General syllabus for third-cycle courses and study programmes for the third-cycle subject area Mathematics and applications

1 Description of the third-cycle subject area at BTH

Mathematics is traditionally divided into three branches: analysis, algebra and geometry.
The third-cycle subject area of Mathematics and applications includes all three of these areas, as well as applications, especially in technology, science and economics. Characteristic for the mathematical research at BTH has largely been an interaction between theory and applications, in the way that the research alternatively focus on problems of application and alternatively on new mathematical theory, the latter actualized by the unresolved problems in current applications.

The subject of Mathematics supports BTH's profile by its very nature of crystallizing relevant alternate formal structures, investigating what applies to them, and to streamline calculations as far as possible. Even when mathematics isn't applied, its core idea is to find what is possible in the most efficient / optimal possible way, in the form of explicit results.

2 Structure of the course/programme

Third-cycle courses and study programmes which finish with a Degree of Licentiate comprise an actual period of study of two years (120 higher education credits) and consist of a course component of minimum 50 higher education credits and a licentiate thesis of minimum 60 higher education credits.

Third-cycle courses and study programmes which finish with a Degree of Doctor comprise an actual period of study of four years (240 higher education credits) and consist of a course component of minimum 100 higher education credits and a dissertation of minimum 120 higher education credits.

A third-cycle student who is admitted to third-cycle studies is given the possibility to take a Degree of Licentiate (according to the above) after having completed minimum 120 higher education credits of the programme that is to be finished with a Degree of Doctor.

For each third-cycle student an individual study plan is set up. The individual study plan describes the individual set-up of the studies. The individual study plan is revised and followed up yearly in accordance with the routines that are established at BTH. The study plan is to show in a convincing way how the goals for the third-cycle student's studies can be attained within the available time period.

In accordance with the Higher Education Ordinance at least two supervisors are appointed for each third-cycle student of whom one is appointed principal supervisor. According to the BTH

local guidelines for the appointing of principal supervisor she/he is to be professor, adjunct professor or docent employed at BTH and is to have undergone supervisor training or hold the equivalent competence. A supervisor, who is not the principal supervisor of the two, is to have a doctoral degree. In addition, further supervisors may be affiliated to the third-cycle student, e.g., from the business sector, if this is for the benefit of the third-cycle student's studies. For these additional supervisors no demand on having a doctoral degree is placed.

2.1 Purpose of the education

BTH conducts third-cycle education in order to contribute with solutions to the complex challenges in society and to meet the demands of a changeable labour market.

Specifically, the third-cycle courses and study programmes aim at developing the third-cycle student's knowledge in the subject area and her/his capacity to independently carry on research-, development-, teaching- and investigatory work based on a scientific foundation in different areas of society. The purpose of the third-cycle education is, in addition, to give the third-cycle student the capacity to critically and independently plan, initiate, and lead such work.

Specifically the third-cycle education in Mathematics and applications aims at training researchers that can use mathematical theory in order to construct, strengthen or streamline existing solutions to problems in engineering, science and economics, as well as advancing the mathematical theory in relevant directions.

2.2 Goals for the education

According to the System of Qualifications in the Higher Education Ordinance (1993:100) according to enclosure.

In addition to goals in the Higher Education Ordinance (1993: 100), the goal of education at a third-cycle level in Mathematics and applications is to train researchers who can formulate and solve mathematical problems, both those that are formulated from applications and other problems, and mathematically answer the key issues affecting them.

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

Ability of constructive research collaboration with researchers from other disciplines and the ability of able presentation of research results, in writing as well as orally, are also included in the educational goals.

2.3 Realization of the education

The third-cycle student carries on research and writes a scientific work (licentiate thesis/doctoral dissertation). In support of this, the education may include lectures, seminars, literature studies, project assignments, group supervision and individual supervision. Courses for each third-cycle student are established individually in consultation with the supervisors and the examiner and are entered into the individual study plan.

The supervision of the education aims at assisting the third-cycle student regarding choice of research domain, scientific method and organization and planning of the scientific work and pertaining studies. The supervisors are to assist with subject competence and see to that the work holds an international quality level. Furthermore, the supervision aims at introducing the third-cycle student to the scientific community and its demands on ethics, honesty and critical thinking.

The third-cycle student is to participate in national and international contexts and present her/his own research.

During the education period the third-cycle student is to take part of the scientific activities which are conducted in the scientific environment at the department/faculty by attending seminars and guest lectures, and, in the normal case, give one seminar per year about her/his thesis work.

