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Faculty of Health, Science and Technology

# Programme syllabus for doctoral studies in Chemical Engineering

## **Syllabus Approval**

The programme syllabus was approved by the Faculty Board of Health, Science and Technology on 26 October 2023 and is in effect as of 26 October 2023.

General stipulations for third-cycle education are provided in the Higher Education Act and in the Higher Education Ordinance. The Licentiate/Doctoral programme is offered to the extent permitted by available funding.

### **1. General Information**

The chemical engineering research at Karlstad University includes studies on sustainable processes and materials based on lignocellulosic raw materials. The research is focused on energy-efficient processes and systems analysis, cellulose chemistry and pulping technology, paper technology unit processes, coating technology, and packaging applications. The research is highly multidisciplinary and is often conducted in collaboration with partners at other universities and research institutes, as well as with external partners at both national and international levels. The methods include everything from a fundamental and theoretical approach to significantly more applied and experimental methods. Since chemical engineering includes a large number of sub processes, there is a significant amount of research equipment available. Much of this equipment is focused on forest industry processes and materials, ranging from pulp production and derivatisation processes to fiber treatment (both chemical and mechanical) and paper technology unit operations for manufacturing various kinds of paper products. The research field also includes additional value-adding processes such as coating and other conversion operations for paper material, as well as textile material production processes. In connection to the previously mentioned research, theoretical modelling – including relevant experiments for validation – is also important. Upscaling is often an integrated part of research projects, whether conducted at Karlstad University or in collaboration with external actors. Digitalised chemical engineering industrial processes are common, which means they are also common in the process-focused research at the discipline.

In compliance with Karlstad University's equal opportunity policy, the subjects of equality and diversity shall be included in PhD studies. The doctoral student should also learn about multidisciplinary approaches and gain experience from interactions across traditional disciplinary borders. Pursuant to Karlstad University's environmental policy, the programme shall also include environmental aspects and sustainability issues.

## 2. Programme Outcomes

The general outcomes of licentiate or doctoral studies in terms of knowledge and understanding, competence and skills, and judgement and approach are specified as follows in the System of Qualifications (Higher Education Ordinance, Annex 2):

### *Degree of Licentiate*

#### *Knowledge and understanding*

*For a Degree of 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 Degree of 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, and*
- 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 Degree of 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, and*
- demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning.*

### *Degree of Doctor*

#### *Knowledge and understanding*

*For the **Degree of Doctor** 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, and*
- 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**, 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,*
- 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 dissertation 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 and*
- 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** the third-cycle student shall*

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

### **3. Qualification requirements**

*The requirements for admission to third-cycle courses and study programmes are that the applicant meets the general and specific entry requirements, and is considered in other respects to have the ability required to benefit from the course or study programme.*

#### **3.1 General eligibility**

*A person who has earned a master's degree of at least 240 ECTS credits of which at least 60 ECTS credits are studies at master's level, or who in some other way in the country or abroad has acquired largely equivalent knowledge has general eligibility for admission. If there are special reasons for doing so, the faculty board may grant an individual applicant exemption from the general eligibility (Higher Education Ordinance, Ch.7, section 39).*

#### **3.2 Specific Entry Requirements for Doctoral Studies**

To meet the specific entry requirements for doctoral studies in Chemical Engineering, the applicant must have been awarded a second-cycle qualification with a major in Chemical Engineering or a subject which is deemed equivalent, and which include an independent project of at least 15 credits, in a main field of study deemed relevant to the doctoral programme's specialisation. It is recommended that the independent project at master's level comprises at least 30 credits.

### **4. Admission Procedures**

Applications for admission to doctoral studies are processed in accordance with the procedures prescribed by Karlstad University's admission regulations.

### **5. Selection**

Candidates will be selected based on their assessed capacity to successfully complete a programme at the doctoral level.

The selection will be based on the applicant's previous study results with an emphasis on the quality of independent written work of a scholarly and investigatory nature, particularly at a master level. Candidates will also be assessed based on documented knowledge of relevance to the specialisation of the doctoral programme, as well as documented knowledge of research methodology. The ability to communicate in English, both orally and in writing, as well as the ability to be present and active at the discipline's activities, are also bases for selection.

When a doctoral studentship is announced, the most suitable candidates shall, when possible, be interviewed in order to gather a strong basis for selection. Consideration will also be given to the applicant's research specialisation as well as the capacity of available supervisors at the department.

### **6. Content and Outline**

The doctoral programme in Chemical Engineering aims to further expand the doctoral students' experimental and theoretical knowledge related to the research area. Doctoral students are also trained in independently handling project management, assessment of research results, and dissemination of research findings. Furthermore, doctoral students are to develop their ability to, based on

current problems, learn and apply new methods. Doctoral students shall also develop their ethical approach to their research and consider its role in society. Finally, doctoral students shall develop their professional expertise regarding work tasks both within and outside of academia, and improve their ability to conduct independent research.

