

International Office, LTH

## **General syllabus for third-cycle studies in Industrial Automation TEMIEF00**

The syllabus was approved by the Board of the Faculty of Engineering/LTH 24 September 2007 and most recently amended 8 September 2020 (reg. no U 2020/679).

### **1. Subject description**

Industrial automation involves the integration of information systems with material and energy flows. The subject is based on a synthesis of automatic control, real time systems and instrumentation engineering. Actuators in the form of electrical drives are important components of many integrated systems. Automation concentrates on the structural problems in manufacturing systems, processing industries or power industries. The subject's focus is on the coordination of and interaction between many different components such as machines or processes, rather than control of individual components. Research in industrial automation is often inspired by industrial problems.

### **2. Objective of third-cycle studies at LTH**

The Board of LTH established the following objective for third-cycle studies on 15 February 2007.

The overall objective of third-cycle studies at LTH is to contribute to social development and prosperity by meeting the needs of business and industry, academia and wider society for staff with third-cycle qualifications. LTH shall primarily provide education leading to a PhD or licentiate in the fields of LTH's professional degrees. The

programmes are first and foremost intended for the further training of engineers and architects. The programmes are designed to encourage personal development and the individual's unique qualities.

Third-cycle graduates from LTH shall demonstrate:

- proficiency in research theories and methods and in a critical, scientific approach
- both breadth and depth of knowledge within the subject of his or her third-cycle studies

The programmes aim to develop:

- creativity and independence with the ability to formulate advanced research issues, solve problems and plan, carry out and evaluate projects within a set time frame
- openness to change
- personal networks, both national and international
- social skills and communication skills
- teaching ability
- innovation skills, leadership and entrepreneurship

In order to enable students to achieve these skills and abilities, LTH provides:

- high-quality supervision and good conditions for study in a creative environment
- a good balance between basic and applied research, with openness to wider society
- a range of advanced third-cycle courses at both departmental and faculty level
- a good balance between courses and thesis work
- opportunities to present research findings at national and international conferences and in internationally recognised journals, or by another equivalent method which leads to wide exposure and circulation
- opportunities to spend time in international research environments for short or extended periods

### 3. Learning outcomes for third-cycle studies

The learning outcomes for third-cycle studies are given in the Higher Education Ordinance.

#### 3.1 Licentiate

##### *Knowledge and understanding*

For a Licentiate the third-cycle 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 of research in particular

##### *Competence and skills*

For a Licentiate the third-cycle 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
- demonstrate the ability in both national and international contexts to present and discuss research and research findings in speech and writing and in dialogue with the academic community and society in general
- demonstrate the skills required to participate autonomously in research and development work and to work autonomously in some other qualified capacity.

##### *Judgement and approach*

For a Licentiate the third-cycle student shall:

- demonstrate the ability to make assessments of ethical aspects of his or her 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
- demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning

### **3.2 Doctor of Philosophy**

#### ***Knowledge and understanding***

For the degree of Doctor of Philosophy the third-cycle student shall:

- demonstrate broad knowledge and systematic understanding of the research field as well as advanced and up-to-date specialised knowledge in a limited area of this field
- demonstrate familiarity with research methodology in general and the methods of the specific field of research in particular

#### ***Competence and skills***

For the degree of Doctor of Philosophy the third-cycle student shall:

- demonstrate the capacity for scholarly analysis and synthesis as well to review and assess new and complex phenomena, issues and situations autonomously and critically
- 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
- demonstrate through a thesis the ability to make a significant contribution to the formation of knowledge through his or her own research
- 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
- demonstrate the ability to identify the need for further knowledge

- 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

### ***Judgement and approach***

For the degree of Doctor of Philosophy the third-cycle student shall:

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

### ***Midway Review***

A midway review, with the aim of reviewing the doctoral student's education in relation to the learning outcomes for the degree in the Higher Education Ordinance, is to be implemented at least once during the doctoral student's programme for all doctoral students whose education is to conclude with a doctoral degree.

## **4. General and specific admission requirements**

### **4.1 General admission requirements**

A person meets the general admission requirements for third-cycle courses and study programmes if he or she:

- has been awarded a second-cycle qualification, or
- has satisfied the requirements for courses comprising at least 240 credits of which at least 60 credits were awarded in the second cycle, or
- has acquired substantially equivalent knowledge in some other way in Sweden or abroad.

The higher education institution may permit an exemption from the general entry requirements for an individual applicant, if there are special grounds. Ordinance (2010:1064).

## 4.2 Specific admission requirements

A person meets the specific admission requirements if he or she has:

- at least 30 second-cycle credits of relevance to the field of study

Finally, the student must be judged to have the potential to complete the programme.

Exemptions from the admission requirements may be granted by the Board of LTH.

## 5. Selection

Selection for third-cycle studies is based on the student's potential to profit from such studies.

The assessment of potential in accordance with the first paragraph is made primarily on the basis of academic results from the first and second cycle. Special attention is paid to the following:

- Knowledge and skills relevant to the thesis project and the subject of study. These may be demonstrated through documents appended to the application and at a possible interview.
- An assessment of ability to work independently and to formulate and tackle research problems. The assessment could be made on the basis of the student's degree project and a discussion of this at a possible interview.
- Written and oral communication skills
- Other experience relevant to the third-cycle studies, e.g. professional experience.