The third-cycle student is to carry out a popular science-based presentation of her/his research before the Degree of Licentiate and public defense of the doctoral dissertation and write a popular science-based summary which is to be included in the licentiate thesis respective the doctoral dissertation.

A third-cycle student, employed by the higher education institution as a doctoral student, is recommended to dedicate certain time (not more than 20 per cent of full working hours) to teaching in first- and second-cycle courses and programmes. Such work is financed by the first- and second-cycle courses and programmes and is to be accounted for in the individual study plan.

At an annual meeting with the third-cycle student, supervisor and a special contact person outside the research group, the work, as well as the third-cycle student's development in terms of knowledge, skills, abilities and attitudes that are not evaluated at the examination of third-cycle courses, are evaluated. Following this an individual study plan is drawn up which is updated continuously. It is recommended that third-cycle students also participate in the activities of the doctoral student committee at BTH.

The education should be organized so that the third-cycle student attains the stipulated examination targets. How the knowledge needs of each individual third-cycle student are to be fulfilled in order to attain the examination targets is stated in respective individual study plan.

3 Entry requirements and selection

3.1 General entry requirements
According to 7 Chap. 39 § in the Higher Education Ordinance (1993:100).

3.2 Specific entry requirements
Master's degree, or degree of Master of Science in engineering degree with sufficient depth, within the subject of mathematics or equivalent. The courses in mathematics should comprise

at least 90 credits, of which at least 30 credits at an advanced level. In addition, the degree should comprise at least 15 credits in any application subject. The knowledge requirements as stated above can also be considered fulfilled by the person who in some other way in Sweden or abroad have acquired the equivalent knowledge.

3.3 Selection

According to 7 Chap. 41 § in the Higher Education Ordinance (1993:100) and the current admission regulations at BTH. Selection is to be made in consideration of the applicants' capacity to profit by the education. The foundation for selection among the qualified applicants is the degree of capacity to profit by the third-cycle education, and the access to supervision and other resources in view of the planned specialization of the licentiate thesis/doctoral dissertation.

The bases of assessment applied at the selection for third-cycle education are constituted by:

- Familiarity with the theory and applications of the subject,
- Relevant work experience where appropriate,
- Skills in expression of speech and in writing,
- Familiarity with English,
- Creativity, capacity for initiative, independence and ability to co-operate.

To assess how the applicant fulfills the bases of assessment results are used that show passed higher education courses, quality of the independent work and possible publications, references, interviews together with a personal letter from the applicant which describes the applicant's expectations on and intentions with the education. In certain cases the applicant may undergo specific work tests.

Admission to third-cycle education is done on a continuous basis.

4 Examinations that form part of the education

The education consists of courses and a scientific work. Examinations that form part of the third-cycle education are assessed with the grades pass/failed. A grade on a course and a licentiate thesis, respectively, is determined by a specially appointed examiner. A grade on a doctoral dissertation is determined by a specially appointed grading committee.

For a possible credit transfer, see the current order for credit transfers and the guidelines for credit transfers for first-cycle and second-cycle education.

4.1 Courses

In support of the research work and for the fulfilment of the examination targets generally, the third-cycle student takes a number of courses. Courses completed at BTH as well as courses from other higher education institutions can be included.

For third-cycle courses given at BTH there is to be a written course description which, among other things, states the title of the course in Swedish and English, the course objectives, content and credits. The individual study plan is to regulate which courses can form part of the studies

and how many higher education credits each course should award (for participation in a course originally intended for first- or second-cycle see the guidelines for credit transfer of courses in third-cycle education).

In accordance with the BTH program and action plan for quality work, the third-cycle student who within the framework of the employment is expected to teach is to take the first part (3 higher education credits) of the introductory course in teaching and learning in higher education (7.5 higher education credits).

Components of the education in the areas below are compulsory. How these are examined, through a course or other component, is regulated in each separate individual study plan.
- Research methodology
- Information search for researchers
- Scientific writing and scientific review
- Ethics in research

For the licentiate degree the following courses are required:
- Higher Education Pedagogy or Mathematics Education, at least 3 credits.
- General study course in mathematics of at least 47 credits. This shall include courses from each of the following groups:
  1. Analysis, at least 12 credits
  2. Algebra and Geometry (including discrete mathematics), at least 12 credits
  3. Mathematical modelling, at least 6 credits
  4. Application topics at least 6 credits.

Thus, there is a freedom of choice in direction of the range of courses of at least 11 credits that can be used to select more courses near the dissertation field.

