

# Study Plan for Doctoral Studies in the subject of Electrical Engineering

## 1. Background

At KTH, studies are arranged within programs, at first, second and third cycle levels. Doctoral studies may lead to a Licentiate Degree in Engineering or a PhD degree. Local regulations for these degrees have been established by the Faculty Board and the President (Internal Regulations No. 15/07 in effect as of 1 July 2007).

This course plan for doctoral studies in the subject Electrical Engineering describes the process and criteria for doctoral studies within the framework of the doctoral program Electrical Engineering. Included in the course plan are appendixes listing courses offered by the School of Electrical Engineering. This subject has two areas of specialization:

- Electrical Engineering (EE)
- Sustainable Energy Technologies and Strategies (SETS)

The specialization SETS is part of an Erasmus Mundus program for joint doctoral degrees in Sustainable Energy Technologies and Strategies (SETS Joint Doctorate). A prerequisite for admittance to the SETS specialization here is that a student has been awarded a scholarship for the Erasmus Mundus SETS-program. Description of this specialization will be found below.

Appendix A, which details the agreement defining SETS, is a part of this study plan, which will also include appendixes listing courses included in the program.

## 2. Description of subject and educational objectives

### 2.1. Electrical Engineering

Electrical Engineering as a subject comprehends research in various related fields. Examples of specialized areas include power electronics, electrical machines, electromagnetics, industrial control systems, microsystem technology, signal processing, automatic control, communication theory, communication networks and also fusion and space plasma physics.

### 2.2 Relationship to Electrical Engineering doctoral program

The subject of Electrical Engineering is comprised of in-depth scientific studies within the framework of the Electrical Engineering doctoral program.

The doctoral program contains a range of courses organized in five tracks:

- Energy and electromagnetics
- Information and communications technology
- Microsystems
- Intelligent transportation systems
- Plasma physics

These tracks make it possible to design a course of study for each student individually. They ensure that students gain both general knowledge in the subject area and in-depth knowledge within a specific specialized field of study.

### 2.2 Objectives and criteria

The objective of this program is to educate excellent, independent researchers who are able to contribute to the sustainable development of society. More specifically the program intends to prepare students for highly-qualified, professional research careers in one of the specialized areas of electrical engineering.

Through this course of study the doctoral student will have acquired both general and in-depth knowledge within at least one specialized area of electrical engineering. After completed studies, the student will meet the requirements of the Higher Education Ordinance SFS 2006:1053 and be able to:

- describe and explain theories and empirical results in his/her field of research.
- formulate specific research issues in this field of research.
- use scientific methods and develop new knowledge through his/her own scientific studies.
- critically analyse and evaluate methods applied and results from his/her own scientific studies and those of others.
- present and discuss research results in the scientific community.
- present research in a pedagogical manner outside the scientific community, and also in an educational context.
- assess ethical aspects of research in his/her field, and act in accordance with ethical conclusions.
- identify needs for new knowledge and be proficient in initiating and leading research.

Another goal of this program is that researchers who have completed doctoral studies will be equipped to participate in multi-disciplinary cooperative efforts on issues within their area of focus as well as being able to analyse the role of research in development of society.

The individual study program of each doctoral student must be designed to ensure the achievement of the above-mentioned objectives. Each year when the individual study program is updated, the primary supervisor and the doctoral student together will describe the plan which will enable the student to achieve these goals. If these objectives have not been met by the time a student has completed his/her course of study, the supervisor must be prepared to provide an explanation.

### **Description of the specializations**

Here follows a more detailed description of each specialization.

## **Study Plan for the specialization in Electrical Engineering**

### **1. Background**

See description of subject above.

### **2. Description of subject and educational objectives**

See description of subject above.

### **3. Current research**

Current research is pursued at the School of Electrical Engineering in various areas of specialization which correspond to the different labs at the School.

### **4. Disposition of the Course of Study**

Studies are pursued under the guidance of a primary supervisor, aided by one or more secondary supervisors, in accordance with an individual study program which has been approved by the Director of Doctoral Studies in consultation with the Executive Committee of the program.

Individual study programs must take into account the student's previous knowledge and skills and also the direction that thesis work is taking. Progress is to be assessed at least once a year in connection with a review of the individual study program, which is to be done jointly by the student and primary supervisor. At the same time, an assessment must also be made of the quality of the doctoral student's research environment.

Doctoral studies consist in part of a course component and in part of a thesis component. The distribution of credits between these two components is to be clearly stated in the individual study

program when it is first drawn up, as a student begins his/her studies. Based on the student's background and research field, a list of courses will be compiled which the student will be required to complete in order to fulfil program requirements.

