



General syllabus for third-cycle studies in the third-cycle subject area of Mathematics and Applications

Decided by: The deans jointly.

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Note: This is a translation of the established Swedish-language version of the General Syllabus in the subject. In the event of discrepancies, the Swedish-language version takes precedence.

1 Description of the third-cycle subject at BTH

Mathematics is traditionally divided into three branches: calculus, algebra and geometry. The third-cycle subject area of mathematics and applications includes all three of these areas as well as applications, primarily in engineering, natural sciences and economics. Characteristic of mathematics research at BTH has largely been an interaction between theory and applications, in the sense that the research is alternately about application problems and alternately about new mathematical theory, where the latter has been actualized by unsolved problems in current applications.

The subject of mathematics supports the university's profile areas through its very nature of crystallizing relevant alternative formal structures, investigating what applies to them, and streamlining calculations as far as possible. Theoretical mathematics is also, as a rule, if not always in an obvious way, in the long run linked to applications.

2 Structure of the programme

Doctoral studies that end with a licentiate degree comprise two years of net study time (120 credits) and consist of a course component of at least 45 credits and a licentiate thesis of at least 60 credits.

Doctoral studies that end with a doctoral degree comprise four years of net study time (240 credits) and consist of a course component of at least 90 credits and a thesis of at least 120 credits.

Doctoral students who have been admitted to a doctoral degree are given the opportunity to obtain a licentiate degree (as above) after a part of at least 120 credits has been completed of the education that is to conclude with a doctoral degree.

An individual study plan is drawn up for each doctoral student¹. The individual study plan describes the individual structure of the education. The individual study plan is revised and followed up annually in accordance with the routines established at BTH. The study plan should convincingly demonstrate how the objectives of the doctoral student's doctoral education can be achieved within the available time.

In accordance with the Higher Education Ordinance, at least two supervisors are appointed, one of whom is appointed as principal supervisor. According to the Higher Education Ordinance, an examiner must also be appointed for each

¹ In BTH's general syllabus, the word "doctoral student" is used synonymously with the Higher Education Ordinance "doctoral student" (according to Chapter 1, Section 4 of the Higher Education Ordinance (1993:100)). The choice of words is made to avoid confusion with doctoral studentships and that as a doctoral student, you can be admitted to a licentiate degree and not just a doctoral degree.

doctoral student for assessment and grading of doctoral education. The appointment of supervisors and examiners must be made in accordance with BTH's guidelines. The supervisor, who is not the main supervisor of the two, must have a PhD. In addition, additional supervisors may be attached to the doctoral student, for example from the business sector, if it is of benefit to the doctoral student's studies. For these additional supervisors, there is no requirement to have a PhD.

2.1 Purpose of the education

BTH conducts doctoral education to contribute to solutions to society's complex challenges and meet the demands of a changing labour market.

Specifically, the doctoral education aims to develop the doctoral student's knowledge in the subject area and ability to conduct independent research, development, teaching and investigative work based on a scientific basis in different areas of society. In addition, the purpose of the doctoral degree is to give the doctoral student the ability to critically and independently plan, initiate and lead such work.

Specifically, the PhD program in Mathematics with Applications aims to train researchers who can use mathematical theory to construct, reinforce, or streamline existing solutions for problems in engineering, science, and economics, as well as further develop the mathematical theory in relevant directions.

2.2 Objectives of the programme

According to the System of Qualifications in the Higher Education Ordinance (1993:100) as set out in the appendix.

In addition to the objectives of the System of Qualifications in the Higher Education Ordinance, the aim of third-cycle studies in mathematics with applications is to educate researchers who can formulate and solve mathematical problems, both those formulated from applications and other problems, and mathematically answer central questions that apply to them.

It is also about building relevant mathematical theory. This requires the ability to see connections between application and mathematics from many points of view, and a broad knowledge of existing mathematical theories and methods, and how they interact with applications.

The ability to engage in constructive research collaboration with researchers from other disciplines as well as the ability to present research results well, both orally and in writing, are also among the objectives of the programme.

