



General syllabus for third-cycle subject

Subject	Adopted	Registration number	Ks-kod
Materials science engineering	25 Jan 2011	V-2018-0674	3.2.3
	<i>Revised 13 June 2018</i>		

General syllabus

Adopted by the faculty council/education committee: 25 Jan 2011

Revised: 13 Jun 2018

Subject title in Swedish (and English translation)

State also whether the subject has specialisations.

Teknisk materialvetenskap (Eng. Materials Science and Engineering)

The programme has no specialisations.

Subject description – Main content of the programme

Education is in a wide field spanning from structural materials to functional materials. The various materials studied largely reflect the materials required by Swedish industry, steel and cemented carbide being the prime examples. However, the programme also covers aluminium alloys, ceramics, magnetic materials, materials for data storage and nanomaterials. The content focuses on material properties, microstructures, production processes and the connection between these, i.e. between material properties and microstructures as well as between production processes and microstructures (and even atomic structures).

Programme objectives based on Sweden's Higher Education Ordinance, Annex 2 – Qualifications Ordinance

Each doctoral student's individual study plan shall be designed to guarantee the possibility of attaining the qualitative targets in the Higher Education Ordinance and KTH's objectives. Attainment shall be evaluated for each individual doctoral student. This shall be done annually by monitoring the individual study plan. The latter shall comment on how, vis-à-vis the goals (i.e. targets and objectives), the programme's courses and thesis work achieve progression. Other activities (e.g. supervision and outward-oriented operations in line with education and public outreach) shall also be factored into this.

State the programme elements for promoting goal attainment. Other details are to be given in an appendix to the subject's study plan.

Knowledge and understanding

For a Degree of Doctor, the doctoral student shall demonstrate:

- Wide expertise in, and a systematic understanding of, the research domain; and, deep and current specialist knowledge in a delimited part of the research domain.*
- Familiarity with scientific methodology in general and the specific research domain's methods in particular.*

To attain this goal, doctoral students take part in recommended and optional courses. The recommended courses have the function of further ensuring each doctoral student's wide expertise, insights and abilities. For the doctoral students who undertake departmental duties and teach, basic qualification in teaching and learning in higher education is compulsory. The optional courses are specialised, subject-specific courses that, within his/her research specialisation, each doctoral student takes to ensure his/her: specialist knowledge; specialised methodological know-how; specialised analytical ability; ability to identify and plan research projects; and, ability to identify the need for further knowledge. These courses are selected in consultation with a supervisor. All doctoral students

take part in internal seminars where each doctoral student presents his/her research and has the opportunity to demonstrate his/her ability to present and discuss research. All doctoral students are also expected to present and discuss research at international conferences.

Demonstrate familiarity with scientific methodology in general and the specific research domain's methods in particular. It is considered that this goal is attained by active participation in research, third-cycle courses, scientific discussions and seminars.

Skills and abilities (communication ability included therein)

For a Degree of Doctor, the doctoral student shall:

- Demonstrate an aptitude for scientific analysis and synthesis, as well as for independent critical examination and assessment of new and complex phenomena, issues and situations.*
- Demonstrate an ability to critically, independently, creatively and with scientific precision identify and formulate issues as well as plan and use appropriate methods to conduct research and other advanced assignments within given time frames and examine and evaluate this work.*
- Via a thesis, demonstrate an ability to significantly contribute, through own research, to knowledge development.*
- Demonstrate an ability, in both national and international contexts, to authoritatively present and discuss, orally and in writing, research and research results in dialogues with the scientific community and society in general.*
- Demonstrate an ability to identify further knowledge needs.*
- Demonstrate the potential (within research, education and other advanced, professional contexts) to contribute to societal development and others' learning.*

This goal is attained through: analysis and critical review of earlier work in the area (based on this, suitable methods are selected to solve various research issues); proposals for new research issues; scientific explanation and relevant conclusions in scientific papers; teaching in first and second-cycle education; supervision of degree projects; transferring knowledge to industrial partners and the general public; and, presentation and popular-science articles.

Judgement and approach

For a Degree of Doctor, the doctoral student shall:

- Demonstrate intellectual independence and scientific probity as well as an ability to assess research ethicality.*
- Demonstrate specialised insight into the possibilities and limitations of the discipline, its societal role and the responsibility people bear for how it is used.*

This goal is attained through discussions (with supervisors) of ethical aspects when structuring research projects and before publishing any work. The societal impact of research results is discussed in the academic environment, both locally (the department) and in a wider context. Intellectual independence is made evident through the research student's own initiatives being clearly explained in the thesis. Scientific probity is checked via, for example, the plagiarism check to which the thesis is subjected.

