



**LUND**  
UNIVERSITY

Faculty of Science

October 2, 2007

## **Discipline curriculum for studies at third level (postgraduate studies) in theoretical physics at the Faculty of Science**

**Theoretical Physics – Ladok code MNTEOFTF**

**Theoretical Physics - Computational Biology – Ladok code MNTEOFBB**

**Adopted by the Board for postgraduate studies on May 30, 2007.**

**To be used upon admission to studies starting on July 1, 2007 and thereafter.**

Postgraduate studies are regulated also by the higher education law and ordinance.

This discipline curriculum is valid in the relevant parts for studies towards a licentiate as well as a doctorate degree. Studies at postgraduate level lead to a Doctor of Philosophy degree (240 credits) or to a Licentiate of Philosophy degree (120 credits).

The licentiate degree can be an intermediate step towards the doctorate degree.

A degree is obtained in *Theoretical Physics* or *Theoretical Physics – Computational Biology*.

### **1 Description of the subject**

The department's research is described on its website at: [www.thep.lu.se](http://www.thep.lu.se) .

#### **1.1 Theoretical Physics**

In theoretical physics one builds mathematical models and theories that describe the physical reality. With approximations and simplifications a complex phenomenon is reduced such that the essential underlying mechanisms and relations become clear. In order to refine and improve the models, their predictions are studied numerically and analytically and compared with experimental observations.

The basic tools in theoretical physics are classical mechanics, electrodynamics, statistical physics, the theory of relativity and quantum mechanics. A good theoretical physicist knows all these tools and can apply them to problems far outside the traditional physics arena through finding analogies and relations.

Research at the department of theoretical physics is done in two divisions. The division for theoretical high energy physics studies nature's smallest constituents with emphasis on the theory of colour interaction between quarks and gluons. Research is performed in the border area between theory and experiment in close contact with research groups at the largest accelerator experiments worldwide.

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The division for computational biology and biological physics studies models of protein properties and dynamics as well as interactions between proteins, genes and cells. Research is often done in close collaboration with the biomedical research groups in e.g. the cancer and stem cell area.

This discipline curriculum is valid for both divisions at the department of theoretical physics.

### **1.2 Theoretical Physics – Computational Biology**

Biology and medicine stand at the threshold of developing into quantitative sciences which physics and chemistry have been since long. A mixture of researchers from different areas is essential for progress here. A modified curriculum for postgraduate students with undergraduate degree, not necessarily in theoretical physics, but for example from computer science, chemical engineering or biology, is therefore needed.

Research covers the same areas as above, but happens here without exception in intimate collaboration with biomedical research groups. Research topics include models and analyses of the interaction between genes and proteins, cell-cell interactions and disease development.

This discipline curriculum is valid for the division for computational biology and biological physics.

## **2 Purpose and aims of postgraduate studies**

Education at postgraduate (doctoral) level is to be largely based on the knowledge gained by students at Bachelor's level and Master's level, or equivalent knowledge. The aim of postgraduate education is to develop the knowledge and skills of the student, over and above those at basic and advanced level, so that he or she can pursue independent research.

Postgraduate education in theoretical physics aims, on the one hand to give a good ability to treat physical or biological questions with theoretical, mathematical and numerical methods, and on the other hand to give deepened knowledge in some central areas of theoretical physics with strong emphasis on the special subject area chosen by the student.

The demands laid out in the Higher Education Ordinance for postgraduate degrees can be found in the Appendix.

The postgraduate student shall after the postgraduate education in theoretical physics:

- have acquired a solid knowledge of the field with strong deepening in their own special subject area
- have acquired mastery of the tools and methods belonging to theoretical physics
- have obtained a critical way of thinking and a general sceptical attitude.
- have shown to be able to perform research of high quality under guidance and have been prepared to continue with independent research of high quality.

A quality goal of the postgraduate education in theoretical physics is that those who complete the education will be able to compete for postdoc positions with international top universities and research laboratories.

