



General syllabus for third-cycle subject

Subject	Adopted	Registration number	Ks-kod
Electrical Engineering	30/11/2010 <i>Revised:</i> <i>13/06/2019</i>	V-2019-0638	3.2.3

General syllabus

Established by the Faculty Board/Education Committee 30/11/2010

Revised: 13/06/2019

The subject's Swedish name and its English translation

Elektro- och systemteknik (Electrical Engineering)

Subject description. The primary programme contents

The subject of Electrical Engineering includes research in the field of electricity theory. Examples of fields covered by this subject are electric power and energy systems, electrical machines, electrophysical engineering, electromagnetic field theory, industrial control systems, microsystem technology, signal processing, automatic control, communication theory, communication networks, as well as fusion plasma physics and space plasma physics.

Programme objectives based on the Higher Education Ordinance, Annex 2 Qualifications Ordinance.

The doctoral student's individual study plan must be structured so as to guarantee that the qualitative targets in the Higher Education Ordinance and KTH's objectives are attained. The attainment of these objectives shall be evaluated for each individual student. This will be done annually during a follow-up of the individual study plan. Comments will be made regarding the progression relative to the objectives based on the courses included in the programme and the thesis project. Other activities, such as supervision and external activities in line with the third mission shall also be taken into consideration.

State programme elements to benefit the attainment of goals under the headings below. Details submitted as an appendix of this syllabus for the subject.

Knowledge and understanding

For a Degree of Doctor, the doctoral student must

- demonstrate broad knowledge and systematic understanding of the research domain, as well as advanced and current specialised knowledge in a specific part of the research domain, and*
- demonstrate familiarity with the scientific method in general and the methods employed in the specific research domain in particular.*

This is achieved by:

Elements of the compulsory course AK3014 The Theory and Methodology of Science (see Appendix) or equivalent. Subject courses and thesis project.

Active participation in scientific conferences, workshops, summer courses and seminars.

Discussions with supervisor and research group members.

Skills and abilities, including communication skills

For a Degree of Doctor, the doctoral student must

- demonstrate skills in scientific analysis and synthesis, as well as the ability to independently review and assess new and complex concepts, issues and situations,*
- demonstrate the ability to critically, independently, creatively and with scientific precision identify and formulate issues, as well as plan and use adequate methods to conduct research and other qualified tasks within given timeframes, as well as reviewing and evaluating such work,*

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- *demonstrate the ability to make significant contributions to the development of knowledge through their own research as described in their thesis,*
- *demonstrate the ability to present and discuss research and research results with authority both in writing and verbally in dialogue with the national and international scientific community and society in general,*
- *demonstrate the ability to identify the needs for additional knowledge, and*
- *demonstrate the capacity to contribute to societal development and support others in their learning, both in research and education, as well as other professional contexts.*

This is achieved by:

Elements from the compulsory courses (see Appendix)

AK3014 The Theory and Methodology of Science

AK3012 Supplementary Course in Theory and Methodology of Science

DS3103 Introduction to Scientific Writing

LH3000 Basic Communication and Teaching, or equivalent courses.

The doctoral student will also receive training in:

Performing a literature review of the research domain and maintain an up-to-date contact with this.

Contributing well-conceived suggestions for new issues, hypotheses and research methods.

Drawing relevant conclusions based on research results in collaboration with supervisor.

Critically reviewing previously written research articles on the subject when authoring scientific articles.

Communicating in writing and gradually becoming more independent in the writing process.

Making significant contributions to the writing of research articles.

Actively participating in the publication process.

Making multiple verbal presentations at events such as conferences and seminars.

Designing and producing high-quality posters for conferences.

Teaching on first and/or second cycle courses, if possible.

Participating in supervision of degree projects.

Participating in the writing of research applications.

Judgement and approach

For a Degree of Doctor, the doctoral student must

- demonstrate intellectual independence and scientific integrity, as well as the ability to perform ethical research assessments, and

- demonstrate in-depth insight regarding scientific possibilities and our responsibility in its application.

