

Applied Physics

/Tillämpad fysik/

SCB-codes: 10399, 10499, 20999, 21001

The governing rules common for all PhD Studies at Linköping University's Institute of Technology can be found in the faculty's *Study Handbook for PhD Studies*. Some overall rules can also be found in Linköping University's local rules and regulations as well as in the Higher Education Act and the Higher Education Ordinance.

General description of the research area

The research area covered by the research subject Applied Physics is the applications of physics in biology, chemistry, medicine, life sciences, electronics, nanoscience, materials science and other fields.

Research in Applied Physics aims to use methods, models and approaches based in Physics on various disciplines, such as molecular physics, surface physics, biotechnology, lab-on-a-chip, organic electronics, material optics, bio-, optical and chemical sensors, self-organizing materials, polymeric and soft materials. Many projects in the area have a connection to the life sciences. The subject offers a large number of graduate courses to the PhD students.

In this research subject the PhD students are given many possibilities to collaborate worldwide and currently a large number of collaborative projects are carried out with a variety of research groups around the world, and with national and international industry.

The PhD studies are often conducted in collaboration with other divisions at the departments IFM, IKE, IMH, IMT and ITN, and the university in general. The intention is to offer PhD students with different backgrounds the opportunity to graduate in a multidisciplinary environment. Graduate students who are admitted to the research subject may also be members of a research school. Within these, there are special requirements, but these are all fulfilled within this general study plan.

Eligibility requirements and selection

The basic eligibility requirements as well as the general principles for selection are specified in the faculty's *Study Handbook for PhD Studies*. Details regarding how the selection is made are specified in the respective post announcements.

Specific eligibility requirements

Admission to PhD Studies in the research subject of Applied Physics requires completion of courses of at least 60 ECTS at the master level in a relevant research area. These 60 ECTS should include an independent project (degree project) for at least 30 ECTS in a field relevant to the subject of PhD Studies.

Degree

PhD studies in Applied Physics leads to a Degree of Doctor or a Degree of Licentiate. The latter degree can also serve as a stage in the PhD studies. The Degree of Licentiate comprises at least 120 ECTS, of which courses correspond to at least 30 ECTS and a licentiate thesis of at least 90 ECTS. The

Degree of Doctor comprises 240 ECTS, of which courses correspond to 60 ECTS and the doctoral thesis corresponds to 180 ECTS.

Goals and implementation of the PhD studies

The general goals and objectives of the PhD studies are specified in the introduction to the faculty's *Study Handbook for PhD Studies*, as well as in the Higher Education Ordinance (reprinted in the *Study Handbook's* appendix A).

Regarding this specific research area, after completing the PhD study the student should have:

- Good research area knowledge within the fields of biology, physics, chemistry, electronics, material science and biotechnology that are relevant for the chosen research specialisation
- Good skills in planning experiments and using modern research equipment and/or computer-based calculation methods that are relevant for the chosen research specialisation

The PhD studies in Applied Physics will equip the PhD student with the knowledge and skills to fulfill all the degree objectives. The studies consist of research and thesis work, courses, participation in seminars, attendance at national and international conferences, and oftentimes networking with industry.

The PhD student should acquire a good ability to critically and independently plan, lead, carry out and communicate research and development projects. After completion of the PhD studies, the student should be well prepared to make contributions in research and development in industry as well as in the academic world.

Exactly how the different degree outcomes are treated and tested is indicated more specifically in each PhD student's individual study plan. General examples are given below regarding how the degree outcomes could be treated and tested.

The PhD studies will endow the PhD student with a broad knowledge and understanding of his/her area of research through, for example, work with various research projects, study of basic and wide-ranging courses, participation in some of the multidisciplinary graduate schools' work, etc.

The PhD student will acquire a deep knowledge and understanding of his/her research subject, in particular within his/her research specialisation, through, among other things, work with research projects, participation in the research group's seminars, presentations and discussions, and by actively participating in in-depth courses relevant to the field of research.

The PhD student will develop familiarity with scientific methodology through his/her own research in the research group and in collaboration with other research groups inside and outside of Sweden, as well as by attending a mandatory course in research methodology.

The PhD studies are structured in a way so that two years of full-time studies are required for a Degree of Licentiate, and four years of full-time studies are required for a Degree of Doctor. 1,5 ECTS correspond to one week of full-time studies.