## **3 Admission to postgraduate studies**

### **3.1 Eligibility**

In order to be admitted to postgraduate studies, the applicant must fulfil the requirements for basic and special eligibility. The applicant must also be deemed to have the ability to successfully complete postgraduate studies.

### Basic eligibility

The basic requirements for admission to postgraduate studies are:

- a degree at advanced (MSc) level  
*or*
- completed courses equivalent to at least 240 credits, of which 60 must be at advanced (MSc) level,  
*or*
- the equivalent knowledge or qualifications obtained in some other way, in Sweden or in another country.

Exceptions may be made in special cases, by the Faculty Board, or by the person or persons delegated by the Faculty Board to make this decision.

*Interim regulations:* Those fulfilling the demands for basic eligibility before July 1, 2007 will be deemed to fulfil the basic requirements for admission to postgraduate studies until June 30, 2015. If specific demands for admission to postgraduate studies are made regarding previous education or a degree at basic or advanced level, those who have equivalent knowledge or a degree obtained prior to July 1<sup>st</sup> 2007 shall be considered eligible.

### Special eligibility

- Special eligibility in *theoretical physics* requires an education at bachelor level in physics or theoretical physics and in addition at least 60 credits at master level in physics or theoretical physics, civil engineer degree in technical physics (possibly with some additions) or equivalent knowledge.
- Special eligibility in *theoretical physics – computational biology* requires an education at bachelor level in biomedical areas, chemistry, physics mathematics or computer science, and in addition at least 60 credits at master level in bioinformatics or computational biology.

Special eligibility may be obtained through equivalent studies; this will be assessed in each case.

### Credit for postgraduate studies

If a student has successfully completed university courses in Sweden, or another country, he or she has the right to be given credit for these studies at another university. This does not, however, apply if there is a considerable difference between the courses.

A student may also be awarded credits for studies other than those referred to above, if the knowledge and skills acquired are of such a character and of such an extent that they essentially coincide with the studies for which credit is intended to be given.

Credit may also be given for corresponding knowledge and skills acquired professionally.

The Faculty Board (or others delegated by the Board) may consider whether credits can be given for previous courses or activities in individual cases, upon the request of the applicant.

## 3.2 Announcement of postgraduate studentships and applications

The processes of application and admission are laid out in the Faculty's regulations for admissions, see the homepage of the faculty of science ([www.science.lu.se](http://www.science.lu.se)).

### 3.3 Selection

Applicants will be chosen from among those fulfilling the formal requirements according to their ability to successfully complete postgraduate studies. Applicants who have completed courses or have other qualifications that are expected to be accepted as part of their studies will not automatically have priority over other applicants.

Selection is based on the following:

- Results obtained at basic and advanced level, or equivalent.
- The breadth, depth and relevance of courses taken at basic or advanced level, or equivalent.
- The quality of degree projects and other independent work.
- Applicants who appear to be particularly well suited shall, when possible, be interviewed.
- Other knowledge or skills that are relevant for the subject of research in question.

Gender equality and cultural diversity will be given due consideration in the recruiting and admission of postgraduate students, according to the University's policies on sexual equality, equal opportunities and diversity. The under-represented gender will be given priority in cases of equally good merits, unless there are special reasons why this should not be done.

There must also be good agreement between the student's area of interest and the research carried out at the department in order to ensure adequate supervision.

### 3.4 Admission

Postgraduate students are admitted to four years of full-time studies leading to a doctorate. A licentiate degree may be obtained after two years. Students may be admitted to two years' full-time studies leading to a licentiate degree under special circumstances.

More information on admission can be found on the Faculty's website: [www.science.lu.se](http://www.science.lu.se).

The following admission routines are used. The decision is prepared by a group appointed by the head of the department consisting of the leader of the involved division, involved advisors and a postgraduate students representative. This group is appointed when the position is announced. The division leader presents in consultation with the department head a proposal for decision at least two weeks before the decision is taken. This proposal is made known to the applicants, and the division leader and department head must consider possible complaints regarding the proposal from the applicants. The decision on admission is taken by the department head.