Sustainable development

For a Degree of Doctor, the doctoral student shall:

- Demonstrate knowledge of, and an ability to make, relevant environmental and ethical decisions in order to be able to contribute to sustainable societal development.*

Doctoral students shall be aware of how knowledge in materials science and engineering can be used to contribute to the development of an ecologically, technically, socially and economically sustainable society. As an element in the third-cycle programme, each doctoral student shall acquire knowledge and insights of and into sustainability issues, in particular: questions regarding the definition and

implications of sustainability; and, the links to various relevant factors when planning, financing and managing various materials-based processes and industries.

Specific entry requirements

Subject knowledge requirements and any language requirements are to be entered here.

KTH's general entry requirements for admission third-cycle education apply. Amongst other things, this means that doctoral students are expected to be able to study and write scientific English and to speak English fluently.

In accordance with § 40 of chap. 7 of the Higher Education Ordinance, the imposed specific entry requirements shall be absolutely essential for the student to be able to benefit from the programme. The requirements may relate to:

1. Knowledge from higher education study courses and programmes (or equivalent).
2. Special professional experience.
3. Necessary language ability or anything else made necessary by the programme.

Selection rules

Admission of students to third-cycle education is decided by the head of the school. The selection basis is the degree of ability to benefit from third-cycle education. In the first instance, selection is based on documented material cited by the applicant. Other decision inputs such as applicant interviews and contacts with previous higher education institutions may also be important. Suitability for third-cycle education is determined by considering: grades; earlier activities; interests; and, capacity for independent work and critical analysis.

Content and examination of the course component

Third-cycle education comprises a course component and a thesis requirement:

- A Degree of Licentiate requires 120 higher education credits (HECs), the dissertation component providing at least 60 of these and the course component at least 30.
- A Degree of Doctor requires 240 HECs, the thesis providing at least 120 of these and the course component providing at least 60.

The doctoral programme has no compulsory courses. It does have many subject-specific (optional) courses and a number of strongly recommended courses of a more general character (e.g. theory of science and scientific writing).

Optional courses

There is great flexibility in the selection of courses that are to make up the programme. The principal supervisor and doctoral student are to jointly agree on which courses are most relevant for the doctoral student's education. The courses are to be recorded in the study plan. This is to be updated if any decision by a supervisor and the doctoral student results in changes. Most of the programme's courses are given regularly, e.g. every other year. The course are not listed here, but can be found through KTH's system.

Courses in research skills, teaching and communication

The following courses (or equivalents), which provide academic skills or a deeper understanding of

research, are strongly recommended:

- DS3102 "Writing scientific papers," 5 HECs.
- AK3014 "Theory of science and research methodology," 3 HECs.
- AK3015 "The persevering researcher", 2 HECs.
- LH200V "Basic communication and teaching" (GKU), 3 HECs*.
- MH3906 "Basic supervising", 3 HECs.
- 4H5900 "Supervising and planning", 6 HECs.
- MH3306 "The School of Industrial Engineering and Management's doctoral conference", 2 HECs.
- ME2075 "Leadership and power in industrial organisations: gender perspective and aspects of diversity", 6 HECs.

* Compulsory for doctoral students who undertake teaching.

Relevant online courses (massive open online courses – MOOCs)

Provided the doctoral programme's director (DA) has given approval, credits from relevant online courses by national or international higher education institutions can be transferred.

Crediting of course merits from first and second-cycle education

KTH's regulations on the transfer of higher education credits from first and second-cycle education are adhered to.

Courses from first and second-cycle education can only be counted if they dealt with subject areas that are relevant to the third-cycle programme and only if they are not part of the entry requirements.

Third-cycle courses given by other higher education institutions, national graduate schools or international networks can be counted. All courses should be discussed with the supervisors and approved by the principal supervisor.

When transferring higher education credits, the regulations in KTH's Qualifications Ordinance for third-cycle education are adhered to.

Course examination

Courses that are part of third-cycle education are examined via written examination, oral examinations or project work. Examinations are structured so that the examiner can assure himself/herself that the doctoral student has acquired the course content.

Higher education requirements

Degree of Doctor

The award of a Degree of Doctor requires 240 HECs. The thesis shall provide at least 120 HECs in this.

Thesis

Quality and any other thesis requirements.

Thesis work is a compulsory part of third-cycle education. Said work is aimed at the doctoral student developing an ability to make independent contributions to research and the scientific community. The doctoral thesis and the licentiate dissertation can be written either as a monograph or as a compilation of scientific papers. In this latter case, the thesis shall have a separately edited, introductory summary. Irrespective of form, the thesis is assessed as an entirety.

A doctoral thesis can build on a licentiate dissertation.