The doctoral programme can result in either a doctoral or licentiate degree. The licentiate degree requires two years of study, the equivalent of 120 credits. The doctoral degree requires four years of study, the equivalent of 240 credits. The studies include course work as well as an independent project (licentiate or doctoral thesis).

To earn a licentiate degree, the candidate is required to complete 30 credits of course work and a thesis comprising 75 credits.

To earn a doctoral degree, the candidate must complete 60 credits of course work and a thesis comprising 150 credits.

### **6.1 Courses**

Third-cycle courses are chosen to ensure goal attainment and completion of the doctoral programme, as well as to suit the PhD student's relevant research area. Goal attainment, which is tied to the Higher Education Ordinance (appendix 2), is documented in the individual study plan.

Courses can be both broad and specialised, and they can be offered at Karlstad University as well as other universities. Courses at Karlstad University can be university-wide courses, cross-faculty courses, general courses at the discipline, or specialised courses. Some courses are more appropriate for the early stages of the studies, while others are more relevant for the latter stages of the programme. Courses can be individualised or aimed at a group of doctoral students, and sometimes together with master's students.

Courses that doctoral students take within the framework of the doctoral programme can also include courses focused on professional and personal competencies. The courses are chosen by the doctoral student, in consultation with the supervisor and the examiner. The choice of courses are documented in the individual study plan.

#### **Recommended Courses for Degree of Licentiate**

Introductory paper, 5 credits

Applied statistics and experimental planning, 8 credits

The philosophy and history of science, 7.5 credits

Chemical engineering seminar course, 1.5 credits

Research ethics for doctoral students, introductory course, 3 credits – plus additional courses on the subject, of at least 9 credits.

#### **Recommended Courses for Degree of Doctor**

Introductory paper, 5 credits

Applied statistics and experimental planning, 8 credits

Formulating research, 5 credits

Impact and the Utilisation of Research, 4.5 credits

Academic writing, 5 credits

The philosophy and history of science, 7.5 credits  
Communicating science, 4.5 credits  
Chemical engineering seminar course, 1.5 credits  
Research ethics for doctoral students, introductory course, 3 credits – plus additional courses on the subject, of at least 18 credits.

## **6.2 Licentiate and Doctoral Theses**

Third-cycle students are required to write a thesis for a doctoral or a licentiate degree, either as a monograph or as a compilation thesis. The latter is recommended.

Candidates are required to defend their licentiate thesis at a seminar and their doctoral thesis at a public examination. Further information is available in Karlstad University's policy document. If there are parts of the thesis that are presented in collaboration with others, the individual doctoral student's contribution must be clearly indicated. The thesis should be written in English. In-depth research papers should be written in English. They should also be published in quality scientific journals and have gone through a peer review process before publication.

In order to ensure a satisfactory progression in the doctoral programme, for students aiming for a Degree of Doctor, a follow-up should be conducted when the student is halfway through the programme. Such a follow-up can be conducted through a licentiate thesis or by an external reviewer who evaluate the progression of the student and also assists in planning the finishing stages the doctoral studies. If the follow-up is conducted through a licentiate thesis, this shall include a description of the finishing stages of the doctoral studies. The follow-up shall be documented in writing and be added as an appendix to the individual study plan.

## **6.3 Supervision**

Students admitted to the doctoral programme are entitled to supervision in accordance with the principles stated in the current regulations at Karlstad University.

## **6.4 Individual Study Plan**

At the start of the studies the doctoral student shall, in consultation with their supervisors, draw up an individual study plan. The study plan should include a realistic time plan for coursework, thesis work and supervision. The plan should also include an introduction to the proposed research field and relevant ethical considerations.

The individual study plan shall use the form or system approved by the university.

The individual study plan is subject to continual review (at least once a year). If this results in changes in terms of timetable or project plan, the individual study plan must be revised.

Goal attainment shall be assessed on two occasions during the course of the programme. After one year, an individual goal matrix shall be formulated and added to the research student's individual study plan as an appendix.

One year before the planned date for the licentiate degree and two years before the planned date for the doctoral degree, the outcome of the individual goal matrix is evaluated in connection with the revision of the individual study plan.

If the evaluation shows that the goal attainment is not satisfactory, the plan for the continuing studies will be revised to ensure that the national goals are met by the time of examination. A revised goal matrix is attached to the revised individual study plan.

To monitor goal attainment and the progress of the research project, a mid-way review is conducted approximately halfway through the studies. At this seminar, the examiner and all the supervisors shall attend, as well as at least one person who is not involved in the doctoral student's studies. For a student admitted to a programme with resulting in a Degree of Doctor, the mid-way review can be substituted for a licentiate seminar.

### **6.5 Summative assessment**

Doctoral students are assessed in accordance with the requirements of each individual course syllabus. Licentiate and doctoral theses are assessed in accordance with the Higher Education Ordinance (Chap. 6, Sec. 33-35) and Karlstad University's current regulations.