### 3.5 Supervision

At least two supervisors are to be appointed to each postgraduate student, one of which is the official supervisor. At least one of these supervisors must be a senior lecturer (*docent*) and hold a permanent position at Lund University. The tasks and responsibilities of each supervisor are to be specified in the student's individual curriculum. The supervisor with the greatest responsibility for the completion of the student's work should be the official supervisor. The student has the right to

supervision for the period considered necessary to complete his or her studies, amounting to 240 credits. A student may change supervisor upon request.

## **4 Organisation of postgraduate studies**

### **4.1 General**

When the student is admitted an individual curriculum is drawn up. This is to be revised annually. The individual curriculum describes the organisation of the student's postgraduate work, the extent of which is four years (240 credits). The student also has the right, but not the obligation, to take a licentiate degree (120 credits) after two years of postgraduate studies.

If a student is admitted specifically to take a licentiate degree, then this degree is to be taken.

The individual curriculum is set after consultation between the postgraduate student and supervisor and contains a schedule for the student's education at the postgraduate level. The Faculty Board is of the opinion that departments should follow the template for individual curricula drawn up by the Board for Postgraduate Studies: [www.pixe.lth.se/mnf/indstpl.asp](http://www.pixe.lth.se/mnf/indstpl.asp). Additionally, each semester there will be a discussion among official supervisor, the student and the director of graduate studies (or another person, appointed by the department head, who is not a supervisor for the student) about the progress of the studies, and an update of the individual curriculum.

The grades awarded for examinations at postgraduate level, and the thesis or dissertation, are "Pass" or "Fail".

### **4.2 Thesis/Dissertation**

The research carried out by the student is to be documented in a doctoral thesis or a licentiate dissertation.

#### **Doctoral thesis**

A doctoral thesis is to be equivalent to 150 credits.

Doctoral theses may consist of a collection of scientific papers written by the student together with a summary, or a monography. The scientific papers included may be written by the student alone, or together with co-authors. The contributions of each author should be made clear. The papers are to be of a quality suitable for publication in internationally recognized peer-reviewed scientific journals.

#### **Licentiate dissertation**

A licentiate dissertation is to be equivalent to 75 credits.

The Faculty Board has stated that a licentiate dissertation may consist of a summary and at least one scientific paper (article) that the student has written alone or together with other authors, or as a monograph. The quality of the paper shall be such that it is suitable for publication in an internationally recognized peer-reviewed scientific journal.

### **4.3 Courses**

In the subject of *theoretical physics*, courses amounting to 90 credits are to be taken for a doctoral degree and 45 credits for a licentiate degree.

These courses may be taken within the department, at other departments, other faculties or other universities. The courses should have a written syllabus describing the goals and content of the course and the number of credits. Regarding courses taken at other faculties or universities, the number of credits awarded is to be decided by the student's head of research field. The courses the student is to take are to be specified in his or her individual curriculum.

An introduction course of at least 1½ credits is compulsory, and postgraduate students involved in teaching must take a basic course in pedagogics of 3 credits.

The courses consist of basic courses, specialized courses, overview courses and general courses. A semester counts as 30 credits. A large part of the basic courses should be finished before the remaining courses and the thesis work are started. Most of the courses are self-study courses with supervision. The exam can be oral or written. In some cases examination can, after discussion with the supervisor, happen through a seminar presentation.

The course contents are detailed in a course plan with a literature list which can be obtained at the department. Courses may have overlap with courses at the master level.

### 4.3.1 Theoretical physics

The number of credits given is for the doctorate degree.

#### Basic courses (30 credits total)

These courses form the foundation for the further education at postgraduate level independent of the special subject area the student chooses afterwards. Only if strong reasons are present can a basic course be exchanged for another course if agreed to by the supervisor. Basic courses are:

- Classical mechanics (7.5 credits)
- Fundamental electrodynamics (7.5 credits)
- Statistical physics (7.5 credits)
- Advanced quantum mechanics (7.5 credits)

*or*

Theoretical biophysics (7.5 credits)  
chosen in discussion with the supervisor.