2.3 Implementation of the education

The doctoral student conducts research and writes and defends a scientific work (licentiate thesis/doctoral thesis). To support this, the programme may include lectures, seminars, literature studies, project assignments, group supervision and individual supervision. Courses for each individual doctoral student are determined individually in consultation with the supervisors and the examiner and are included in the individual study plan.

The supervision in the programme aims to assist the doctoral student in the choice of research area, scientific method, and the organisation and planning of the scientific work and associated studies. The supervisors shall assist with subject expertise and ensure that the work maintains an international level of quality. The supervision also aims to introduce the doctoral student to the scientific community and its requirements for ethics, integrity, and critical thinking.

The doctoral student will participate in national and international contexts and present his/her own research.

During the study period, the doctoral student will take part in the scientific activity conducted within the research environment at the department/faculty by attending seminars and guest lectures, and normally give one seminar per year on his/her thesis work.

The doctoral student will carry out an oral popular science presentation of his/her research before the licentiate degree and the public defence of the doctoral thesis and write a popular science summary to be included in the licentiate thesis and doctoral thesis, respectively.

Doctoral students, employed by the university as doctoral students, are recommended to devote some time (no more than 20 percent of full time) to teaching undergraduate education. Such initiatives are funded by undergraduate education and must be described in the individual study plan.

The programme must be designed so that the doctoral student achieves the applicable qualitative targets. How each individual doctoral student's knowledge needs are to be ensured in order to fulfil the qualitative targets is stated in each individual study plan.

3 Eligibility and selection

3.1 General entry requirements

According to Chapter 7. Section 39 of the Higher Education Ordinance (1993:100).

3.2 Specific entry requirements

A Master's degree, or a Master of Science in Engineering degree with sufficient specialisation, in the subject of mathematics or equivalent. The courses in mathematics should comprise at least 90 credits, of which at least 30 credits at C-level. In addition, the degree should comprise at least 15 credits in an application subject. The requirements for prior knowledge as described above can also be considered to be fulfilled by those who have acquired substantially equivalent knowledge in some other way in Sweden or abroad.

3.3 Selection

According to Chapter 7. 41 § in the Higher Education Ordinance (1993:100) and current admission regulations at BTH. Selection shall be made with regard to the applicants' ability to benefit from the programme. The basis for selection among eligible applicants is the degree of ability to benefit from the doctoral education, as well as the availability of supervision and other resources with regard to the planned focus of the licentiate thesis/doctoral thesis.

The assessment criteria applied in the selection process for doctoral studies are:

- Familiarity with the theory and applications of the subject,
- Relevant work experience, if applicable,
- Ability to express oneself in speech and writing,
- Familiarity with English,
- Creativity, initiative, independence and ability to cooperate.

The basis for assessing the applicant's fulfilment of the assessment criteria is the results of completed university courses, the quality of the independent project and any publications, references, interviews and a personal letter from the applicant describing the applicant's expectations and intentions for the programme. In some cases, the applicant may be required to undergo special work samples.

Admission to doctoral studies takes place continuously.

4 Tests included in the education

The programme consists of courses and scientific work. Examinations that are part of doctoral studies are assessed with the grade pass/fail. The grade of the course and the licentiate thesis is determined by a specially appointed examiner. The grade of the doctoral thesis is decided by a specially appointed examining committee.

For any credit transfer, please refer to the current credit transfer procedure and guidelines for credit transfer.

4.1 Courses

To support the research work, and for the fulfilment of the qualitative targets in general, the doctoral student takes a number of courses. Courses completed at BTH as well as other higher education institutions can be included.

For doctoral courses given at BTH, there must be a written course description that states, among other things, the name of the course in Swedish and English, the course objectives, content and credits. The individual study plan must regulate which courses may be included in the programme and how many credits each course is to be counted as (when participating in a course that is originally intended for first- or second-cycle level, please refer to the guidelines for credit transfer of courses in third-cycle education).

Elements of the education in the following areas are compulsory. How these are examined, through a course or other element, is regulated in each individual study plan.

- Research Methodology
- Information retrieval for researchers
- Scientific writing and review
- Ethics in research

For a licentiate degree, it is required that the course component includes courses from the following subject groups:

1. Calculus, at least 6 credits.
2. Algebra and Geometry (including Discrete Mathematics), at least 12 credits.
3. Mathematical Modelling and Applied Mathematics, at least 6 credits.

