Programme syllabus

Master's Programme, Smart Electrical Networks and Systems, 120 credits
Masterprogram, smarta elektriska nätverk och system
120.0 credits

Valid for students admitted to the education from autumn 13 (HT - Autumn term; VT - Spring term).

This is a translation of the Swedish, legally binding, programme syllabus.

Programme objectives

This programme is a joint programme among eight European universities engaged in the framework of European Institute of Innovation Technology (EIT) and the knowledge area “InnoEnergy” that aims to promote innovative solutions to the Energy area.

The programme parts at KTH has much resemblance with and is run in conjunction with the programme Electric Power Engineering (TELPM). The focus in this programme is on existing technologies as well, but with a strong emphasis on novel and innovative technologies that may cause the evolution of the existing electric power grid into a ‘Smart Grid’. Thematically, the following three subject areas are covered at KTH:

1. Smart electric power systems (focusing on power system dynamics, stability and control, electricity markets, distributed generation).

2. Design, control and monitoring of intelligent power components (focusing on the physical and technical fundamentals for design, testing, controllability and condition based maintenance of electrical low and high voltage components, equipment and systems).

3. Electrical energy conversion technologies (focusing on electrical machines and power electronics).

The purpose of this programme is that the participants (after successful completion) will be able to identify, explain, analyse and solve classical problems within the electric power area, but also analyze new concepts and innovations and the possibilities and limitations of these new products all the way from idea to commercialisation.

Knowledge and understanding

For the Master’s Degree, the student should:

- have a thorough understanding of and high competence in electrical engineering principles, electrical energy systems, electrical energy conversion technologies, electrical machines and power electronics, electro-technical design principle, power system control and operation, diagnostic and monitoring technologies
- have knowledge and understanding of current theories and developments in electrical power engineering
- have a thorough knowledge and understanding of the concepts in the philosophy and methodology of science to analyse, criticise and report on scientific information from published source
- have insight in the process from innovative idea to commercial product

Skills and abilities

For the Master’s Degree, the student should be able to:

- independently apply mathematics and natural science to the electric power engineering
• employ a range of techniques and modern electric power engineering tools to identify, analyse and solve the
  electric power engineering problems in professional and research environments
• effectively communicate and function in a team.
• propose and investigate the innovation processes from idea to final product.

Ability to make judgements and adopt a standpoint

For the Master’s Degree, the student should show:

• insight into the role of electric power engineering in society, economy and environment
• awareness of ethical aspects in research and development work
• show independent learning ability for continuing professional development.
• ability to identify innovations and perform analysis on their route towards the electricity market

Extent and content of the programme

The programme lasts for two academic years (120 higher education credits) on the advanced level (second cycle). The
language of instruction throughout the programme is English. The fulfilment of the programme requires a mandatory
change of university between the first and second study year, i.e. 60 ECTS credits have to be studied at another
university within the consortium.

Eligibility and selection

Basic admission requirements Basic eligibility to be accepted to the master’s programme requires a completed
Bachelor's degree, corresponding to a Swedish Bachelor's degree (180 higher education credits), or equivalent academic
qualifications from an internationally recognised university. The university has to be listed in the latest edition of the
International Handbook of Universities. Students should have in addition, good knowledge in English, oral and written,
is required. Applicants must provide proof of their proficiency in English. Specific admission requirements Specific
eligibility to the programme requires:

• electrical engineering (including three phase electrical circuits or machines) equivalent to 60 higher education
  credits
• mathematics (calculus, numerical methods, algebra, probability theory) equivalent to at least 30 higher
  education credits.

The specific eligibility requirements can be assessed as not-fulfilled if: 1. the CGPA is less than 75% of the highest
grade
2. the degree awarding institution is not considered to meet acceptable quality standards by the authorities of the
country in which the institution is located
3. the degree does not qualify for admission to equivalent Master level in the country where the degree is awarded.

Selection process The selection process for the program is based on a total evaluation of the following selection
criteria: University, CGPA, motivation letter where a mandatory part is to explain in what way the student can be
innovative and produce new smart grid solutions, working experiences relevant to the programme, references and a
final interview after a first selection. Information on the eligibility requirements can be found in the local admission
policy of KTH at http://www.kth.se/studies/master/admission?l=en

Implementation of the education

Structure of the education

The programme lasts for two academic years, with one year at another university within the InnoEnergy framework. At
KTH, the academic year is divided into two terms. The autumn term starts in late August and runs until the middle of
January. The spring term begins in the middle of January and runs until the end of May/the beginning of June. The
Christmas break is two weeks and the Easter break one week. Specific dates may be found at http://www.kth.se/studies
/calendar?l=en. Each term consists of two study periods. Each study period comprises seven weeks of scheduled tuition
such as lectures, laboratory lessons, etc., followed by one week of examinations free from scheduled tuition. There are also re-examination periods in January, June and in August. The programme offers five compulsory courses in the first year (37.5 higher education credits), and two (15 higher education credits) if attending the second year. The conditional elective and elective courses may be selected in both first and second year.

Courses
The programme is course-based. Lists of courses are included in appendix 1.

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Grading system
Courses in the first and the second cycle are graded on a scale from A to F. A-E are passing grades, A is the highest grade. The grades pass (P) and fail (F) are used for courses under certain circumstances.

All courses are graded on a scale from A to F. A-E are passing grades, A is the highest grade.

Conditions for participation in the programme
For promotion to study year two at a partner university, the student should have passed all 60 credits from the first year, but a minimum of 45 higher education credits are obligatory.