For the Degree of Doctor, the following is required:
- Optional courses in mathematics and mathematical modelling of at least 30 credits.

Also courses in philosophy of science, information retrieval, mathematics education or the history of mathematics can be included, in both the Degree of Licentiate and the Degree of Doctor. For the Degree of Licentiate, these courses may not exceed 5 credits and for the Degree of Doctor, these courses may not exceed 10 credits.

The choice of courses is to be characterized by flexibility with regard to the third-cycle student's prior knowledge and the specialization of the research work and is to be determined in consultation between the third-cycle student, supervisors and examiner. The examination format is determined by the examiner in consultation with the supervisors. Goal attainment is tested by the examiner.

All compulsory courses or components are to be completed before the doctoral dissertation is publicly defended at the public defence of the doctoral dissertation. Other courses and components are to be chosen so that the third-cycle student obtains both breadth and depth in

the research domain. The courses are also to benefit the third-cycle student's competence and skills, her/his studies or scientific work.

4.2 Scientific work

Scientific work in the form of a licentiate thesis/doctoral dissertation is to be designed as an integrated, connected scientific work (monograph) or as a summary – introductory chapter – together with pertaining scientific academic papers (compilation), which the third-cycle student has written alone or together with another person. The scientific work is written in English or Swedish.

The licentiate thesis is to be defended orally at a public licentiate seminar. For further information please see "Regulations for licentiate seminars" established by BTH.

The doctoral dissertation is to be defended orally at a public defence of doctoral dissertation. For further information please see "Regulations for the public defence of a doctoral dissertation" established by BTH.

The doctoral dissertation should be on such a level that the quality requirements for publication in known international, scientific journals or similar publications are met. It is highly recommended that the thesis is written in English for the degree of licentiate as well doctor.

5 Degree

5.1 Examination targets

Goals according to the System of Qualifications in the Higher Education Ordinance (1993:100) according to enclosure.

5.2 Title of qualification

The degree title of third-cycle studies in Swedish at BTH consists of a general degree with the addition of a prefix. The prefix is normally teknologie (Technology).

Third-cycle students studying for a Degree of Licentiate in Mathematics and applications normally receives the Swedish degree title teknologie licentiatexamen (Eng. Degree of Licentiate of Technology).

Third-cycle students studying for a Degree of Doctor in Mathematics and applications normally receives the Swedish degree title teknologie doktorsexamen (Eng. Degree of Doctor of Philosophy).

Exceptions to the prefix Technology in the Swedish degree: For individuals who do not have a second-cycle technical education[1] a degree of Philosophy will be awarded. The prefix should be clarified in the individual study plan. For a degree of Philosophy the Swedish degree title is:

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[1] A technical education refers to a Master's degree in Engineering, Master's degree in Science or equivalent in a technical or mathematical-scientific field.

Filosofie licentiatexamen (Eng. Degree of Licentiate of Philosophy).

Filosofie doktorsexamen (Eng. Degree of Doctor of Philosophy).

6 Effective date and interim regulations
This general syllabus becomes effective on June 1, 2018.

Third-cycle students admitted before June 1, 2018 will complete, as a general rule, their studies according to the older general syllabus. If a third-cycle student so requests and it is deemed suitable, the relevant examiner may accept a transfer to the new general syllabus. The third-cycle student will then report the transfer to the relevant Dean and attach a copy of an updated individual study plan updated according to the new general syllabus.

ANNEX
General qualifications

Degree of Licentiate [Licentiatexamen]

Scope
A Degree of Licentiate is awarded

either after a third-cycle student has completed a study programme of at least 120 credits in a subject in which third-cycle teaching is offered,

or after a third-cycle student has completed one part comprising at least 120 credits of a study programme intended to conclude with the award of a PhD, if a higher education institution decides that a Degree of Licentiate of this kind may be awarded at the institution.

Outcomes

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.

Thesis

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

Miscellaneous

Specific requirements determined by each higher education institution itself within the parameters of the requirements laid down in this qualification descriptor shall also apply for a Degree of Licentiate with a defined specialisation.

Degree of Doctor

Scope

A Degree of Doctor is awarded after the third-cycle student has completed a study programme of 240 credits in a subject in which third-cycle teaching is offered.

Outcomes

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 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, 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.

Research thesis (doctoral thesis)

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

Miscellaneous

Specific requirements determined by each higher education institution itself within the parameters of the requirements laid down in this qualification descriptor shall also apply for a Degree of Doctor with a defined specialisation.