For a doctoral degree, it is required that the course component includes courses from the following subject groups:

1. Analysis, at least 15 credits.
2. Algebra and Geometry (including Discrete Mathematics), at least 20 credits.
3. Mathematical Modelling and Applied Mathematics, at least 15 credits.

Courses in philosophy of science, information retrieval, mathematics education or the history of mathematics can also be included in both a licentiate degree and a doctoral degree.

The choice of courses shall be characterized by flexibility with regard to the doctoral student's prior knowledge and the focus of the research work and shall be determined in consultation between the doctoral student, supervisor and examiner. The form of examination is determined by the examiner in consultation with the supervisor. Goal fulfilment is assessed by the examiner.

All compulsory courses or components must be completed before the doctoral thesis is orally defended at a public defence. Other courses and modules should be chosen so that the doctoral student has both breadth and depth within the research area. The courses should also benefit the doctoral student's skills and abilities, his or her studies or scientific work.

4.2 Scientific work

Scientific work in the form of a licentiate thesis/doctoral thesis shall be designed as a coherent, scientific work (monograph) or as a summary and associated scientific papers (compilation), which the doctoral student(s) have authored alone or jointly with another person. The scientific work is written in English or Swedish.

The licentiate thesis must be defended orally at a public licentiate seminar. For further information, please refer to the "Rules for licentiate seminars" established by the university.

The doctoral thesis must be defended orally at a public defence. The thesis must have previously been quality assured as described in "Appendix – Quality assurance of doctoral thesis". For further information, please refer to the "Rules for public defences" established by the university.

The doctoral thesis should be at such a level that the quality requirements for publication in recognized scientific journals or comparable publications are met. It is strongly recommended that the thesis is written in English for both licentiate and doctoral degrees.

5 Degree

5.1 Qualitative targets

Objectives according to the System of Qualifications in the Higher Education Ordinance (1993:100), "Appendix - System of Qualifications (Higher Education Ordinance (1993:100))".

In addition to the objectives of the System of Qualifications in the Higher Education Ordinance, the doctoral student must demonstrate knowledge of gender equality issues in research.

5.2 Title of qualification

The title of the doctoral degree at BTH consists of a general degree with the addition of a prefix.

A doctoral student who is pursuing a licentiate degree in the subject and who has a technical qualification is² normally awarded the title of Degree of Licentiate. In other cases, the title of the degree is Degree of Licentiate.

A doctoral student who is pursuing a doctoral degree in the subject and who has a technical qualification is normally awarded the title of Doctor of Philosophy. In other cases, the title of the degree is Doctor of Philosophy.

The prefix must be clarified in the individual study plan.

6 Entry into force and transitional provisions

This general syllabus enters into force on 1 January 2024.

As a general rule, doctoral students admitted before this date complete their studies according to an older general syllabus. If a doctoral student so wishes and it is deemed appropriate, the examiner concerned may approve the transition to a new general syllabus. The doctoral student must then notify the relevant dean of the transition and attach a copy of an individual study plan updated according to the new general syllabus.

² In this context, technical education refers to a Master of Science in Engineering, a Degree of Master of Science or equivalent in a technical or mathematical-natural sciences field.

Appendix - Quality assurance of doctoral thesis

To ensure the quality of doctoral theses in Mathematics with applications at BTH, the following procedure is followed.

Final seminar

When 6–4 months remain until the planned public defence, a seminar is arranged at which the doctoral student has the chance to present their thesis in its current form. The principal supervisor must inform the subject representative in good time that it is time for the final seminar.

All senior researchers at the Department of Mathematics and Natural Sciences will be invited to this seminar. In addition, an *external reviewer*, who is a researcher at docent level or professor level, is invited to participate in the seminar, either physically or digitally.

The external reviewer has three main tasks:

1. Read the draft thesis.
2. Act as an opponent at the seminar.
3. Submit a brief statement to the principal supervisor, the subject representative and the dean of the Faculty of Science. The statement must state the external reviewer's assessment of whether the thesis meets the requirements for *approval* as a Swedish doctoral thesis. The opinion should be received no later than one week after the seminar.