A number of courses at the doctoral studies level are provided through the Electrical Engineering doctoral program. Other relevant courses found outside of the program may also be included.

The research component of the studies will be under the guidance of the primary supervisor with the support of one or more secondary supervisors.

## **5. Courses**

All courses are to be classified in one of three different categories:

*General skills:* This category includes courses that are fundamental to research studies. These are general courses that are relevant to all doctoral students in the program. They include university pedagogy (ways of teaching), courses in research methods, history of research and patent law.

*Basic courses:* This category includes courses that form the basis for studies in each specialized area.

*Advanced courses:* These are advanced courses at research level (third cycle) that are specific to, and provide in-depth knowledge of an area of specialization.

The Director of Doctoral Studies will determine classification of courses in consultation with the Executive Committee of the program. Courses will be organized within five tracks.

## **6. Thesis**

Of considerable weight in the requirements for a licentiate or a doctorate degree is the thesis. A thesis can be either a compilation of scientific papers with an introduction and a short summary (compilation thesis), or a monograph. The thesis must be written in English. A doctoral thesis may be based on a licentiate thesis. Both licentiate and doctoral theses must be written individually.

A licentiate thesis must contain a review of previous work in the same field and relate this new contribution to existing knowledge within the area. It must be possible to publish component parts of the licentiate thesis in recognised, international journals with referee review. The normal requirement is one submitted journal article and one published conference article.

A doctoral thesis must include new theoretical and/or empirical research results in a relevant research field and also relate this new contribution to existing knowledge in the field. It must be possible to publish component parts of the thesis in recognised, international journals with referee review. The normal requirement is to have at least one article accepted for publication, one article submitted for publication and three conference contributions published.

## **7. Qualifications and admission**

### *7.1 Qualifications*

In order to be admitted to the Electrical Engineering program, the basic requirements concerning qualifications in accordance with Chapter 7, Section 39 of the Higher Education Ordinance must be met.

In addition to basic qualification requirements, a candidate must normally have earned a university degree. This degree must be the equivalent of a Master of Science in Engineering with a

concentration relevant to the research area. Normally a Master's degree in a relevant research field fulfils this requirement.

Applicants are expected to be able to read and write scientific texts in English as well as being able to communicate verbally in English.

### *7.2 Admission*

The selection of applicants for admission is based on their qualification, suitability and projected ability to complete doctoral studies in Electrical Engineering, especially in the field of research to which they are applying. Selection is to be made from among the candidates who fulfil the qualification requirements. Important aspects such as the applicant's degree of maturity, ability to make independent judgements and critical analyses are considered during the selection process. Applicants' study results from courses at second level or results achieved from independent project work are also important.

## **8. Examinations in the Course of Study**

Regulations stated in the national degree ordinance and local KTH examination procedures apply.

### *8.1 Licentiate and doctorate degrees*

Studies may lead to a licentiate or a doctorate degree.

The licentiate degree comprises 120 credits, of which the course component must include a minimum of 45 credits and a maximum of 60 credits. At least 50 % of the course credits must come from third cycle courses.

The following combination of courses is required for the licentiate degree:

*General skills:* A minimum of 5 credits and maximum of 10 credits

*Basic courses:* A minimum of 10 credits

*Advanced courses:* A minimum of 10 credits

A maximum of 10 credits from basic courses from the first cycle in science and technical subjects may be included in the licentiate degree.

A licentiate thesis must be presented and defended in accordance with KTH regulations.

The doctorate degree comprises 240 credits of which the course component must be a minimum of 75 credits and a maximum of 120 credits. At least 60 % of the course credits must be from third cycle courses.

The following combination of courses is required for the doctorate degree:

*General skills:* A minimum of 10 credits and a maximum of 20 credits

*Basic courses:* A minimum of 20 credits

*Advanced courses:* A minimum of 20 credits

A maximum of 10 credits from basic courses from the first cycle in science and technical subjects may be included in the doctorate degree.

A doctoral thesis must be presented and defended in accordance with KTH regulations. A doctoral thesis may be based on a licentiate thesis.

### *8.2 Examinations included in the course of study*

Courses included in the individual study program should normally entail written examinations. In certain cases, an oral examination may be permissible. The nature of the examination must be such that it is possible to measure whether the objectives of the course have been achieved.

## **Study Plan for specialization in Sustainable Energy Technologies and Strategies (SETS)**

### **1. Background**

This specialization leads to a joint degree according to the requirements established in the Framework Agreement of the European Commission (see appendices 1-3). KTH, Comillas and TUDelft are the Higher Education Institutions awarding the joint degrees.

