



Faculty of Health, Science and Technology

Curriculum for Third-Cycle Education in Chemistry

(Forskarutbildning i kemi)

Curriculum Approval

The curriculum was approved by the Faculty Board of Technology and Science 2008-09-04.

Revised by the Faculty Board of Health, Science and Technology 2015-04-24 and is effective from 2015-07-01.

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

PhD studies in chemistry are given with five specializations at Karlstad University: analytical chemistry, biochemistry, physical chemistry, materials science, and chemistry education. Chemistry as a subject includes the study of basic and applied processes at the molecular level. These studies lead to the creation of new knowledge, development of new processes and methods, and provide support for the social and technological development in many different areas.

At Karlstad University is currently conducted research of fundamental nature with relevance to applied chemistry. The research is mainly based on experimental approaches at the molecular level. The research is conducted through partnerships and other forms of knowledge exchange, in line with the technological development in the current research.

In analytical chemistry, research is conducted on separation methods, both in bioanalytical chemistry and for metals. In biochemistry, the main field is macromolecular structure and function in biological processes, using molecular genetics and biotechnological applications.

The physico-chemical research is focused on surface and colloid chemistry and nanomaterials. The materials science research in chemistry is multidisciplinary and is focused on molecular processes in the boundary layer, and combines natural sciences, particularly chemistry and physics, with engineering sciences. The chemistry education research is conducted in close cooperation with both specialized topic research and teacher training. Research may address all the considerations linked to the substantive teaching of chemistry. It may be for classroom studies and student teachers and active teachers' perceptions and professional development.

The objective of a doctoral program in chemistry is that the PhD students shall demonstrate advanced knowledge and skills and be able to apply modern methods and model systems in their subject area as well as to train and develop their ability to independently run scientific projects and evaluate and communicate results in science and in society in general.

In accordance with Karlstad University's policy for gender equality must gender perspective in education at the graduate level be included. The PhD student will also get insights on multi-disciplinary approaches and experiences of meetings across traditional subject boundaries.

2. Aims and Objectives

The general objectives of licentiate or doctoral studies in terms of knowledge and understanding, competence and skills, and judgement and approach are specified as follows in the *Higher Education Ordinance, Annex 2, SFS 2006:1053*):

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, independently 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 independently 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 a 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 a **Degree of Doctor** the third-cycle 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, independently 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 a **Degree of Doctor** the third-cycle student shall

- *demonstrate intellectual independence 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.*

Subject-Specific Objectives

The graduate program in Chemistry aims at deepens the PhD students' experimental and theoretical knowledge in the field of research and to train PhD students to independently take responsibility for project management, evaluation and dissemination of research information. Furthermore, the PhD students should develop their ability, within current problems, assimilate and apply new methods. The PhD students shall also develop their ethical approach. Finally, the PhD students should develop their professional skills to work in and outside academia as well as their ability to conduct independent research.

3. Admission Requirements

A person who meets the general admission requirements as well as the specific admission requirements and is judged to have the ability otherwise required for pursuing the programme successfully is eligible for admission.

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.6*).

3.2 Special eligibility

3.2a Special eligibility for admission to the graduate level, specialization Analytical Chemistry, Biochemistry, or Physical Chemistry

Special eligibility for admission to postgraduate studies in chemistry with specialization in analytical chemistry, biochemistry, or physical chemistry has to be fulfilled by a degree at advanced level in chemistry, or other subject for consideration deemed equivalent, which includes an independent project (thesis) at the advanced level comprehensive at least 15 credits in the main field relevant for research training in the chosen specialization. It is recommended that the scope of the independent work on the advanced level is at least 30 credits.

3.2b Special eligibility for admission to the graduate level, specialization in Chemistry Education

Special eligibility for admission to postgraduate studies in chemistry with specialization in chemistry education, the educational qualifications at advanced level, which includes courses in the natural science subject area corresponding to at least 90 credits, including 15 credits thesis, of direct relevance to the PhD studies, or who have a teacher's degree or equivalent under the old degree order, with at least two years professional experience as a teacher of chemistry.

3.2c Special eligibility for admission to the doctoral level, specialization Materials Science

Special eligibility for admission to postgraduate studies in chemistry with specializing materials science, requires a master or master of science degree with a major in materials science, material physics, chemistry, or chemical engineering, with a specialization in relevant fields. It is also required 90 credits in materials science relevant topics or major areas, including at least 60 credits, of which at least 15 credit degree project, at an advanced level within the project relevant areas, and 15 credits in mathematics.