## 6. Degree requirements

Third-cycle studies lead to a PhD or, if the student wishes or if it has been specified in the decision on admission, to a licentiate. The student also has the right to complete a licentiate as a stage in his or her third-cycle studies, but is not obliged to do so.

The requirements for a licentiate are:

- passed courses of at least 45 credits, and
- a passed thesis of a scope corresponding to studies of at least 75 credits

The thesis and courses shall comprise at least 120 credits in total.

The requirements for a PhD are:

- passed courses of at least 75 credits, and
- a passed thesis of a scope corresponding to studies of at least 165 credits

The thesis and courses shall comprise at least 240 credits in total.

## 6.1 Degrees awarded

The programme can lead to the following degrees:

- *Teknologie licentiatexamen*/Licentiate in Engineering
- *Teknologie doktorsexamen*/Doctor of Philosophy in Engineering

or:

- *Filosofie licentiatexamen*/Licentiate of Philosophy
- *Filosofie doktorsexamen*/Doctor of Philosophy

## 7. Course component

The programme is to include courses. For each course, an examiner shall be appointed at the department that delivers the course. The examiner shall draw up a written syllabus which states the course title in Swedish and English, the learning outcomes of the course, the course content and the number of credits.

The individual study plan is to include details of which courses the individual student shall or may include in his or her studies and how many credits for each course may be included in the degree. Courses taken at other faculties or higher education institutions may also be included in the study plan.

It is compulsory to participate in and pass the course Introductory Workshop for Newly Admitted Doctoral Students at LTH (*Introduktionskurs för nyantagna doktorander vid LTH*) GEM056F or the equivalent.

It is also compulsory to attend and earn a Pass grade on the course Research Ethics, GEM090F.

As industrial automation is a broad field, it is important that every doctoral student takes courses that will enable the doctoral students at the department to communicate and have at least a superficial understanding of one another's research. Therefore, basic courses in the following subjects are prioritised: automatic control, mathematical statistics, signal processing, software systems and electric machine systems. In addition, courses in areas such as teaching and learning, presentation techniques, literature searching and research methodology are deemed important.

The following guidelines apply to the composition of the course component of the programme.

## **7.1 Licentiate**

The course component is to include courses from at least three of the following subject areas:

- Electrical energy engineering
- Automatic control
- Industrial automation
- Mathematics, in particular matrix theory and optimisation
- Computer science
- Mathematical statistics and/or signal processing

The emphasis in the courses is determined by the specialisation of the thesis.



## 7.2 Doctor of Philosophy

The course component is to include courses from at least three of the following subject areas:

- Electrical energy engineering
- Automatic control
- Industrial automation
- Mathematics, in particular matrix theory and optimisation
- Computer science
- Mathematical statistics and/or signal processing

The emphasis in the courses is determined by the specialisation of the thesis.

## 8. Thesis

The programme shall include a research project documented in a licentiate or doctoral thesis.

The principal supervisor is responsible for ensuring that the thesis project has a relevant focus and scope. Research projects in industrial automation usually have a reference group. The reference group is made up of individuals with expertise in the subject and often include representatives of both industry and academia. During their third-cycle studies, doctoral students are expected to take gradually increasing responsibility for the design of the research. In order to ensure high quality in the research, the results should be published in national and international forums such as journals or conferences. Participation in seminar activities at the home department is also an important part of third-cycle studies, as this provides opportunities for continual critical review of the work. Supervisors and the steering group form the basis of a network, of which the doctoral student is invited to take advantage. Students are encouraged to spend time at research institutions abroad, as this offers good opportunities to expand their network.

## 8.1 Licentiate thesis

The licentiate thesis comprises study of at least 75 credits. The subject of the thesis is decided in consultation between the doctoral student and the supervisors, and is entered into the individual study plan. The thesis is written in English and resembles a short doctoral thesis in structure.

The licentiate thesis is graded either pass or fail by an examiner appointed by the head of department. The thesis is presented at a public seminar, where it is scrutinised by an informal reviewer appointed by the principal supervisor. At the licentiate seminar, the subject is presented in general terms and the doctoral student discusses his or her thesis with the informal reviewer on the basis of questions posed by the latter.

## 8.2 PhD thesis

The PhD thesis comprises study of at least 165 credits. The thesis is to be written in English and structured either as a monograph or as a compilation thesis. The thesis is to be presented and defended publicly.

## 9. Transitional provisions

For doctoral students with an admission date of 1 January 2019 or later, it is compulsory to participate in and pass the course Introductory Workshop for Newly Admitted Doctoral Students at LTH (*Introduktionskurs för nyantagna doktorander vid LTH*) GEM056F or the equivalent in order to fulfil the requirements for the degree.

For doctoral students admitted on or after 1 January 2021, it is compulsory to attend and earn a Pass grade on the course Research Ethics, GEM090F.

The midway review is compulsory for doctoral students admitted on or after 1 January 2019.