuous discussions within one's own research group and reflecting, in one's thesis, on the sustainability aspects of one's own research project. For the Degree of Doctor, it can be achieved by completing the compulsory courses: The Sustainable Scientist and Basic Communication and Teaching and, to a greater degree, by completing the third-cycle courses in electrical engineering that include sustainability elements.

#### 1.4.2 Compulsory courses

The following four courses (or equivalent) are mandatory for the Degree of Doctor for all programme specialisations.

- Basic Communication and Teaching, 3.0 credits.
- Philosophy of Science and Research Methodology - short course, 3.0 credits (students having completed a philosophy of science course in their master's studies must take FAK3012 Supplementary Course in Theory and Methodology of Science 3.0 credits instead).
- The Sustainable Scientist, 2.0 credits (compulsory for Degree of Doctor only, not Licentiate degree).
- Introduction to Scientific Writing, 2.0 credits, or Writing Scientific Articles 5.0 credits (compulsory for Degree of Doctor only, not Licentiate degree).

#### 1.4.3 Recommended courses

Doctoral students are encouraged to take a language course (Swedish, if necessary, otherwise English or another language). Language courses should be at university level (first or second cycle) and should not exceed 6 credits.

Other courses are decided on an individual basis, in consultation with the supervisor, and documented in the individual study plan.

#### 1.4.4 Conditional elective courses

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#### 1.4.5 Requirements for the degree

##### 1.4.5.1 *For those specialising in information and signal processing or decision and control engineering*

#### **Degree of Doctor**

*A Degree of Doctor comprises 240 credits. At least 120 credits must consist of the doctoral thesis*

#### Thesis

*Quality requirements and possible other requirements for the thesis.*

A doctoral thesis can be written in the form of a monograph or in the form of a compilation thesis, and must include new theoretical and/or empirical research results in a relevant research domain as well as relating these to previous research in the domain. The main scientific results must meet the quality requirements for publication in internationally recognised peer-reviewed journals.

A doctoral thesis should normally be based on at least four articles submitted for publication in journals or as conference papers (of which at least one publication is a journal article and at least one has been accepted), with the doctoral student listed as the main author on at least one of these. However, the expected number of publications varies between different sub-domains

and is decided on an individual basis, in consultation with the supervisor. The thesis must be presented and defended according to KTH's rules. A doctoral thesis can be based on a licentiate thesis.

#### Courses

*The doctoral student shall have completed courses of at least 75 higher education credits, of which at least 60 per cent (45 credits) must be at third-cycle level, and no more than 10 credits may be at first-cycle level.*

#### Degree of Licentiate

*A Degree of Licentiate comprises at least 120 credits. At least 60 credits must consist of the academic paper.*

#### Thesis

*Quality requirements and possible other requirements for the licentiate thesis.*

A licentiate thesis must include new research results in a relevant research domain as well as relating this new contribution to current research in the domain. The main scientific results must meet the quality requirements for publication in internationally recognised peer-reviewed journals.

A licentiate thesis should normally be based on at least one article submitted for publication in a journal and at least one article accepted for publication in a journal or as a conference paper. However, the expected number of publications varies between different sub-domains and is decided on an individual basis, in consultation with the supervisor. The thesis must be presented and defended according to KTH's rules.

#### Courses

*The doctoral student shall have completed courses of at least 45 higher education credits, of which at least 22 credits must be at third-cycle level, and no more than 10 credits may be at first-cycle level.*

*1.4.5.2 For those specialising in electromagnetic engineering, electric power and energy systems, microsystems or plasma physics*

#### Degree of Doctor

*A Degree of Doctor comprises 240 credits. At least 120 credits must consist of the doctoral thesis*

#### Thesis

*Quality requirements and possible other requirements for the thesis.*

A doctoral thesis can be written in the form of a monograph or in the form of a compilation thesis and must include new theoretical and/or empirical research results in a relevant research domain as well as relating these to previous research in the domain. The main scientific results must meet the quality requirements for publication in internationally recognised peer-reviewed journals.

A doctoral thesis should normally be based on at least four articles submitted for publication in journals or as conference papers (of which at least one publication is a journal article and at least one has been accepted), with the doctoral student listed as the main author on at least one of these. However, the expected number of publications varies between different sub-domains

and is decided on an individual basis, in consultation with the supervisor. The thesis must be presented and defended according to KTH's rules. A doctoral thesis can be based on a licentiate thesis.

#### Courses

*The doctoral student shall have completed courses of at least 60 higher education credits, of which at least 45 credits must be at third-cycle level, and no more than 10 credits may be at first-cycle level.*

#### Degree of Licentiate

*A Degree of Licentiate comprises at least 120 credits. At least 60 credits must consist of the academic paper.*

#### Thesis

*Quality requirements and possible other requirements for the licentiate thesis.*

A licentiate thesis must include new research results in a relevant research domain as well as relating this new contribution to current research in the domain. The main scientific results must meet the quality requirements for publication in internationally recognised peer-reviewed journals.

A licentiate thesis should normally be based on at least one article submitted for publication in a journal and at least one article accepted for publication in a journal or as a conference paper. However, the expected number of publications varies between different sub-domains and is decided on an individual basis, in consultation with the supervisor. The thesis must be presented and defended according to KTH's rules.

#### Courses

*The doctoral student shall have completed courses of at least 30 higher education credits, of which at least 15 credits must be at third-cycle level, and no more than 10 credits may be at first-cycle level.*

#### 1.4.6 Other elements in the education to promote and ensure goal fulfilment

It is recommended for doctoral students to present at seminars corresponding to 30, 50 (or licentiate degree) and 80 per cent degree progress.

## 2 Admission to education at third-cycle level (qualification etc.)

Admission to education at third-cycle level is regulated in Chapter 7, Section 40 of the Higher Education Ordinance and in the admission regulations at KTH. KTH's regulations on specific prerequisites and such abilities in other respects as are needed to assimilate the education in the relevant subject at the doctoral level are set out below.

### 2.1 Specific prerequisites

To be admitted to the third-cycle education in **Electrical Engineering**, the applicant must have passed courses resulting in at least 60 credits at minimum second-cycle level in **Electrical Engineering** or other subjects deemed directly relevant to the chosen specialisation. These entry



requirements can be also be considered fulfilled by an applicant who has acquired essentially equivalent knowledge in arrangement.

In order to be admitted to third-cycle education in **Electrical Engineering**, the applicant must have knowledge of English equivalent to English 6.

## **2.2 Assessment criteria for testing the ability to assimilate the education**

The following assessment criteria apply for testing the ability to assimilate the education:

Selection for third-cycle education is based on assessed ability to assimilate such education. The ability assessment is primarily based on having passed courses and programmes that satisfy the entry requirements. Particular consideration is given to the following:

1. Knowledge and skills relevant for thesis work and the subject.  
These can be shown through attached documents and a possible interview
2. Assessed ability to work independently
  - a. ability to formulate and tackle scientific problems
  - b. ability to communicate well in speech and writing
  - c. maturity, judgement and ability to analyse critically and independently

The assessment may be based, for example, on degree projects and discussion of these at a possible interview.

3. Other experience relevant for third-cycle education, e.g. professional experience.

## **3 The other regulations needed**

### **3.1 Transitional regulations**

Doctoral students admitted under a previous programme syllabus have the right to switch to the most recently adopted and valid general syllabus. Requests to adopt a new syllabus are made to the director of third-cycle education. However, changing syllabi requires that the new syllabus can be achieved in time.