4. Admission Procedure

Applications for admission to doctoral studies are processed in accordance with the procedures prescribed by the Board of Karlstad University.

5. Selection

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

Selection is based on the applicant's previous studies with an emphasis on the quality of the written independent projects of research and investigation character included in the training, particularly at the advanced level. In the selection, also the applicant's documented knowledge of the subject with

relevance to research training orientation and documented knowledge in scientific methodology is taken into account. Whenever possible, applicants who appear to be the most suitable, should undergo an interview to obtain a good basis for the final decision. Emphasis is also placed on the candidate's research focus and the existing supervisory capacity in the subject.

6. Content and Outline

The doctoral programme can lead to a doctoral or licentiate degree. The licentiate degree requires two years of study, the equivalent of 120 ECTS cr. The doctoral degree requires four years of study, the equivalent of 240 ECTS cr. The studies include coursework and an independent project (licentiate thesis or doctoral thesis).

To earn a licentiate degree, the student is required to complete coursework of at least 30 credits and a thesis of at least 75 credits.

To earn a doctoral degree, the student is required to complete coursework of at least 60 credits and a thesis of at least 150 credits.

6.1 Courses

The courses for the PhD students are selected with relevance to their research, but also so that the fulfilment of postgraduate education is achieved. The compliance rate is reported in the individual study plan.

Recommended courses for a licentiate degree

The philosophy and history of science, 7.5 credits.

Introductory essay, 5 credits.

Recommended courses for the Ph.D.

The philosophy and history of science, 7.5 credits.

Introductory essay, 5 credits.

Research formulation, 5 credits.

Graduate Courses in Chemistry

The courses are selected based on the student's specialization. The courses in chemistry offered at Karlstad University are:

- Introductory essay, 5 credits
- Research Formulation 5 credits
- Seminars in natural and engineering sciences, 2 credits
- Literature study of chemistry I, 5 credits
- Literature study of chemistry II, 10 credits
- Applied statistics and experimental Design, 8 credits
- Bioenergetics, 7.5 credits
- Enzyme chemistry, 7.5 credits
- Physical chemistry 1, 4 credits
- Physical chemistry 2, 4 credits
- Physical chemistry 3, 4 credits
- Polymer physical chemistry, 4 credits
- Physical chemistry of surfaces and colloids, 4 credits

Courses

Courses at Karlstad University and other universities nationally and internationally, in the research subject and other relevant subjects, may be appropriate to include in the PhD studies. The examiner in consultation with the student and supervisor determines the number of credits. The student's need for theoretical and practical broadening and deepening shall be the basis for selection of courses during the training. Course selection is done in consultation with the examiner and supervisor, and is chosen so that the fulfilment of postgraduate education is achieved. Goal achievement is reported in an annex to the individual study plan.

6.2 Licentiate and Doctoral Theses

Third-cycle students are required to write a thesis for a licentiate or a doctoral degree, which may be a monograph or a compilation thesis. The latter alternative is recommended. The licentiate thesis is to be defended at a licentiate seminar and the doctoral thesis at a public examination. Further information is provided in the policy documents Regulations on the Licentiate Thesis and Regulations on Doctoral Thesis and Public Defence Procedures. The thesis topic for either degree is chosen in consultation with the advisor and examiner. The thesis summary should preferably be written in English. The included articles should preferably be written in English.

6.3 Supervision

Admitted students are entitled to advisors in accordance with the principles stated in the current policy document at Karlstad University.

6.4 Individual Study Plan

At the start of the studies, the student shall draw up an individual study plan (ISP) in consultation with the advisors. The plan shall include a realistic estimate of time for course work, thesis work and supervision. The plan shall also include a project description and relevant ethical considerations.

The ISP is drawn up according to the form or system devised by the university.

The individual study plan is subject to continual revision (at least once a year) and shall be revised if changes in time or project plan are required.

Goal attainment in licentiate/doctoral studies shall be monitored on occasions in the course of studies. After one year, an individual qualifications matrix is formulated and attached to the student's individual study plan.

One year before the preliminary date of licentiate degree completion and two years before the preliminary date doctoral degree completion the outcome of the individual qualifications matrix is evaluated when the ISP is followed up. If the evaluation indicates that the goal attainment is not satisfactory, the study plan is revised to ensure that the national requirements are met at the time of the final examination. The revised qualifications matrix is attached to the individual study plan.

6.5 Examination

Licentiate/doctoral students are examined in accordance with the requirements of each individual course syllabus. Doctoral or licentiate theses are examined in accordance with the *Higher Education Ordinance* (Ch.6, sections 40-47) and Karlstad University's current policy document.