A thesis for a Degree of Doctor shall include new theoretical or empirical research results that, in the chosen subject area, the doctoral student has developed via theoretical or empirical research projects. It shall also include an overview of earlier research in the chosen subject area and shall position the doctoral student's contribution in relation to earlier research. Regardless of whether the doctoral thesis is presented as a monograph or as a compilation of scientific papers, it shall be of such quality that it is assessed to equate to at least four papers published in internationally recognised, peer-reviewed scientific journals.

A monograph thesis shall normally be 80,000 – 100,000 words, i.e. between 220 and 260 pages. Besides a summarising, introductory chapter of normally around 50 pages, a compilation thesis shall include at least four publishable scientific papers (the international standard in this area). At the time of the public defence of the thesis, at least two papers must have been published in internationally recognised, expert reviewed scientific journals.

Final seminar

Before finalisation of the doctoral thesis, each doctoral student shall present his/her results at a final seminar at least 6 months (to be assessed by the principal supervisor) before the planned public defence. This final seminar is part of the quality review of the subject study plan and aims to ensure that the doctoral thesis is of a high scientific quality.

Before this seminar, an independent, external or internal quality reviewer (who has not previously been involved in the doctoral student's work and who has at least docent qualifications) is to be appointed. The reviewer shall review papers, conference submissions, manuscripts, draft theses (if available) and any other relevant material that is to be included in the thesis. A final thesis is not required at this point. The quality reviewer will write an opinion with comments and recommendations. He/she may also suggest changes in the material.

All supervisors and doctoral students in the programme are to be invited to the final seminar. The reviewer is expected to attend or to participate via Skype (or equivalent). The doctoral student's supervisors and the director of the doctoral programme shall attend the final seminar. The director of the doctoral programme is to appoint someone from the supervisor assembly to chair the seminar. This may not be one of the doctoral student's supervisors. After thesis presentation and questioning, the group of supervisors (at least three in addition to supervisor and assistant supervisor) comes together. The content and quality of the thesis is discussed at this meeting.

When all recommendations from the seminar have been taken into account, the reviewer has to approve the further presentation of the dissertation, i.e. that the public defence of doctoral thesis can take place.

Courses

A Degree of Doctor in the subject requires 60 HECs from courses.

Degree of Licentiate

The award of a Degree of Licentiate requires at least 120 HECs. An academic paper shall provide at least 60 HECs in this.

Academic paper

Quality and any other academic paper requirements.

A licentiate dissertation should either contain new scientific discoveries or an application of an existing scientific discovery in a new area. It should also contain an overview of previously completed research in the selected area and demonstrate the doctoral student's contribution in relation to said previous research.

Regardless of whether the licentiate dissertation is written as a monograph or a compilation of scientific papers, the work input should be at least half that of a doctoral thesis with 2 – 3 papers publishable in internationally recognised, peer-reviewed scientific journals.

After approval by the principal supervisor, the licentiate dissertation is to be presented at a public licentiate seminar with an external reviewer in accordance with KTH's rules.

Courses

A Degree of Licentiate in the subject requires 30 HECs from courses.

Appendix

Qualitative targets (KTH's objectives included therein), as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance) for concretising the subject and how the programme is structured to support the attainment of goals (targets and objectives) by doctoral students.

Degree of Doctor

<p>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</p> <p><i>For a Degree of Doctor, the doctoral student shall:</i></p>	<p>Concretisation and adaptation of targets to the third-cycle subject area</p>	<p>Programme elements for promoting goal attainment</p>
<p><i>Demonstrate: wide expertise in, and a systematic understanding of, the research domain; and, deep and current specialist knowledge in a delimited part of the research domain.</i></p>	<p>It is considered that this goal is attained by taking part in third-cycle courses and reading and following relevant scientific literature. Goal attainment can be checked via: the writing of scientific papers (in the form of submissions for conferences and journals) and the doctoral thesis; and, the presentation and discussion (at conferences and seminars) of own and others' research results.</p>	<p>Participation in third-cycle courses, study of specialised courses. Writing conference and journal submissions.</p>
<p><i>Demonstrate familiarity with scientific methodology in general and the specific research domain's methods in particular.</i></p>	<p>It is considered that this goal is attained and checked via, for example: taking part in relevant third-cycle courses; and, in thesis work and scientific papers, identifying and using current (for the area) methods in solving proposed research issues.</p>	<p>Participation in relevant third-cycle courses dealing with research methodology and theory of science.</p>
<p><i>Demonstrate an aptitude for scientific analysis and synthesis, as well as for independent critical examination and assessment of new and complex phenomena, issues and situations.</i></p>	<p>It is considered that this goal is attained and checked via, for example, having: identified not previously observed phenomena and, as a result thereof, proposed new research issues; contributed a scientific explanation; and, drawn relevant conclusions in scientific papers and conference submissions that the doctoral student has written/co-written.</p>	<p>By writing journal submissions, participating in international conferences, presenting research results at seminars and in the department.</p>
<p><i>Demonstrate an ability to critically, independently, creatively and with scientific precision identify and formulate issues as well as plan and use appropriate</i></p>	<p>It is considered that this goal is attained and checked via, for example: critical examination of work in the domain (summarised in the scientific papers that the</p>	<p>By studying recommended and optional courses. Writing conference and journal submissions. Making literature surveys. Presenting research results</p>