Recognition of previous academic studies
Under certain circumstances, and in agreement with the programme director, credits for previous studies can be received according to the local policy of KTH, see http://www.kth.se/info/kth-handboken/II/13/3.html

Studies abroad
Studies abroad is mandatory within the SENSE program. If the first year is studied at KTH, then a second study year, including the master thesis work, is performed at another partner university represented in Spain, France, Germany, Belgium, The Netherland and Poland. The program is also hosting students in a second study year from other partner universities.

Degree project
For second year students only:

The final degree project is worth 30 higher education credits, and corresponds to five months of full-time study. It may be carried out either at the university or in industry. The project is summarised in a written report, and finally presented at a seminar. The project should have a clear relevance to smart grids concepts and should have a clear orientation towards innovative solutions of relevance for the electric power area. The project work can begin if the student has an agreement with an examiner, the student has obtained 75 higher education credits at least all courses completed from the first year, and at least 15 higher education credits from completed courses in the second year, the student has completed the courses relevant to the project subject. The final degree project is expected to be performed during semester 4 of studies, and be finished in the end of semester 4. The project presentation is normally given in a seminar session and in a joint exhibit. More information on the KTH policy on the degree project can be found at http://www.kth.se/info/kth-handboken/II/15/5.html

Degree
The student will achieve double master’s degree after fulfilment of all requirements.

To graduate with a master’s degree, a master’s degree student must obtain 120 higher education credits and meet the following degree requirements:

- all compulsory courses (37.5 higher education credits for a first years students and 15 higher education credits for second years students) have been successfully completed,
• conditional elective courses (1) corresponding to at least 30 higher education credits have been successfully completed.
• conditional elective courses (2) corresponding to at least 7.5 higher education credits have been successfully completed.
• the final degree project (30 higher education credits) has been successfully completed. In addition to the requirements stated above, a master’s degree student must submit the original certificate from previous education (Bachelor’s or similar),
• a proof that all financial obligations (student union fee) to KTH have been met. Degree names Students who have successfully completed a two-year Master's programme (120 higher education credits) will be awarded a "Teknologie masterexamen", translated into English as "Degree of Master of Science (two years)". More information on the degree requirements can be found in the local admission policy of KTH at http://www.kth.se/info/kth-handboken/II/19/1x.html

Appendix 1 - Course list
Appendix 2 - Programme syllabus descriptions
Appendix 1: Course list

Master's Programme, Smart Electrical Networks and Systems, 120 credits (TSENM), Programme syllabus for studies starting in autumn 2013

**General courses**

**Year 1**

**Mandatory courses (37.5 credits)**

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>EG2021</td>
<td>Power System Analysis, part 1</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EH2740</td>
<td>Computer Applications in Power Systems, basic course</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EI2455</td>
<td>Smart Electrical Networks and Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EJ2200</td>
<td>Electrical Machines and Drives</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EJ2300</td>
<td>Power Electronics</td>
<td>7.5</td>
<td>Second cycle</td>
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**Conditionally elective courses**

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
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</tr>
</thead>
<tbody>
<tr>
<td>EG2050</td>
<td>System Planning</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EG2060</td>
<td>Electricity Market Analysis</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EG2070</td>
<td>FACTS and HVDC in Electric Power Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EG2110</td>
<td>Power System Stability and Control</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EH2030</td>
<td>Business Development and Quality Management</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EI2430</td>
<td>High-voltage Engineering</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EI2433</td>
<td>Electrotechnical Modelling</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EI2435</td>
<td>Power Grid Technology and Components</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EI2440</td>
<td>Electrotechnical Design</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EJ2210</td>
<td>Analysis of Electrical Machines</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EJ2420</td>
<td>Seminars in Electrical Machines and Power Electronics</td>
<td>1.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>
### Recommended courses

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>AK2036</td>
<td>Theory and Methodology of Science with Applications (Natural and Technological Science)</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EG2040</td>
<td>Wind Power Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EH2720</td>
<td>Management of Projects</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2620</td>
<td>Nonlinear Control</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

### Supplementary information

In order to earn a degree from the program, which is a double degree program, the student must complete 60 credits of coursework from one university in the first year and 60 credits of coursework from the other university in the second year. The university attended the second year must be a partner university in a different country from the first year’s university.

A student who studies the first year at KTH must take a minimum of 60 course credits: specifically 37.5 credits of compulsory courses, 15 credits of specified conditional elective courses and 7.5 credits of elective courses.

### Year 2

#### Mandatory courses (15.0 credits)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>EG2031</td>
<td>Power System Analysis, part 2</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EI2435</td>
<td>Power Grid Technology and Components</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

#### Conditionally elective courses

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>EG2080</td>
<td>Monte Carlo Methods in Engineering</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EH2030</td>
<td>Business Development and Quality Management</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EH2720</td>
<td>Management of Projects</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EH2730</td>
<td>Requirements Engineering</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EH2740</td>
<td>Computer Applications in Power Systems, basic course</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EH2750</td>
<td>Computer Applications in Power Systems, Advanced Course</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EJ2221</td>
<td>Design of Permanent Magnet Synchronous Machines</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EJ2311</td>
<td>Modulation of Power Electronic Converters</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
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<td>Nonlinear Control</td>
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A student who study the second year at KTH must take a minimum of 30 course credits: specifically 15 credits of compulsory courses and 15 credits of conditional elective/recommended courses. The remaining 30 credits consists of the MSc thesis work.
Appendix 2: Specialisations

Master's Programme, Smart Electrical Networks and Systems, 120 credits (TSENM), Programme syllabus for studies starting in autumn 2013

This programme has no specialisations.