This is achieved by:

Elements of the compulsory course AK3127 The Sustainable Scientist (see Appendix) or equivalent.

The doctoral student will also receive training in:

Scientific integrity, making ethical research assessment and deepening their understanding of science's role in society over the course of writing scientific papers and their thesis.

Understanding the meaning of plagiarism and how to avoid it.

Having an open, curious and explorative attitude.

Reflecting on ethical issues from the course The Sustainable Scientist in their own research.

Sustainable development

For a Degree of Doctor, the doctoral student must

- demonstrate knowledge and ability to make environmental and ethical assessments in order to contribute to a sustainable societal development.

This is achieved by:

Elements of the compulsory course AK3127 The Sustainable Scientist (see Appendix) or equivalent.

Two programme-specific courses (see Appendix) for every track of the specialisation Electrical Engineering contain elements of sustainable development, which will be examined. The programme specialisation International Track in Electrical Engineering contains equivalent elements of sustainable development in its course component.

Sustainability issues relevant to the subject in question must be brought up in the doctoral thesis.

The doctoral student will also receive training in:

Reflecting on sustainability issues based on the course The Sustainable Scientist in their own research.

SPECIALISATION ELECTRICAL ENGINEERING

Specific entry requirements

Admission to third-cycle studies in Electrical Engineering requires the applicant to have completed courses equivalent to at least 120 higher education credits from second-cycle studies or higher in the subject Electrical Engineering or other subjects deemed directly relevant to the specialisation in question. These requirements will also be considered fulfilled by applicants who have acquired the equivalent knowledge through other means. Normally, a master's degree in the relevant research domain fulfils these requirements. Applicants are expected to be able to read and write scientific texts in English, as well as being able to communicate verbally in English.

Selection rules

Selection for third-cycle studies is made based on the assessed ability to benefit from such studies. The assessment of this ability is primarily made based on qualifying education. The following is given particular attention:

1. Knowledge and skills relevant to writing a doctoral thesis on the subject.
These can be demonstrated through appended documents and a potential interview.
2. Assessed ability to conduct independent work
 - a. ability to formulate and tackle scientific problems.
 - b. ability to communicate verbally and in writing.
 - c. maturity, judgement and the ability to conduct independent critical analysis.

Assessment can be based on factors such as a degree project and discussion of said project during a potential interview.

3. Other experiences relevant to the third-cycle studies, e.g. professional experience.

Contents and examination of the course component

All third-cycle courses are divided into two categories:

- *General skills:* This covers courses fundamental to third-cycle studies. The courses are general and relevant to all doctoral student's attending the programme. They provide knowledge and skills in teaching and learning in higher education, verbal communication, scientific writing, scientific theory, research methodology, research ethics, research application, innovation processes, including application for patents and sustainable development.
- *Programme-specific courses:* This includes basic or specialised courses for studies in the subject in question.

Classification is done by the Director of Third-Cycle Education at the School of Electrical Engineering and Computer Science after consultation with the Third-Cycle Programme Co-ordinator. A number of courses within a number of different tracks are offered within the framework of the third-cycle programme in Electrical

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Engineering.. The Director of Third-Cycle Education has the opportunity to delegate the classification to the supervisor for courses not given at the School of Electrical Engineering and Computer Science.

Courses included in the individual study plan shall normally include a written examination. A verbal examination may be possible in certain cases. The examination shall be of such a nature as to assess whether the intended course learning outcomes have been achieved.

Degree requirements

Degree of Doctor

A doctoral degree covers 240 credits. The thesis component shall cover at least 120 credits.

Thesis

A doctoral thesis shall contain new theoretical and/or empirical research results within a relevant research domain and place these in relation to previous research in the given field.

The thesis must, at least in part, be publishable in recognized, peer-reviewed international publications.

In the case of a compilation thesis, at least four articles should be accepted for publication in journals or as conference articles (at least one publication must be an article in a journal) with the doctoral student as the main author of at least one.

The thesis shall be presented and defended pursuant to KTH's regulations.