The Royal Institute of Technology (KTH) has, together with five other Higher Education Institutions, signed and established the Erasmus Mundus Joint Doctoral Degree in Sustainable Energy Technologies and Strategies (SETS). The other institutions are:

1. Universidad Pontificia Comillas (Comillas), Madrid, Spain
2. Delft University of Technology, (TUDelft), Delft, the Netherlands
3. Johns Hopkins University (JHU) Baltimore, MD, USA
4. Université Paris Sud 11 (Paris SUD11), Paris, France
5. Florence School of Regulation (FSR), Florence, Italy

Below follows a description of the subject matter included and the requirements for the joint degree applicable for this specialization.

### **2. Description of subject and educational objectives**

See description of subject above.

### **3. Current research**

SETS includes research in the following areas:

- **Future energy networks:** multi-energy carrier systems; security and reliability of energy systems; integration of renewables; integration of electric vehicles; demand side management; active networks; and de-centralized control.
- **Regulation and economics of energy systems in future European scenarios:** regulatory schemes for promoting energy transition, including new decision-tools for policy makers; regulatory incentives to promote energy efficiency; and new market designs.
- **Sustainable development:** definition and quantification of economic and sustainability indices for regional grids and microgrids; environmental life-cycle analysis; power system operations and design for sustainability; analysis of government policies designed to promote sustainability, including design and evaluation of international environmental agreements; monitoring and enforcement of environmental regulation.

Focus will be on analysis of sustainable energy technologies and strategies in a comprehensive manner and on contributing to economic growth and sustainable development in order to implement new strategies and technology, along with other research results.

#### **4. Disposition of the Course of Study**

The disposition of the course of study will be governed by the agreement which regulates the joint doctoral program, see Appendix A.

#### **5. Courses**

There are no compulsory courses for this specialization. Recommended courses include research, theoretical courses to deepen knowledge of subjects and courses leading to generic competences, in accordance with the regulations in force at the universities awarding degrees.

#### **6. Thesis**

Of considerable weight in the requirements for a doctorate degree is the thesis. A thesis can be either a compilation of scientific papers with an introduction and a short summary (compilation thesis), or a monograph. The thesis must be written in English and must be written individually.

A doctoral thesis must include new theoretical and/or empirical research results in a relevant research field and also relate this new contribution to existing knowledge in the field. At least two articles must have been published or accepted for publication in a journal listed in *Journal Citation Report (JCR)*.

#### **7. Qualifications and admission**

##### *7.1 Qualifications*

In order to be admitted to the SETS specialization, the applicant must have completed the equivalent of 300 university credits (högskolepoäng), of which at least 60 credits must be included in a Master of Science degree and on the master's level.

This degree must be the equivalent of a Master of Science in Engineering with a concentration relevant to the research area.

Applicants must exhibit sufficient skills in English, according to the criteria established annually by the Management Board of the program. To be admitted to this specialization requires a scholarship from the Erasmus Mundus SETS program. For details about this and the process of admission, see Appendix A.

##### *7.1 Admission*

Details concerning the admission process may be found in Appendix A.

#### **8. Examinations in the Course of Study**

##### *8.1 General Criteria*

This specializations leads exclusively to the doctorate degree comprising 240 credits (högskolepoäng) Regulations for examination are as given in the Higher Education Ordinance. In addition, KTH's local regulations must be complied with by students defending their thesis at KTH. The quality review of the thesis must be done according to the procedure found in Appendix A. The public defence of the thesis must be effected according to the procedure found in Appendix A. This includes, among other things, regulations concerning the Examination Committee. The normal time span for completion of doctoral studies is four academic years, but the thesis may be defended at an earlier date if all criteria are met.

##### *8.2 Criteria for the Course Component of studies*

The doctoral degree includes a course component including a minimum of 60 credits (högskolepoäng). At least 30 of these credits must be earned through specific, approved courses. The remaining 30 credits may be earned through research carried out by the student within the research group. These credits may be acquired from the various Higher Education Institutions included in the mobility pathway. Any course approved by one of the Higher Education Institutions in the Joint Doctorate program, will be recognized by all other partners in the program. The course component must be completed prior to the beginning of the fourth academic year.

### *8.3 Criteria for Mobility*

A minimum of eighteen months must be spent at the home university. A minimum of nine months must be spent at another one of the Higher Education Institutions which awards the joint doctorate in SETS degree. If any time of the mobility is spent in the country where a student's Master's degree was awarded, then at least six months must be spent at a third Higher Education Institution.