The selection of an external reviewer is made by the Head of Subject in consultation with the Head of Department. If the external reviewer has no previous experience of defending doctoral theses in Sweden, it is the responsibility of the principal supervisor to inform the external reviewer of the requirements for a Swedish doctoral thesis.

Roles at the public defence

A person who has acted as an external reviewer in accordance with the above shall not be a member of the examining committee at the public defence. He or she should, in normal cases, not act as an opponent at the public defence.

Appendix - System of Qualifications (Higher Education Ordinance (1993:100))

Licentiate degree

Extent

A licentiate degree is awarded

either after the doctoral student has completed a course of study of at least 120 credits in a subject for third-cycle studies,

or after the doctoral student has completed a part of at least 120 credits of a course of study that is to conclude with a doctoral degree, if the higher education institution decides that such a licentiate degree can be awarded at the higher education institution.

Target

Knowledge and understanding

For a licentiate degree, the doctoral student must

- demonstrate knowledge and understanding in the field of research, including current specialist knowledge in a limited part of this area as well as specialised knowledge of scientific methodology in general and the methods of the specific research area in particular.

Competence and skills

For a licentiate degree, the doctoral student must

- demonstrate the ability to identify and formulate issues critically, autonomously and creatively and with scientific accuracy, and to plan and, using appropriate methods, carry out a limited research project and other advanced tasks within predetermined time frames and thereby contribute to the formation of knowledge and to evaluate this work,

- demonstrate the ability to present and discuss, orally and in writing, research and research results in both national and international contexts in dialogue with the scientific 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 licentiate degree, the doctoral student must

- demonstrate the ability to make assessments of research ethics in their own research,
- demonstrate insight into the possibilities and limitations of science, its role in society and the responsibility of the individual for how it is used, and
- demonstrate the ability to identify his or her need for further knowledge and to take responsibility for his or her knowledge development.

Scientific paper

For a licentiate degree, the doctoral student must have had a scientific thesis of at least 60 credits approved.

Other

For a licentiate degree with a certain specialisation, the specified requirements that each higher education institution itself determines within the framework of the requirements in this qualification descriptor shall also apply.

Phd

Extent

A doctoral degree is awarded after the doctoral student has completed a course of study of 240 credits in a subject for third-cycle studies.

Target

Knowledge and understanding

For a doctoral degree, the doctoral student shall:

- demonstrate broad knowledge and a systematic understanding of the research area as well as in-depth and up-to-date specialist knowledge in a defined part of the research area, and
- demonstrate familiarity with scientific methodology in general and with the methods of the specific research area in particular.

Competence and skills

For a doctoral degree, the doctoral student shall:

- demonstrate the ability to conduct scientific analysis and synthesis as well as to independently critically examine and assess new and complex phenomena, issues and situations,

- demonstrate the ability to identify and formulate issues critically, independently, creatively and with scientific accuracy, and to plan and, using appropriate methods, conduct research and other advanced tasks within predetermined time frames, and to review and evaluate such work,
- demonstrate by means of a thesis the ability to make a significant contribution to the formation of knowledge through their own research,
- demonstrate the ability to present and discuss research and research results in both national and international contexts, orally and in writing, in dialogue with the scientific community and society in general,
- demonstrate the ability to identify the need for further knowledge, and
- demonstrate the ability to contribute to the development of society and support the learning of others, both in research and education as well as in other qualified professional contexts.

Judgement and approach

For a doctoral degree, the doctoral student shall:

- demonstrate intellectual independence and scientific probity as well as the ability to make assessments of research ethics, and
- demonstrate in-depth insight into the possibilities and limitations of science, its role in society and the responsibility of the individual for how it is used.

Scientific dissertation (doctoral thesis)

For a doctoral degree, the doctoral student must have received a passing grade for a scientific thesis (doctoral thesis) of at least 120 credits.

Other

For a doctoral degree with a certain specialisation, the specified requirements that each higher education institution itself determines within the framework of the requirements in this qualification descriptor shall also apply.