A doctoral thesis may be based on a licentiate thesis.

Courses

The course component consists of at least 75 credits and may not cover more than 120 credits.

At least 60 per cent of the course credits must be from third-cycle studies.

A maximum of 10 credits from first-cycle studies may be included in the doctoral degree.

The general skills courses must cover at least 10 credits and no more than 20 credits.

The following general skills courses are compulsory (see Appendix for additional comments):

- LH3000 Basic Communication and Teaching, 3 credits
- AK3014 The Theory and Methodology of Science – minor course*, 3 credits
- DS3103 Introduction to Scientific Writing, 2 credits
- AK3127 The Sustainable Scientist, 2 credits

*Students who have already completed a course in research methodology at master's level will instead be taking

- AK3012 Supplementary Course in Theory and Methodology of Science, 3 credits.

Licentiate degree

The licentiate degree shall cover at least 120 credits. The thesis component shall cover at least 60 credits.

Dissertation

A licentiate thesis must contain an overview of previous research in a relevant research domain and place this in relation to new contributions made to current research in said domain. The thesis must, at least in part, be publishable in recognized, peer-reviewed international journals.

For a compilation paper, at least one article should normally be submitted to a journal and at least one article should be accepted for publication in a journal or as a conference article.

The thesis shall be presented and defended pursuant to KTH's regulations.

Courses

The course component consists of at least 45 credits and may not cover more than 60 credits.

At least 50 per cent of the course credits must be from third-cycle studies.

A maximum of 10 credits from first-cycle studies may be included in the licentiate degree.

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The general skills courses must cover at least 5 credits and no more than 10.

General skills courses (see Appendix for additional comments):

- LH3000 Basic Communication and Teaching, 3 credits
- AK3014 The Theory and Methodology of Science – minor course*, 3 credits
- DS3103 Introduction to Scientific Writing, 2 credits
- AK3127 The Sustainable Scientist, 2 credits

*Students who have already completed a course in research methodology at master's level will instead be taking

- AK3012 Supplementary Course in Theory and Methodology of Science, 3 credits.

SPECIALISATION

INTERNATIONAL TRACK IN ELECTRICAL ENGINEERING

Background

This specialisation is used for international education collaborations and leads to a doctoral degree/licentiate degree in Electrical Engineering. The EECS at KTH is a partner in a collaboration. Every collaboration is specified in its corresponding appendix. The terms and conditions established through the network's framework agreement as described in the appendices apply.

Specific entry requirements

Admission to third-cycle studies in Electrical Engineering requires the applicant to have completed courses equivalent to at least 120 credits from second-cycle studies or higher in the subject Electrical Engineering or other subjects deemed directly relevant to the specialisation in question. These requirements will also be considered fulfilled by applicants who have acquired the equivalent knowledge through other means. Normally, a master's degree in the relevant research domain fulfils these requirements. Applicants are expected to be able to read and write scientific texts in English, as well as being able to communicate verbally in English.

Selection rules

Selection for third-cycle studies is made based on the assessed ability to benefit from such studies. The assessment of this ability is primarily made based on qualifying educational efforts. The following is given particular attention:

1. Knowledge and skills relevant to writing a doctoral thesis on the subject.

These can be demonstrated through enclosed documents and a potential interview.

2. Assessed ability to conduct independent work

- a. ability to formulate and tackle scientific problems.

- b. ability to communicate verbally and in writing.

- c. maturity, judgement and the ability to conduct independent critical analysis.

Assessment can be made from factors such as a degree project and a discussion of said project during a potential interview.

3. Other experiences relevant to the third-cycle studies, e.g. professional experience.

Contents and examination of the course component

The degree covers a course component consisting of at least 60 credits. These higher education credits may be awarded by the various higher education institutions included in the mobility plan.

Courses included in the individual study plan shall normally include a written examination. A verbal examination may be possible in certain cases. The examination shall be of such a nature as to assess whether the intended course learning outcomes have been achieved.

