

Reg.no. 2023/1978

*Deciding Authority: The Faculty Board*

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# **General syllabus for Mathematics/Applied Mathematics at Mälardalen University**

Den svenska versionen av den allmänna studieplanen har tolkningsföreträde ifall det råder oenighet om hur texten ska förstås.

The Swedish version of the general syllabus has priority in interpretation if there is disagreement about how the text should be understood.

## Table of Contents

<b>General syllabus for Mathematics/Applied Mathematics at Mälardalen University .....</b>	<b>1</b>
<b>Third-cycle subject .....</b>	<b>3</b>
Third-cycle subject area.....	3
<b>Additional information.....</b>	<b>3</b>
<b>Purpose and objective of the third-cycle studies.....</b>	<b>3</b>
<b><i>Degree of Licentiate</i> .....</b>	<b>4</b>
<b><i>Degree of Doctor</i> .....</b>	<b>5</b>
<b>Structure of third-cycle studies.....</b>	<b>6</b>
Individual study plan .....	6
Course component.....	6
Courses.....	6
Other credit-bearing components .....	7
Review of ongoing studies .....	7
Doctoral thesis .....	7
Licentiate thesis .....	8
<b>Examination.....</b>	<b>8</b>
Degree of Doctor.....	8
Public defence of the doctoral thesis .....	9
Degree of Licentiate.....	9
Licentiate seminar .....	10
<b>Title of qualifications .....</b>	<b>10</b>
<b>Entry requirements .....</b>	<b>10</b>
General entry requirements .....	10
Specific entry requirements .....	10
Selection .....	11
<b>Coming into effect and interim regulations .....</b>	<b>12</b>

## **Third-cycle subject**

### **Third-cycle subject area**

Mathematics is a science that uses logical conclusions to study concepts with well-defined properties, established in axioms. Concepts, theoretical frameworks, and methods from the various branches of mathematics have long been important tools in technical and scientific applications. The importance of mathematics has increased further in recent decades due to the rapid development of computer technology, together with a growing awareness of the applicability of mathematics in life sciences, humanities, and social sciences. This has also given rise to new mathematical research problems that, together with scientific issues, contribute to driving mathematics forward.

The mathematics/applied mathematics third-cycle subject area covers the entire domain of mathematical research, including mathematical analysis, geometry, algebra, logic, discrete mathematics, computational mathematics, probability theory and statistics. The third-cycle subject also includes various applications in other subject areas that make a substantial contribution to the mathematical theory.

### **Additional information**

*Rules and guidelines for third-cycle courses and study programmes at Mälardalen University* as well as other national and local provisions, provide a framework for the general syllabus.

### **Purpose and objective of the third-cycle studies**

The purpose of the third-cycle education is that the doctoral student will develop knowledge, generic skills and an approach that is needed to independently plan, implement, and report scholarly studies both orally and in writing in the mathematics/applied mathematics third-cycle subject area.

Third-cycle courses and study programmes can lead to two different qualifications: a Degree of Doctor (240 credits equivalent to full-time study of four years) and a Degree of Licentiate (120 credits equivalent to full-time study of two years).

Through active participation in courses and work on a doctoral thesis or licentiate thesis, as well as active participation in other credit-bearing components conducted within the third-cycle subject area the following qualitative targets are supported at the third-cycle level following the Higher Education Ordinance, Appendix 2 (SFS 1993:100).

## *Degree of Licentiate*

### **Goals**

#### *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 doctoral 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 doctoral 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.

#### *Thesis*

For a Degree of Licentiate, the doctoral student shall have been awarded a pass grade for a research thesis of at least 60 credits.

## *Degree of Doctor*

### **Goals**

#### *Knowledge and Understanding*

For a Degree of Doctor, the doctoral 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 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 a Degree of Doctor, the doctoral 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.

### *Research Thesis (doctoral thesis)*

For the Degree of Doctor, the doctoral student shall have been awarded a pass grade for a research thesis (doctoral thesis) of at least 120 credits.

## **Structure of third-cycle studies**

### **Individual study plan**

For each doctoral student, an individual study plan must be established following Chapter 6, Section 29 of the Higher Education Ordinance. The individual study plan must include the University's and the doctoral student's commitments and a timeline for the doctoral students' education. The individual study plan must define activities that provide prerequisites to reach the national as well as subject-specific qualitative targets.

The individual study plan must be regularly followed up and may be changed to the required extent by the University, after consultation with the doctoral student and their supervisor.

As previously stated, 120 credits are required for a Degree of Licentiate and 240 credits for a Degree of Doctor. The scope of the course component and the respective academic paper/doctoral thesis is clarified in the section below.