Below are some examples of how PhD students in the research area of Applied Physics acquire skills and competencies:

- By independently planning and carrying out experimental research
- By participating in the research group's seminars, presentations and discussions. This includes regularly reporting the attained results, presenting plans for continued work and holding critical discussions of the research work.
- By participating in relevant national and international conferences and presenting at such fora research results, orally and/or as *poster* by participating in discussions about the research.
- By describing and formulating research results in research reports and scientific articles, initially under the guidance of more experienced researchers and eventually by independent initiative
- By critically analysing and reviewing reports and articles produced by others
- By participating in some of the multidisciplinary graduate schools' work
- By participating in so-called non-core subject courses such as presentation techniques, leadership, management, patent and intellectual property law, methodology/ethics and pedagogy

The PhD student in Applied Physics will develop judgment and approach through, for example:

- Attending a mandatory course in research ethics
- Participating in seminars and conferences within his/her area of research together with his/her research group and with collaboration partners
- Practicing the ability to critically and constructively review others' results, reports and articles, and at the same time learning how to receive others' critical and constructive critique

PhD students in Applied Physics will demonstrate their intellectual autonomy by, among other things, writing a thesis. This is often written in the form of a compilation thesis. It is also possible to write a monograph thesis.

Thesis

The overall rules regarding the format, submission and grading of a thesis can be found in the faculty's *Study Handbook for PhD Studies*.

a) Doctoral thesis

The extent of the scientific research should correspond to at least three years of full-time research work. The research results are submitted in a doctoral thesis, which can be presented either as a continuous piece of work or as a compilation of scientific essays.

The thesis should be of such level of quality that it, in its entirety, can be judged to meet reasonable requirements to be accepted for publication in scientific journals of good quality.

In a compilation thesis, the greater part of the included works should be accepted for publication or published.

b) Licentiate thesis

The extent of the thesis work should correspond to at least 1,5 years of full-time work. The thesis can consist of one or several scientific essays and/or an investigative report conducted on scientific grounds.

Both types of theses can be done as part of teamwork, but the student's contribution should consist of independent work and be specifically accounted for in the thesis' introduction.

Individual study plan

An individual study plan will be formulated for each PhD student. The detailed planning of courses and other components will be conducted in consultation with the supervisor and documented in the individual study plan (see *Study Handbook for PhD Studies*, section 5.3). The study plan should be established within one month after admission to PhD studies, and it should be revised at least once a year.

Supervision

General rules governing supervision of PhD studies can be found in Chapter 4 of the *Study Handbook for PhD Studies* and in the *Policy for the supervision of PhD Studies*.

At the beginning of the PhD studies, a main supervisor will be appointed for each PhD student. Moreover, one or more co-supervisors will be appointed. The supervisors' roll is to guide the student during the period of study regarding, among other things, course selection and selection of research projects. The student and the supervisors should meet regularly to discuss and consult on the progress of the research work.

Courses

Faculty course requirements

Scientific theory, methodology and ethics

All PhD students admitted as of 1 January 2010 should complete mandatory courses as decided by the faculty in methodology and ethics, or be deemed to have equivalent competencies, in order to receive a degree.

Pedagogic studies

All PhD students who teach should complete a basic course in pedagogy. At least 3 ECTS from this course should be included in the PhD studies, and any remaining credits should be counted as departmental duties (see *Study Handbook for PhD Studies*, section 5.5).

Courses within the core of the research area

Because of the interdisciplinary nature of the research area, PhD courses should be tailored to the students' background and specialisation. It is important that the PhD student acquire solid knowledge within his/her core research area. This is ensured by the requirement that courses within the core research area should make up at least 38 ECTS for a Degree of Doctor, and 15 ECTS for a Degree of Licentiate. What is deemed to be the core research area is determined individually in each PhD student's individual study plan. It is also possible for the PhD student to take courses that broaden his/her studies in the subject.

Courses within non-core field

Besides courses within the specialised research area, the PhD student can also select courses in non-core field (e.g. presentation techniques, leadership, intellectual property law, project management, etc.).

Accreditation

Master courses that are equivalent to at most half of the course requirements for the degree, that do not form part of the basic or specific eligibility requirements for the specialisation, and that are relevant to the PhD studies may be counted toward the degree. The PhD student should submit an application for accreditation using an intended form; the application is to be approved or rejected by the main supervisor, and a positive decision on accreditation can be made by the Director of PhD Studies at the Department. A decision to reject an application for accreditation may not be made by the Director of PhD Studies at the Department, rather, such a decision can only be made by the faculty's Board of PhD Studies.

Other courses and activities

Courses taken at other departments or universities, such as summer schools, may be included, just as self-study within special fields. Likewise, special activities such as symposia, seminars, contract research, etc. may be reported and included as components of the PhD studies. For a course to be approved, the student must have passed the examination, which can be done in writing or orally. In certain cases, another way of examining the student's knowledge can be devised in agreement with the supervisor.

Transitional provisions

Changes to the general study syllabus do not apply to those who have already been admitted to the PhD studies in the research area. A change to the new general study syllabus may however be approved if both the main supervisor and the PhD student agree. In such a case, this should be documented in the individual study plan.