



LUND UNIVERSITY

Faculty of Science

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Faculty Board

## General Syllabus for Third-Cycle Studies in Numerical Analysis, NANUMA01

*This is a translation of the general syllabus approved in Swedish.*

**This syllabus was approved by the Board of the Faculty of Science on 12 February 2014 and applies to third-cycle students admitted from this date.**

**The syllabus is based on the Higher Education Ordinance (1993:100) Chapter 6 Sections 1–11, 25–36, Chapter 7 Sections 34–41 and Annex 2 Qualifications Ordinance.**

### 1. Available degrees

The programme described in this syllabus can lead to one of the following degrees:

Doctor of Philosophy in Numerical Analysis

Licentiate of Philosophy in Numerical Analysis

In consultation with the Faculty of Engineering/LTH, the Faculty Board has decided (NA35 643/2005) that students admitted to third-cycle studies at the Faculty of Science on the basis of an MSc in Engineering shall be entitled to be awarded the degrees of Doctor of Philosophy in Science or Licentiate of Science without special application.

### 2. Subject description

Numerical Analysis comprises two main branches, numerical mathematics and technical-scientific computation, with broad interfaces with mathematics, computer science and subjects of application. Numerical mathematics aims to construct and analyse numerical algorithms for calculation and to develop mathematical software. Technical-scientific computation aims to solve complex problems within applied mathematics and to develop advanced program systems, occasionally on computers and processors with special architecture. The boundary between the two specialisations is porous and most research projects include elements of both.

Modern computational methodology is a vital aspect of an increasing number of fields of science and engineering and is often the decisive link in the classical nexus of theory and experiment in science. As very few problems formulated in mathematics can be solved by analytical computation, almost all significant problems of application need to be approached via approximative, numerical methods of computation. This is the case with, for example, approximative

solutions to non-linear problems, differential and integral equations, and problems in complex or variable geometry. The third-cycle programme in Numerical Analysis is mainly focused on broad categories of problems such as these. Major emphasis is placed on the stability, thoroughness, effectiveness and reliability of the methods, as the computations are expansive and carried out with limited precision.

The current research areas are described on the department website <http://www.maths.lu.se/na/>.

### **3. Objectives**

Third-cycle courses and study programmes shall be based fundamentally on the knowledge acquired by students in first- and second-cycle courses and study programmes, or its equivalent. In addition to the requirements for first- and second-cycle courses and study programmes, third-cycle courses and study programmes shall develop the knowledge and skills required to be able to undertake autonomous research.

The third-cycle programme in Numerical Analysis aims train research students to be able to conduct research of a high standard, both individually and in groups, and work within higher education or the private or public sectors with advanced tasks requiring research experience.

The general outcomes for third-cycle courses and study programmes are defined in the Higher Education Ordinance Annex 2 Qualifications Ordinance .

#### **3.1. Outcomes for a degree of Doctor**

##### ***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 the ability 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 thesis 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.

## **3.2. Outcomes for a degree of Licentiate**

### ***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 have:

- 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.

## 4. Admission requirements

The requirements for admission to third-cycle courses and study programmes are that the applicant meets the general and specific entry requirements that the higher education institution may have laid down, and is considered in other respects to have the ability required to benefit from the course or study programme.

### *General admission requirements*

A person meets the general entry requirements for third-cycle courses and study programmes if he or she:

1. has been awarded a second-cycle qualification, or
2. has satisfied the requirements for courses comprising at least 240 credits of which at least 60 credits were awarded in the second cycle, or
3. has acquired substantially equivalent knowledge in some other way in Sweden or abroad.

The head of department may permit an exemption from the general entry requirements for an individual applicant, if there are special grounds.

*Transitional provision:* Those who meet the general admission requirements for doctoral programmes before 1 July 2007 will also be considered to meet the general admission requirements for third-cycle courses and study programmes until the end of June 2015.

If a specific number of credits or a qualification from previous first- or second-cycle courses and study programmes are required for admission to third-cycle courses and study programmes, those with corresponding credits or qualifications from undergraduate programmes awarded before 1 July 2007 will also be eligible.