Degree requirements

Doctoral degree

A doctoral degree covers 240 credits. The thesis component shall cover at least 120 credits.

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Thesis

A doctoral thesis shall contain new theoretical and/or empirical research results within a relevant research domain, as well placing these in relation to previous research in the given field.

The thesis must, at least in part, be publishable in recognized, peer-reviewed international publications.

For a compilation thesis, at least four articles should be accepted for publication in journals or as conference articles (at least one publication must be an article in a journal) with the doctoral student as the main author of at least one.

The thesis shall be presented and defended pursuant to KTH's regulations.

A doctoral thesis may be based on a licentiate thesis.

Courses

The course component adheres to KTH's minimum requirements for a doctoral degree.

The courses shall consist of at least 60 credits and may not cover more than 120 credits.

At least 45 of the credits must be from courses that are part of third-cycle studies.

A maximum of 10 credits from first-cycle studies may be included in the doctoral degree.

The general skills courses must cover at least 10 credits any no more than 20 credits.

The following general skills courses are compulsory (see Appendix for additional comments):

- LH3000 Basic Communication and Teaching, 3 credits
- AK3014 The Theory and Methodology of Science – minor course*, 3 credits
- DS3103 Introduction to Scientific Writing, 2 credits
- AK3127 The Sustainable Scientist, 2 credits

*Students who have already completed a course in research methodology at master's level will instead be taking

- AK3012 Supplementary Course in Theory and Methodology of Science, 3 credits.

These courses may be replaced by equivalent courses with similar contents from other higher education institutions included in the mobility plan.

Licentiate degree

The licentiate degree shall cover at least 120 credits. The dissertation component shall cover at least 60 credits.

Dissertation

A licentiate dissertation must contain an overview of previous research in a relevant research domain and place this in relation to new contributions made to current research in that domain. The paper must, at least in part, be publishable in recognized, peer-reviewed international publications.

For a compilation thesis, at least one article should normally be submitted to a journal and at least one article should be accepted for publication in a journal or as a conference article.

The paper shall be presented and defended pursuant to KTH's regulations.

Courses

The course component adheres to KTH's minimum requirements for licentiate degrees.

The courses shall consist of at least 30 credits and may not cover more than 60 credits.

At least 15 of the credits must be from courses that are part of third-cycle studies.

A maximum of 10 credits from first-cycle studies may be included in the licentiate degree.

The general skills courses must cover at least 5 credits any no more than 10.

General skills courses (see Appendix for additional comments):

- LH3000 Basic Communication and Teaching, 3 credits
- AK3014 The Theory and Methodology of Science – minor course*, 3 credits
- DS3103 Introduction to Scientific Writing, 2 credits
- AK3127 The Sustainable Scientist, 2 credits

*Students who have already completed a course in research methodology at master's level will instead be taking

- AK3012 Supplementary Course in Theory and Methodology of Science, 3 credits.

Goal attainment

Programme objectives based on the Higher Education Ordinance, Annex 2 Qualifications Ordinance, with concretisation for the subject and information about the programme structure to support the doctoral student in attaining the objectives.

The following section describes how the requirements outlined in the Higher Education Ordinance are connected to the *compulsory general skills courses* of the programme for both doctoral and licentiate degrees.

Additionally, the thesis project and points listed under “Programme objectives” (see above) help contribute to the goal attainment.

The progression towards the objectives shall be evaluated regularly by doctoral students in consultation with their supervisor, with final assessment conducted by the Director of Third-Cycle Education.

The **compulsory general skills courses** assigned to the specialisation **Electrical Engineering** are

LH3000 Basic Communication and Teaching, 3 credits

AK3014 The Theory and Methodology of Science – minor course*, 3 credits

DS3103 Introduction to Scientific Writing, 2 credits

AK3127 The Sustainable Scientist, 2 credits

*Students who have already completed a course in research methodology at master’s level shall instead take AK3012 Supplementary Course in Theory and Methodology of Science, 3 credits.