### **Course component**

Doctoral students are expected to acquire broad basic knowledge in mathematics/applied mathematics as well as knowledge that contributes generally to their research through the course component.

The course component must also include theory of science and research ethics and may also include other subjects of importance for the doctoral education, for example, higher education pedagogy or project management.

The doctoral student chooses their course component in consultation with their supervisor.

### *Courses*

For a Degree of Licentiate in mathematics/applied mathematics a course component of at least 45 credits is required of which at least 30 credits are in mathematics/applied mathematics, of which

- at least 5 credits in algebra and discrete mathematics
- at least 5 credits in analysis and geometry
- at least 5 credits in applied mathematics
- and additionally, at least 5 credits in their own research domain.

For a Degree of Doctor in mathematics/applied mathematics a course component of at least 90 credits is required of which

- at least 15 credits in algebra and discrete mathematics
- at least 15 credits in analysis and geometry
- at least 15 credits in applied mathematics
- and additionally, at least 15 credits in their own research domain.

#### *Other credit-bearing components*

The course component is made up of courses and other credit-bearing components. Courses can be taken at MDU or another higher education institution and must be documented in the individual study plan. Other credit-bearing components may be:

- An individual reading course where the doctoral student acquires the agreed literature through self-study and supervision and reports their knowledge through written assignments and/or examinations.
- Courses from previous education that exceed the entry requirements if the principal supervisor deems them to have a suitable specialisation and sufficient level (credit transfer). The study period must be proportionally reduced according to Chapter 5, Section 7 of the Higher Education Ordinance.
- Seminar activity where attendance at 10 seminar instances is valued at 1 credit and the student's own seminar or presentation at a conference is valued at 1 credit. A maximum of 5 credits can be earned in this manner.

#### **Review of ongoing studies**

Within the framework of doctoral education at MDU, a doctoral student shall present the ongoing doctoral studies internally but also at public seminars/reviews to provide the research community and the public insight into the research being conducted at the University. The reviews allow the doctoral student to discuss the ongoing work and have it reviewed by internal and external senior researchers. At MDU there are two compulsory review sessions at which the doctoral student shall present their project, as follows:

- Mid-way review or licentiate seminar
- Final review/preview

#### **Doctoral thesis**

The programme includes a scholarly project which is documented in a doctoral thesis corresponding to at least 120 credits. The research must be conducted in a subject area that is listed in the latest version of the *Mathematics Subject Classification*.

The scholarly work must be of a quality that meets the requirements for publication in recognised international peer-reviewed scientific journals or comparable publications.

A doctoral thesis in mathematics/applied mathematics must be designed as a compilation thesis or as a monograph and must be written in English.

A compilation thesis consists of papers and a compilation part (introductory chapter of a compilation thesis – known as a *kappa* in Swedish). The papers must meet the quality requirements for publication in international peer-reviewed journals. The compilation part must illustrate the various papers, how they are connected and what joint knowledge they have generated.

The thesis must include a summary in Swedish and a summary in English.

#### **Licentiate thesis**

A licentiate thesis corresponding to at least 60 credits in mathematics/applied mathematics must be designed as a compilation thesis or as a monograph and must be written in English.

A compilation thesis will consist of papers and a compilation part (introductory chapter of a compilation thesis, known as a *kappa* in Swedish). The papers must meet the quality requirements for publication in international peer-reviewed journals. The compilation part must illustrate the various papers, how they are connected and what joint knowledge they have generated.

The licentiate thesis must include a summary in Swedish and a summary in English.

#### **Examination**

Third-cycle courses and study programmes are concluded with a Degree of Doctor or a Degree of Licentiate. The doctoral student who has a doctoral degree as their goal has the right, but no obligation, to graduate with a licentiate degree as a stage in the third-cycle education.

#### **Degree of Doctor**

At an overall level, an understanding of axiomatic, deductive methods such as the foundations of mathematics and the ability to apply this at a high level is required, exploratory knowledge of the different mathematical subject areas and understanding of how different mathematical subject areas are connected, as well as exploratory knowledge of how and why mathematics is applied in other sciences.

In the mathematical subject area in which the doctoral student's own research is conducted, exploratory knowledge of which research



specialisations are available and the methods used is required, familiarity with publishing traditions as well as personal experience of the peer review process.

In the research domain that is directly related to the doctoral student's own research, detailed knowledge of the current state of research is required in the form of approaches, methods, results, and connections to other domains/problems. For applied projects, a good understanding of the theoretical background of the application is also required.

