Translation of Subject Curriculum (Study Plan) for Third-cycle (PhD) Education

Scientific Computing

Scientific Computing with specialization in Numerical Analysis

Swedish title: Beräkningsvetenskap; Beräkningsvetenskap med inriktning mot numerisk analys

TNBEVE00 (Scientific Computing)
TNBEVE01 (Scientific Computing with specialization in Numerical Analysis)


The Study Plan for third-cycle studies consists of three parts: a general part, this subject specific study plan, and each doctoral student's individual study plan.

Objective

In relation to first- and second-cycle education in the subject area, the graduate level education shall give additional insight into the central parts of the area and expert knowledge in at least one subarea. Supervision and thesis work shall prepare the doctoral student for critical and independent research activities or other professional activities with high demands for subject area expert knowledge and research competence.

The doctoral student shall also be able to present her/his own goals and results orally and in writing to different target groups in English and, in the case of Swedish-speaking doctoral students, in Swedish.

Subject description

Scientific Computing concerns the study of methods required for advanced computer-based computations. This includes Numerical Analysis, i.e., development and analysis of numerical methods for
efficient computation of solutions to problems expressed as mathematical models. It also includes computational models and methods for data analysis. In addition, Scientific Computing includes the study of algorithms and software techniques that are required for efficient implementation of computational methods on high-performance computing platforms. Focus is on development of methods, but there is a close interaction with applications. The subject area of Scientific Computing is interdisciplinary with interfaces to Mathematics, Computer Science, and application areas, primarily within Science and Technology. The doctoral degree will be labeled “Scientific Computing”. Alternatively, doctoral students who specialize in development and analysis of numerical methods can choose to have the doctoral degree labeled “Scientific Computing with specialization in Numerical Analysis”

Eligibility

Basic Eligibility
The basic eligibility for third-cycle studies is described in the general part of the study plan.

Special Eligibility
A person has special eligibility for a third-cycle program in Scientific Computing and Scientific Computing with specialization in Numerical Analysis if she/he has passed examinations in courses of relevance for Scientific Computing, corresponding to a minimum of 90 credits.

Admission
Applicants for third-cycle program in Scientific Computing and Scientific Computing with specialization in Numerical Analysis must submit an application to the head of the Department of Information Technology. Admissions to places in third-cycle programs take place normally twice per year.

Upon admission to postgraduate education, the Swedish title of the degree is to be specified in the application. According to decision (TEKNAT 2012/215), postgraduate education in Scientific Computing and Scientific Computing with specialization in Numerical Analysis shall lead to a *filosofie doktorsexamen* or *teknologie doktorsexamen*. The English rendering will in either case be a licentiate/doctorate degree of philosophy.
At the time of admission, the department must provide a financial assistance plan demonstrating sufficient support to cover the maintenance of the applicant as well as her/his research.

Program structure

At the time of admission, each doctoral student and her/his supervisor shall draw up an individual study plan after consultation with the professor in charge of third-cycle studies. The plan is to be approved by the Head of the Department (by delegation of the Faculty Board) at the time of admission.

The individual study plan shall be annually reviewed by the doctoral student and her/his supervisor jointly, and supplemented with a summary of the achieved results and the plans for the coming year. Significant changes as well as any disagreement on the individual study plan shall be reported to the Head of the Department or, if deemed necessary, to the Third-cycle Educational Board.

Courses

The third-cycle studies may include different kinds of courses, such as lectures, literature studies, practical training, field studies, etc. The courses are intended to provide a wider insight into the subject as a complement to the competence acquired during research.

A doctoral degree should include courses corresponding to normally 70-90 higher education credits. The exact number of credits is specified in the individual study plan. A licentiate degree should include courses corresponding to 40 higher education credits.

The course part of the third-cycle program contributes to attainment of goals for third-cycle education according to the Higher Education Ordinance. This concerns in particular, but not exclusively, goals related to “Knowledge and understanding”. For attainment of other goals, there is training and assessment in apprenticeship format as well as participation in seminars, conferences, etc., within the thesis part of the education.

It is presumed that all courses taken by doctoral students are third-cycle courses. Some first- and second-cycle courses of importance for the third-cycle education in Scientific Computing and Scientific Computing with specialization in Numerical Analysis can be included in the doctoral degree, after approval by the supervisor. Such approval should be applied very restrictively.
The range of courses offered is revised continuously. The individual study plan shall be in accordance with the following guidelines:

- **Outlook**: The individual curriculum must include such courses that give a sufficiently broad overview of numerical methods for different types of mathematically formulated problem settings. Moreover, the individual curriculum must include parts of Scientific Computing that intersect with Computer Science, for example, algorithms and programming techniques for implementation on high-performance computing platforms. In addition, it is recommended to include some course in an application area within, e.g., science or engineering. This part of the education should normally encompass ca. 30 credits.

- **Specialization**: The curriculum shall provide specialization in aspects of Scientific Computing of particular relevance for the doctoral student’s research. A recommendation is to include individual courses, where the doctoral student is reading literature needed for the thesis work. This part of the education shall encompass at least 20 credits.

- **Other perspectives**: An additional objective for the curriculum is to provide non subject-specific perspectives on research. A course in research ethics of at least 2 higher education credits is mandatory for licentiate and doctoral degree. A course in university educational theory is also mandatory for doctoral students who teach at basic and advanced level. It is also recommended to include a course in Philosophy of Science. In addition, the curriculum can for example include courses that give complementing knowledge in Mathematics and Computer Science as well as courses providing a preparation for a career in industry.

- **Independence**: Some of the credits taken by the doctoral student must be for independent literature studies that have not been supported by organized, course-like education.

For doctoral students who wish to get the doctoral degree label “Scientific Computing with specialization in Numerical Analysis”, it is required that the thesis project is in the area of Numerical Analysis and that the curriculum includes at least 40 credits of courses in Numerical Analysis. It is also required that the course part provides knowledge about the research frontline in the area of Numerical
Analysis covered by the thesis work, and in addition that the course part includes third-cycle courses on established methods and corresponding theory for numerical solution of ordinary differential equations and partial differential equations as well as on numerical linear algebra.

**Requirements for doctoral degree**

The requirements for a doctoral degree consist of on the one hand passed examinations in the courses included in the approved individual study plan of each doctoral student, and on the other hand a passed public defense of the doctoral thesis. The program leading to the doctoral degree amounts to 240 higher education credits (four years of full-time studies), of which the thesis part amounts to a minimum of 120 higher education credits and the course part to a minimum of 70 higher education credits.

**Requirements for licentiate degree**

A doctoral student who has acquired at least 120 higher education credits (two years of full-time studies) is eligible for a licentiate degree. The requirements for this are that the doctoral student both has passed the examinations included in the program stage and has received the grade pass for a thesis amounting to a minimum of 60 higher education credits. The course part amounts to a minimum of 40 higher education credits.

**Other**

If the doctoral student does not complete a licentiate degree, he/she shall instead give a half-time seminar, which is publicly announced within the department at least two weeks in advance. The half-time seminar shall consist of a 45 minute presentation, in which the doctoral student presents his/her scientific problem, an overview of his/her research, its methodology and achieved results, as well as planned research, in a manner that is accessible to an audience with a background in Scientific Computing. An external reviewer should take part in the seminar. After the presentation, there should be a scientific discussion where the external reviewer and other members of the audience provide feedback. The course on research ethics that is mandatory for the licentiate and doctoral degrees must be completed before the half-time seminar.