Translation of Curriculum Statement for Graduate Level (Third-level) Education

Engineering Sciences with specialization in Materials Analysis

Swedish title: Teknisk fysik med inriktning mot materialanalys

TNTEKF07

Swedish Curriculum adopted by the Board of the Faculty of Science and Technology (Board for Third-level Education) on 2008-07-02. Translation approved on 2010-09-03.

The Curriculum Statement for Third-level Education consists of three parts: a general part, this subject specialized curriculum statement, and each doctoral student's individual study plan.

Objective
Supervision and thesis work will make the student well prepared to carry out independent scientific research. After the education, the student will be familiar with scientific questions and methods in materials analysis, and will have reached thorough knowledge within the specific area of the thesis. The student will be able to critically assess his/her own scientific work and that of others.

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
The field of materials analysis includes the study of materials properties such as their structure, chemical composition, and electronic structure. Important in materials analysis are nanoaspects, where the studied materials and their physical properties are characterised down to atomic scale in electron and atomic force microscopes. The subject is focussed on the understanding of atomic and nano-scale origin of physical and chemical properties of materials. Research is of both, experimental and theoretical nature; both applied and fundamental aspects are accommodated in this research subject.
All materials types are studied, both hard and soft matter. The study of materials analysis includes the understanding of the basis of experimental analytical work which contains the study of methodology as well as of experimental techniques. The work in materials analysis includes materials characterisation, the development of analysis techniques, theoretical understanding and modelling of particle-material interaction, the understanding of particle optics, -emission and -detection, but also the understanding of the physics and chemistry of the underlying material related problem. The material could be elaborated by the research program, a collaborating group or a materials science related company. International collaborations are well presented in this research subject. In materials science, several advanced techniques are used, in particular transmission and scanning electron microscopy as well as the related techniques of high resolution electron microscopy (HREM), electron diffraction (SAD, CBED), quantitative imaging techniques, energy dispersive X-ray spectroscopy (EDS), electron holography, cathode luminescence (CL), electron beam lithography (EBL). The technique of focussed ion beam is used for local sputtering as well as for ion beam induced deposition (IBID). The understanding development of novel techniques includes the simulation of diffraction patterns, images or beam based structuring processes. Other techniques applied include electron spectroscopy for chemical analysis (ESCA), atomic force microscopy (AFM) and electrical measurements including nano- and micromanipulators. An important part of this education consists in obtaining confidence with several of these techniques and develop expert knowledge about their possibilities and limits. All instruments used in this research subjects will equally be used for materials structuring and manipulation on the nanometer to micrometer scale. A central field in the analysis of modern solid state materials is the manipulation of such materials through modification of their mechanic, thermal, electrical and magnetic properties. This can be done macroscopically but also by applying focused electron and ion beams. The research students shall characterise such samples by application of one or several of the techniques named above, in particular electron microscopy. The acquired knowledge can be equally applied to build new instruments.

Eligibility

Basic Eligibility
The basic eligibility for third level education is described in the general part of the curriculum statement.
Special Eligibility

Special eligibility is assigned to a candidate who has taken courses within all relevant areas in the subject with sufficient breadth and depth. Thus, special eligibility is considered a candidate with one of the following:

a) has obtained a Masters degree in engineering (Swedish “Civilingenjör”) from a Swedish technical University/College and hence taken courses within the relevant areas of the subject

b) in a different way has gained knowledge principally to the same extent as in a), irrespectively of the country of study

Admission

Applicants for third level program in Engineering science with specialization in materials analysis must submit an application to the head of the Department of Engineering Science. Admissions to places in third level programs take place normally six times per year.

In connection with the admission it must be stated how it is planned to finance both the personal maintenance of the doctoral student, and her/his research.

Program structure

In connection with the admission, each doctoral student and her/his supervisor shall draw up an individual study plan after consultation with the professor in charge of the third level program. The plan is to be approved by the head of the department (by delegation of the Faculty Board), in connection with the admission.

The individual study plan shall be reviewed jointly by the doctoral student and her/his supervisor, annually, and be provided with a summary of the achieved results and the plans for the coming year. Significant changes and any disagreement on the individual study plan shall be reported to the head of the department or, if deemed necessary, to the Board for Third-level Education.

Courses

Within the third level program there may be different kinds of courses, such as lectures, literature studies, practical training, field studies, etc. The courses are intended to provide wider insights into the subject as a complement to the specialist competence acquired in the research work. The courses included in the individual study plan may be
chosen from relevant courses given by Uppsala University, other Swedish universities and universities abroad.

Courses that are required for special eligibility may not be counted in as a part of the individual study plan.

**Requirements for doctoral degree**

The requirements for doctoral degree consist of on one hand passed examinations in the courses included in the approved individual study plan of each doctoral student, and on other hand 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 60 higher education credits.

**Requirements for licentiate degree**

A stage of at least 120 higher education credits (two years of full-time studies) in the third level program may be completed with a licentiate degree. The requirements for this are that the doctoral student both has passed the examinations included in the program stage and has got an academic paper amounting to a minimum of 60 higher education credits passed. The course part amounts to a minimum of 30 higher education credits.

**Other**

The PhD work in materials analysis can in many cases also be connected to a research problem coming from a company, an institute or similar organisation.

Further information can be obtained from the Department of Engineering Sciences, [http://www.teknik.uu.se/](http://www.teknik.uu.se/).