



Faculty of Health, Science and Technology

Curriculum for Third-Cycle Education in Mathematics

(Studieplan för utbildning på forskarnivå i matematik)

Curriculum Approval

Approved by the Faculty Board of Technology and Science on 28 November 2000. Revised by the Faculty Board of Technology and Science, FAK2 2008/162 and valid from 30 October 2008. Revised by the Faculty Board of Health, Science and Technology on 8 April 2016, effective from the date of decision.

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 discipline of mathematics at Karlstad University offers two doctoral programmes in different research areas, namely mathematics and mathematics education.

Since time immemorial, mathematics has been a foundation for thinking. Its development has been intellectually driven, but also, to a great extent, inspired by its applications in physics and technology. In the last decades, this aspect has been reinforced in the fields of physics, chemistry, technology, medicine, economy and the social sciences. Modern computer science is also based on mathematics. This has led to a dramatic expansion of the mathematics discipline in recent decades.

Mathematics is a major subject at all levels of education. The need for more and broader research on teaching and learning mathematics in relation to the Swedish school system and higher education is well documented. There is a great demand for highly qualified teachers in mathematics education and mathematics at all levels of education.

Cooperation with other higher education institutions in Sweden and abroad is established in the doctoral programme in mathematics. In accordance with Karlstad University's equal opportunities policy, gender issues are addressed throughout the programme. Doctoral students are also introduced to multi-disciplinary approaches and involved in interdisciplinary experiences.

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:

Degree of Licentiate

Knowledge and understanding

For a Degree of Licentiate third-cycle students 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 third-cycle students 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 independently in some other qualified capacity.*

Judgement and approach

*For a **Degree of Licentiate** third-cycle students shall*

- *demonstrate the ability to make assessments of ethical aspects of their 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 their ongoing learning.*

Degree of Doctor

Knowledge and understanding

*For a **Degree of Doctor** third-cycle students 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** third-cycle students shall*

- *demonstrate the capacity for scholarly analysis and synthesis as well as to review and assess new and complex phenomena, issues and situations independently 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 thesis the ability to make a significant contribution to the formation of knowledge through their 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** third-cycle students 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

Upon completion of the doctoral programme, students should have acquired the knowledge and skills relevant to the chosen doctoral programme specialisation and contributed new and relevant knowledge to the field concerned in a form of a thesis. Students should also have acquired the skills to carry out independent research in their thesis area. In addition, students should have knowledge of other disciplines, their knowledge traditions and science paradigms and be able to communicate their research results comprehensibly. Finally, students should be acquainted with the future relevant employment market.

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 cr. 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 requirements (Higher Education Ordinance, Ch. 6).

3.2 Special eligibility

A person who has completed a master-level degree in mathematics with a specialisation in the relevant area, or has acquired equivalent qualifications in some other way in Sweden or abroad has special eligibility for admission to doctoral studies in mathematics.

A person who has completed a master-level degree in mathematics with a focus on mathematics education, which includes courses in mathematics and mathematics education of at least 90 ECTS cr., including an independent degree project of 15 ECTS cr., or has a degree in teaching with a major in mathematics, or equivalent according to earlier degree requirements, has special eligibility.

4. Admission Procedure

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

5. Selection

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

In the ranking and selection of the candidates, special attention is paid to previous studies, especially to the quality of independently documented research or development projects completed, especially at master's level in the proposed area. Considerable weight is given to teaching qualifications and teaching experience in the selection of doctoral students to the mathematics education programme. Special consideration is also given to the candidate's possibility to be present and participate in the departmental research environment.

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 or doctoral thesis).

To earn a licentiate degree, the candidate is required to complete at least 50 ECTS credits of coursework and a thesis of at least 60 ECTS cr. To earn a doctoral degree, the candidate must complete at least 90 ECTS credits of course work and a thesis of at least 120 ECTS cr.

6.1 Courses

General/university-wide courses

General and/or university-wide courses must be included in the programme to the extent required by local/national regulations. Courses relevant to the fulfilment of the national requirements in the Higher Education Ordinance (listed in Section 2 above) should primarily be chosen.

Subject-specific courses

At the doctoral level, courses are often offered as directed reading. Courses may also, upon approval, be taken at other universities.

Below, examples are given of the content of subject-specific courses. Courses are chosen in consultation with examiner and advisor with the purpose of ensuring broad and systematic knowledge of the research field and current specialist knowledge of the thesis area. Courses are partly chosen with regard to the student's prior knowledge and to the occurrence of overlapping content in various courses.

Examples of content:

Algebra: linear and abstract algebra, number theory, Galois theory

Topology and geometry: general and algebraic topology, differential geometry

Analysis: functional analysis, measure and integration theory, ordinary and partial differential equations, real and complex functions theory

Numerical and applied mathematics: numerical analysis, mathematical modelling, kinetic theory, coding theory

Licentiate and doctoral courses in mathematics education mainly centre on the three fields of

- Mathematics and the history of mathematics in a science perspective
- The research field of learning and teaching mathematics and mathematics education
- Basic pedagogical theories of relevance to mathematics education research and research methodology and theories in the field

Seminars and conferences

Students are required to participate actively in research seminars and guest lectures in mathematics even if these are not directly related to their curriculum.

Students are also expected to actively participate in seminars and international conferences (i.e. with posters or presentations) and may be credited for participation to a maximum of 4.5 ECTS cr. for licentiates and 9 ECTS cr. for doctoral students in consultation with the examiner and advisor.

6.2 Licentiate and doctoral theses

Third-cycle students are required to write a thesis for a licentiate degree and/or a doctor's degree, which should either be a monograph or a compilation thesis. The articles in a compilation thesis must meet the requirements for publication in reputable international journals with peer-review procedures. The student's own contribution must be clearly distinguishable. The licentiate thesis is 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.

6.3 Supervision

Students admitted to the doctoral programme are entitled to supervision 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 coursework, 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 two occasions in the course of studies. After one year, an individual goal 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 of doctoral degree completion the outcome of the individual goal 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 goal matrix is attached to the individual study plan.

6.5 Examination

Third-cycle 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, Secs. 33–35) and Karlstad University's current policy document.