The **compulsory general skills courses** assigned to the **International Track in Electric Engineering** are the same as above. These courses may however be replaced by equivalent courses with similar contents from other higher education institutions included in the mobility plan.

This must also be considered when specific KTH courses are mentioned in the table for goal attainment below.

Doctoral degree

Doctoral degree, qualitative targets stipulated by the Higher Education Ordinance	Concretisation and adaption of the objectives for the third-cycle subject Electrical Engineering	Programme elements intended to promote goal attainment (text in quotes recites material from course syllabuses)
Demonstrate substantial knowledge in, and systematic understanding of, the research domain, as well as advanced and current specialised knowledge in a specific part of the research domain.	Demonstrate substantial knowledge in, and systematic understanding of, the subject electrical engineering, as well as deep and current specialised knowledge in a specific part of the research domain.	Subject courses and thesis project.
Demonstrate familiarity with the scientific method in general and the methods employed in the specific research domain in particular.	Demonstrate familiarity with the scientific method in general and the specific research methods employed in the field of electrical engineering in particular.	Course AK3014: “Describe theoretical and methodological scientific problems and apply basic theoretical and methodological scientific concepts”, “Identify and critically discuss basic theoretical and methodological scientific problems pertaining to theoretical, natural and social sciences, both verbally and in writing”, “Identify and critically discuss basic scientific theoretical and methodological problems of a study, the design of an experiment, the use of a particular method of measurement and the use of a particular model, both verbally and in writing”.
		Course AK3014: “Describe basic

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Demonstrate skills in scientific analysis and synthesis, as well as the ability to independently review and assess new and complex concepts, problems and situations.	Additional concretisation is not required.	theories on the epistemological and explanatory prerequisites of the sciences". Course AK3012: "Critical analysis of theoretical and methodological problems within the student's own area of research, as well as in other areas of research".
Demonstrate the ability to critically, independently, creatively and with scientific precision identify and formulate issues, as well as plan and through adequate methods conduct research and other qualified tasks within given timeframes, as well as reviewing and evaluating work of said nature.	Additional concretisation is not required.	Course AK3014: "The fundamental problems shared by all the natural sciences and the general strategies, methods and concepts developed by modern science to deal with these problems" and "analyse the relation between the results that has been achieved in a study and the conclusions that are explained of the results."
Demonstrate the ability to make significant contributions to the development of knowledge through their thesis.	Additional concretisation is not required.	Course DS3103: "Understand the basic principles of scientific writing intended for both specialised and non-specialised demographics", "Applying the IMRD structure when writing an article", "argue convincingly for a research idea with reference to published research material" and "correctly use and refer to source material according to publication standards."
Demonstrate the ability to with authority present and discuss research and research results both in writing and verbally in dialogue with the national and international scientific community and society in general.	Additional concretisation is not required.	Course LH3000: "Present and explain subjects and perform activating tasks within the field of study in question" and "Show an ability to use and apply basic concepts, material and methods and conditions of teaching and learning within higher education" Course DS3103: "Understand the basic principles of scientific writing intended for both specialised and non-specialised demographics" and "popular scientific writing".
Demonstrate the ability to identify the needs for additional knowledge.	Additional concretisation is not required.	Course LH3000: "Give and receive feedback" and "Preparation, practice and reflection together with reading and sharing experiences and ideas about teaching and learning with others"
Demonstrate the capacity to contribute to societal development and support others in their learning, both in research and education, as well as other professional contexts.	Additional concretisation is not required.	Course DS3103: "Argue convincingly for a research idea with reference to published research material" Course AK3127: "Innovation, intellectual property and product sales".
Demonstrate intellectual independence and scientific integrity, as well as the ability to perform ethical research assessments.	Additional concretisation is not required.	Course AK3127: "Basic research ethics. Key ethical issues and concepts (such as autonomy and informed consent). Research misconduct. The relevance of the research norms of basic ethical theories. Ethical review and

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		research ethics committees, the new law on research ethics review.”
Demonstrate in-depth insight regarding the possibilities and limitations of science and our responsibility in its application.	Additional concretisation is not required.	Course AK3127: “The researcher’s responsibility for the consequences of their research.” And “Innovation – Different ways to create value and impact from research results.”
Demonstrate knowledge about and the ability to make environmental and ethical assessments in order to contribute to a sustainable societal development.	Local KTH goal	Course AK3127: “Key concepts and issues. Ethical responsibility for sustainability. The moral responsibility of researchers, engineers and experts. Interactions between science, policy and society. Corporate responsibility.” In addition to the intended learning outcomes for the programme-specific courses related to sustainable development.

