



General syllabus for third-cycle education in 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: calculus, algebra and geometry. The third-cycle subject mathematics and applications includes all three of these areas as well as applications, especially in engineering, science and economics. Characteristic of mathematics research at BTH has largely been an interaction between theory and applications, in 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. Even theoretical mathematics usually has, if not always in an obvious way, in the long run connected to applications.

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 at least 45 higher education credits and a licentiate thesis of at least 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 at least 90 higher education credits and a dissertation of at least 120 higher education credits.

A third-cycle student who is admitted to the Degree of Doctor 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.

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. The supervisors and the examiner will be appointed according to BTH's guidelines. The supervisor, who is not the main supervisor of the two, must have a PhD. In addition, further supervisors may be affiliated



to the third-cycle student, e.g., from industry, if this is for the benefit of the third-cycle student's studies. For these additional supervisors there is no demand on having a doctoral degree.

2.1 Purpose of the education

BTH conducts third-cycle education 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 Degree of Doctor is, in addition, to give the third-cycle student the capacity to plan, initiate, and lead such work critically and independently.

Specifically, the third-cycle program in mathematics with applications aims to train researchers who can use mathematical theory to construct, reinforce or streamline existing solutions for problems in technology, science and economics, as well as further develop 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.

Utöver examensordningens mål i högskoleförordningen (1993:100) är målet med utbildning på forskarnivå i matematik med tillämpningar att utbilda forskare som kan formulera och lösa matematiska problem, både sådana som är formulerade från tillämpningar och andra problem, och matematiskt besvara centrala frågor som gäller dem.

Det handlar också om att bygga upp relevant matematisk teori. Detta kräver förmåga att se samband mellan tillämpning och matematik ur många synvinklar, och en bred kunskap om befintliga matematiska teorier och metoder, och hur de växelverkar med tillämpningar.

Förmåga till konstruktivt forskningssamarbete även med forskare från andra vetenskapsområden samt förmåga till god presentation, skriftligen såväl som muntligen, av forskningsresultat tillhör också utbildningens mål.

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, e.g., 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 defence of the doctoral dissertation and write a popular science-based summary which should be enclosed in the licentiate- and doctoral thesis.

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.

The education should be organized so that the third-cycle student attains the stipulated qualitative targets. How the knowledge needs of each individual third-cycle student are to be fulfilled to attain the qualitative 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

A master's degree in engineering with sufficient in-depth study, 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 any application subject. The requirements for prior knowledge as described above can be considered fulfilled even by those who, in another order within or outside the country, have acquired essentially equivalent knowledge.

3.2 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.



Examples of 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.
- Ability to express oneself in speech and writing,
- Familiarity with English,
- Creativity, initiative, independence, and ability of cooperation.

To assess how the applicant fulfils the bases of assessment, the following are used: results from higher education courses, quality of the independent work and possible publications, references, interviews, possible personal knowledge, and 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.

4.1 Courses

In support of the research work and for the fulfilment of the qualitative targets generally, the third-cycle student studies several 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).

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
- Introductory course in the third-cycle subject Spatial Planning, with a focus on planning theory and the subject's intra-scientific discussion



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

- Analysis, at least 6 credits.
- Algebra and Geometry (including Discrete Mathematics), at least 12 credits.
- Mathematical Modelling and Applied Mathematics, at least 6 credits.

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

- Analysis, at least 15 credits.
- Algebra and Geometry (including Discrete Mathematics), at least 20 credits.
- 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 licentiate and doctoral degrees.

The choice of courses is to be characterized by flexibility about 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 part – together with pertaining scientific academic papers (compilation), which the third-cycle student has written alone or together with another person or persons. The scientific work is written in English or Swedish.

The licentiate thesis is to be presented orally at a public licentiate seminar. For further information, see "Rules for licentiate seminars" established by BTH.

The doctoral thesis must be defended orally at a public defence. The thesis must previously have been quality assured according to the description in "Appendix – Quality assurance of doctoral thesis" For further information, please refer to the "Rules for defending a doctoral thesis" 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 be written in English for both licentiate and doctoral degrees.



5 Degree

5.1 Qualitative targets

Goals according to the System of qualifications in the Higher Education Ordinance (1993:100) according to “Enclosure – System of qualifications (Higher Education Ordinance 1993:100)”.

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”.

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

Third-cycle student taking 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 education¹ 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:

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 October 1, 2022.

Third-cycle students admitted before October 1, 2022, 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.

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.



Enclosure I – Quality assurance of a doctoral thesis

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

Final seminar

When 6–4 months remain until the planned dissertation, a seminar is arranged at which the research student gets the chance to present their thesis in its current form. The main 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 Science will be invited to this seminar. In addition, an *external reviewer*, who is a researcher at associate professor 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 dissertation draft.
2. Be an opponent at the seminar.
3. Leave a brief opinion to the main supervisor, subject representative and dean of the Faculty of Engineering Sciences. In the opinion, the external reviewer's assessment of whether the thesis meets the requirements for *approval* as a Swedish doctoral thesis must be stated. The opinion should be received no later than one week after the seminar.

The choice of external reviewer is made by the subject representative in consultation with the head of department. If the external reviewer lacks previous experience from dissertations in Sweden, it is the responsibility of the main supervisor to inform the external reviewer about the requirements for a Swedish doctoral thesis.

Roles at the dissertation

A person who has acted as an external reviewer in accordance with the above shall not be included in the examination board at the time of the dissertation. He or she should not, in the normal case, act as an opponent at the time of defending his or her thesis.



Enclosure – System of qualifications (Higher Education Ordinance 1993:100)

Degree of Licentiate

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.