### *Specific admission requirements*

To be admitted to the third-cycle programme in Numerical Analysis the student must have passed independent study courses in mathematics comprising at least 60 credits including at least 30 credits in Numerical Analysis. Relevant computer science skills can also be taken into account. A degree project of at least 30 credits must be included.

Equivalent knowledge acquired through corresponding programmes will be assessed individually.

In order to enable interdisciplinary initiatives and important specialisations in certain areas, students with qualifications in subjects other than Numerical Analysis may be considered for admission.

## 5. Selection

In selecting between applicants who meet the requirements, their ability to benefit from the course or study programme shall be taken into account. However, the fact that an applicant is considered able to transfer credits from prior courses and study

programmes or for professional or vocational experience may not alone give the applicant priority over other applicants.

The following selection criteria will be applied:

Study record from undergraduate and Master's courses or the equivalent. The breadth, depth and relevance of undergraduate and Master's courses or the equivalent. The quality of the degree project and other independent work.

Other knowledge and skills of relevance to the research specialisation.

Suitable candidates should be called to an interview, if possible.

The recruitment and selection to third-cycle studies must always take diversity and gender balance into account, in compliance with the Lund University gender equality policy, equal opportunities policy and diversity plan. The underrepresented gender should always be given precedence in cases of equal qualifications, unless there are valid reasons to the contrary.

Furthermore, it must be possible for the department to offer expert supervision in the student's research specialisation.

## **6. Degree requirements**

The completion of the third cycle programme results in a degree of Doctor of Philosophy or, if the student so wishes or if this is stated in the admission decision, a degree of Licentiate. The student may also but is not obliged to complete a degree of Licentiate as a stage in the third-cycle programme.

The degree of Doctor comprises 240 credits and the degree of Licentiate 120 credits.

For a degree of Doctor or Licentiate the research student must have successfully completed a PhD or Licentiate thesis and passed all courses and other components specified below. The head of department (or person to whom the task has been delegated) is to check and determine if all the formal requirements of a degree of Doctor or Licentiate have been satisfied.

### **6.1. Thesis**

The programme is to include a research project documented in a PhD or Licentiate thesis. The thesis is to be defended orally at a public defence and reviewed by a faculty examiner (opponent).

#### ***PhD thesis***

The PhD thesis is to comprise 120–150 credits.

The PhD thesis can be designed as *compilation thesis* or as a *monograph*.

A compilation thesis consists of copies of a number of research articles or manuscripts and a summarising chapter. The articles may be written by the doctoral student individually or in cooperation with others, but the summarising

chapter must be written individually by the doctoral student. The research articles must be of a quality required for publication in recognised peer-reviewed journals and it must be possible to determine the contributions of different authors. The summarising chapter is to consist of an introduction to the research area of the thesis and a presentation and discussion of the findings of the articles. The presentation and discussion shall be written in a form and style that is independent and different from the articles. This makes it possible to situate the findings in a wider context.

A monograph thesis is a unified report including descriptions of the research issue, research questions, methods, analysis, findings and discussion.

### ***Licentiate thesis***

The Licentiate thesis is to comprise 60–75 credits.

The Licentiate thesis can be designed as a summary of at least one research article (or manuscript), written by the student individually or in cooperation with others, or a unified research report (monograph). The thesis must be of a quality required for publication in recognised peer-reviewed journals and it must be possible to determine the contributions of different authors. For more information on summary and monograph theses, please see compilation thesis and monograph thesis above.

## **6.2. Courses and other programme components**

The courses and other components of the third-cycle programme in Numerical Analysis are to comprise 90–120 credits for a degree of Doctor and 45–60 credits for a degree of Licentiate. The credits required from courses are to be specified in the individual study plan and are to be adapted to the character and orientation of the research project and the research task of the doctoral student.

The required courses and other components can be offered at Lund University or at other higher education institutions. The head of department (or person to whom the task has been delegated) determines the number of credits that can be transferred from courses and other components offered at other faculties or higher education institutions.

The introductory course of 1.5 credits, of which 0.5 credits consist of the faculty-wide introductory course to PhD studies, is compulsory for all research students and Introduction to teaching methods (3 credits) is compulsory for all research students who teach.