Licentiate degree

Licentiate degree, qualitative targets stipulated by the Higher Education Ordinance	Concretisation and adaption of the goal for the third-cycle subject Electrical Engineering	Programme elements intended to promote goal attainment (text in quotes recites material from the course syllabus)
Demonstrate knowledge and understanding in the research domain, including current specialist knowledge in scientific methodology in general and in the specific research domain in particular.	Demonstrate knowledge and understanding in electrical engineering, including current specialist knowledge in a specific part of this field, as well as scientific methodology in general and in electrical engineering in particular.	Course AK3014: “Describe theoretical and methodological scientific problems and apply basic theoretical and methodological scientific concepts”, “Identify and critically discuss basic theoretical and methodological scientific problems pertaining to theoretical, natural and social sciences, both verbally and in writing”, Identify and critically discuss basic scientific theoretical and methodological problems of a study, the design of an experiment, the use of a particular method of measurement and the use of a particular model, both verbally and in writing”.
Demonstrate the ability to critically, independently, creatively and with scientific precision identify and formulate problems, to plan and use adequate methods to conduct specified research and other qualified tasks within given timeframes in order to help contribute to the development of knowledge, as well as reviewing and evaluating work of said nature.	Additional concretisation is not required.	Course AK3014: “The basic problems shared by all the natural sciences and the general strategies, methods and concepts developed by modern science to deal with these problems” and “analyse the relation between the results achieved in a study and the conclusions motivated by the results.”
Demonstrate the ability to clearly present and discuss research and research results both in speech		Course LH3000: “Present and explain subjects and perform activating tasks within the field of study in question” and “Show an ability to use and apply basic concepts, material and methods in, for teaching and learning within

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and in writing in dialogue with the national and international scientific community and society in general.	Additional concretisation is not required.	higher education” Course DS3103: “Understand the basic principles of scientific writing intended for both specialised and non-specialised demographics” and “popular scientific writing”. “Applying the IMRD structure when writing an article”, “argue convincingly for a research idea with reference to published research material” and “correctly use and refer to source material according to publication standards”.
Demonstrate the skills necessary for independent participation in research and development efforts and to work independently in other qualified operations.	Additional concretisation is not required.	Subject courses and thesis project.
Demonstrate the ability to perform ethical research assessments and applying these to one’s own research.	Additional concretisation is not required.	Course AK3127: “Basic research ethics. Key ethical issues and concepts (such as autonomy and informed consent). Research misconduct. The relevance of the research norms of basic ethical theories. Ethical review and research ethics committees, the new law on research ethics review.”
Demonstrate insight regarding the possibilities and limitations of science and our responsibility in its application.	Additional concretisation is not required.	Course AK3127: “The researcher’s responsibility for the consequences of their research.” And “Innovation – Different ways to create value and impact from research results.”
Demonstrate the ability to identify their need for additional knowledge and take responsibility for the development of their own knowledge.	Additional concretisation is not required.	Course LH3000: “Give and receive feedback” and “Preparation, practice and reflection together with reading and sharing experiences and ideas about teaching and learning with others”
Demonstrate knowledge and ability to make environmental and ethical assessments in order to contribute to a sustainable societal development.	Local KTH goal	Course AK3127: “Key concepts and issues. Ethical responsibility for sustainability. The moral responsibility of researchers, engineers and experts. Interactions between science, policy and society. Corporate responsibility.” In addition through the intended learning outcomes for programme-specific courses related to sustainable development.