For a Degree of Doctor, a total of 240 completed higher education credits are required, consisting of:

- approved courses and other credit-bearing components of at least 90 higher education credits
- a completed doctoral thesis comprising at least 120 higher education credits

#### **Public defence of the doctoral thesis**

The doctoral student must independently defend their doctoral thesis at a public defence.

The thesis will be examined by an examining committee who award a grade of Pass or Fail.

#### **Degree of Licentiate**

At an overall level, an understanding of axiomatic, deductive methods such as the foundation of mathematics is required, exploratory knowledge of the various mathematical subject areas as well as exploratory knowledge of how and why mathematics is applied in other sciences.

In the mathematical subject area in which the doctoral student's own research is conducted, exploratory knowledge of which research specialisations are available and the methods used is required.

In the research domain that is directly related to the doctoral student's own research, knowledge of the current state of research is required in the form of approaches, methods, results, and connections to other domains/problems. For applied projects, an understanding of the theoretical background of the application is also required.

For a Degree of Licentiate, a total of 120 completed higher education credits are required, consisting of:

- approved courses and other credit-bearing components of at least 45 higher education credits
- a completed licentiate thesis of at least 60 higher education credits

### **Licentiate seminar**

The doctoral student must independently defend their licentiate thesis at a public defence.

The licentiate thesis will be examined by an examining committee who award a grade of Pass or Fail.

### **Title of qualifications**

*For a Degree of Doctor*

Degree of Doctor of Philosophy

If another title of qualification is requested this must be specified in the application for the defence of the doctoral thesis.

*For a Degree of Licentiate*

Degree of Licentiate of Science

If another title of qualification is requested this must be specified in the application for the licentiate seminar.

The regulations for the title of the degrees can be found in the *Local System of Qualifications at Mälardalen University*.

### **Entry requirements**

#### **General entry requirements**

A person will meet the general entry requirements to doctoral education, according to Chapter 7, Section 39, of the Higher Education Ordinance if they:

1. have graduated with a qualification at master's (second-cycle) level, or
2. have fulfilled course requirements of at least 240 higher education credits, of which at least 60 are at master's level, or
3. have acquired equivalent knowledge in some other way, in or outside of Sweden.

The University may grant an exemption from the general entry requirements for an individual applicant if there are particular grounds, according to Chapter 7, Section 39 of the Higher Education Ordinance.

#### **Specific entry requirements**

To be admitted to third-cycle studies in mathematics/applied mathematics specific entry requirements must be met. The applicant must have:

at least 90 credits in the subject area, of which at least 60 credits at master's (second-cycle) level, or have acquired equivalent

substantial knowledge in another way according to the supervisors' committee.

Exemptions from the entry requirements can be decided on by the Faculty Board's Engineering Committee.

Exemption from qualification requirements regarding compulsory courses can be applied for, for example, by doctoral students admitted to the later part who on the start of their studies not have the breadth of courses as described for licentiate students according to this study plan.

### **Selection**

Selection between applicants who fulfil the entry requirements is done according to the following order of importance:

1. the applicant's suitability
2. availability of a suitable supervisor in the candidate's area of interest,
3. a demonstrated high level of skill in the type of activity included in the doctoral education,
4. grades in mathematical courses,
5. other educational qualifications.

If two applicants are deemed to be equal on these criteria, priority will be given to the applicant who is assessed to contribute most to improved equality in the subject.

When assessing the ability to carry out activities related to the third-cycle studies, the following will be considered particularly:

1. Knowledge and skills that are relevant to the subject and the scientific activities. These can be demonstrated through attached documents or an interview.
2. An assessed ability to work independently and an ability to formulate and address scientific problems. Assessment may be based on a degree project or academic paper at master's level, other scholarly writing, or a discussion around this at a possible interview.
3. The ability to communicate orally and in writing through the language(s) that are specified in the application. This ability may be demonstrated through attached documents or an interview.
4. Other relevant qualifications, for example, professional experience.

Assessment of applicants following the above criteria will be carried out by the supervisors' committee.

Doctoral students may also be admitted without advertising if they are funded in another way, for instance through another employment, scholarships, or international exchange programmes. The supervisors' committee will assess such admissions following the same criteria as above (i.e. the ability to complete the third-cycle studies during the appointed time and the availability of a suitable supervisor).

### **Coming into effect and interim regulations**

The existing syllabus will come into effect on 1 January 2024.

Doctoral students admitted before this date have the right to follow the syllabus and examination requirements which were valid when the doctoral student was admitted. If the doctoral student requests it and the supervisors' committee approve, the doctoral student may be allowed transfer to the programme according to the new syllabus. Transfer to the new general syllabus must then be documented in the individual study plan.