If knowledge of quantum mechanics at the master level is not present, such a course must be added in addition to the basic courses. If the mathematical background is less than the equivalent of 60 credits the course on mathematical methods in physics (7.5 credits) must be added.

#### Special courses (at least 30 credits)

These courses are connected to the thesis work and to the literature studies in connection with it. It is therefore very important to choose these in close discussion with the supervisor.

Examples of special courses are:

- Advanced electrodynamics (7.5 credits)
- Group theory (7.5 credits)
- Relativistic quantum mechanics and quantum field theory (7.5 credits)
- Advanced quantum field theory (7.5 credits)
- Advanced particle physics (7.5 credits)
- Mathematical methods of physics (7.5 credits)

As special courses count as well active participation in summer schools and conferences (1.5 credits per week). Examination is done through an oral presentation (seminar) of a part of the content of the summer school or conference.

### **Overview courses in modern physics (at least 15 credits)**

These courses are part of the basis for modern physics. Only if strong reasons are present can overview courses be exchanged for another course. Examples of overview courses are:

- General relativity
- Solid state physics
- Elementary particle physics
- Theoretical biophysics

### **General courses (at most 7.5 credits)**

This concerns courses not related to the research subject but of value for the postgraduate student, such as

- Introduction to PhD studies (1.5 credits) (obligatory)
- Introductory pedagogical course (3 credits) (obligatory for postgraduate students with teaching duties)
- Philosophy of science
- Publishing methodology
- Research dissemination

## **4.3.2 Theoretical physics – computational biology**

The number of credits given is for the doctorate degree.

### **Basic courses (30 credits total)**

These courses form the foundation for the further education at postgraduate level independent of the special subject area the student chooses afterwards. Only if strong reasons are present can a basic course be exchanged for another course if agreed to by the supervisor. Basic courses are:

- Statistical Physics (7.5 credits)
- Computational physics (7.5 credits)
- Programming in bioinformatics (7.5 credits)
- Introductory molecular biology (7.5 credits)

### **Special courses (at least 30 credits)**

These courses are connected to the thesis work and to the literature studies in connection with it. It is therefore very important to choose these in close discussion with the supervisor.

Examples of special courses are:

- Systems theory (7.5 credits)
- Biophysical chemistry (7.5 credits)
- Mathematical methods of physics (7.5 credits)
- Expression analysis (7.5 credits)
- Systems biology (7.5 credits)
- Artificial neuronal networks (7.5 credits)

As special courses count as well active participation in summer schools and conferences (1.5 credits per week). Examination is done through an oral presentation (seminar) of a part of the content of the summer school or conference.

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- Philosophy of science
- Publishing methodology
- Research dissemination

### 4. Studies till licentiate degree

For both *theoretical physics* and *theoretical physics – computational biology* the above mentioned for the doctorate degree is valid in the applicable parts.

The licentiate degree requires courses for 45 credits. Those should be chosen mainly among the basic courses (at least 22.5 credits) and special courses.

As special courses count as well active participation in summer schools and conferences (1.5 credits per week). Examination is done through an oral presentation (seminar) of a part of the content of the summer school or conference.

### 5 Examination

The head of research field and the official supervisor are responsible for ensuring that all the formal demands for a doctoral or licentiate degree have been satisfied.

#### **Doctoral degree**

A doctoral degree comprises 240 credits. In order to obtain a doctoral degree (PhD) the student must have passed the examinations required at this level, and his or her thesis must be approved. The thesis is to be defended verbally at a public defence (*disputation*). The grade is decided by the examination board. The thesis is to be equivalent to at least 150 credits.

#### **Licentiate degree**

A licentiate degree comprises 120 credits. In order to obtain a licentiate degree the student must have passed the examinations required at this level, and his or her dissertation must be approved. The dissertation is to be equivalent to at least 75 credits, and is presented at a public seminar. The grade is decided by the examiner after consultation with an assessment board.

### 6 General interim regulations

Students who commenced studies for a postgraduate degree prior to July 1, 2007, according to the previous regulations, have the right to continue their programme and obtain their degree according to these regulations, up until June 30, 2015.