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<p>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</p> <p><i>For a Degree of Doctor, the doctoral student shall:</i></p>	<p>Concretisation and adaptation of targets to the third-cycle subject area</p>	<p>Programme elements for promoting goal attainment</p>
<p><i>methods to conduct research and other advanced assignments within given time frames and examine and evaluate this work.</i></p>	<p>doctoral student has written and in the licentiate/doctoral thesis); and, based on the foregoing knowledge, appropriate choice of methodology for solving proposed research issues. The final assessment of goal attainment here is made by the examining committee at the public defence of the thesis.</p>	<p>at seminars. Writing a doctoral thesis.</p>
<p><i>Via a thesis, demonstrate an ability to significantly contribute, through own research, to knowledge development.</i></p>	<p>It is considered that this goal is attained and checked via a thesis approved by an examining committee.</p>	<p>Approved thesis (following public defence thereof).</p>
<p><i>Demonstrate an ability, in both national and international contexts, to authoritatively present and discuss, orally and in writing, research and research results in dialogues with the scientific community and society in general.</i></p>	<p>It is considered that this goal is attained through presentations at scientific national and international conferences and seminars.</p>	<p>By writing and presenting conference submissions nationally and internationally. Writing popular science papers in relevant national journals.</p>
<p><i>Demonstrate an ability to identify further knowledge needs.</i></p>	<p>It is considered that this goal is attained via the need for new knowledge having been identified and having led to proposals for new research. This is documented in scientific papers and should be discussed in the thesis.</p>	<p>In connection with development of the research project, writing scientific papers and the thesis.</p>
<p><i>Demonstrate the potential (within research, education and other advanced, professional contexts) to contribute to societal development and others' learning.</i></p>	<p>It is considered that this goal is attained via: teaching in first and second-cycle education or in company presentations; supervision of degree projects; or, transferring knowledge to any industrial partners.</p>	<p>Recommended courses in teaching and learning in higher education. Recommended participation in the department's first and second-cycle study courses and programmes. Supervising bachelor and master degree projects.</p>
<p><i>Demonstrate intellectual independence and scientific probity as well as an ability to assess research ethicality.</i></p>	<p>Intellectual independence is made evident through the research student's own initiatives being clearly explained in the thesis. Scientific probity is checked via, for example, the plagiarism check to</p>	<p>Discussion of the structuring of research projects. The research student's input is presented in the thesis. Discussions of ethical aspects. Plagiarism check.</p>

<p>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</p> <p><i>For a Degree of Doctor, the doctoral student shall:</i></p>	<p>Concretisation and adaptation of targets to the third-cycle subject area</p>	<p>Programme elements for promoting goal attainment</p>
	<p>which the thesis is subjected.</p>	
<p><i>Demonstrate specialised insight into the possibilities and limitations of the discipline, its societal role and the responsibility people bear for how it is used.</i></p>	<p>By taking part in and monitoring discussions and debates in the local scientific environment at the department and in a wider context.</p>	<p>By discussing, in research seminars, the discipline's possibilities and limitations and monitoring debates at national and international levels.</p>
<p><i>(KTH's objectives for ESD) Demonstrate knowledge of, and an ability to make, relevant environmental and ethical decisions in order to be able to contribute to sustainable societal development.</i></p>	<p>Doctoral students shall be aware of how knowledge in materials science and engineering can be used to contribute to the development of an ecologically, technically, socially and economically sustainable society. As an element in the third-cycle programme, each doctoral student shall acquire knowledge and insights of and into sustainability issues, in particular: questions regarding the definition and implications of sustainability; and, the links to various relevant factors when planning, financing and managing various materials-based processes and industries.</p>	<p>It is recommended that doctoral students study courses in sustainable development. Doctoral students are encouraged, to participate in external conferences and seminars where sustainable development issues are discussed.</p>

Degree of Licentiate

<p>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</p> <p><i>For a Degree of Licentiate, doctoral students shall:</i></p>	<p>Concretisation and adaptation of targets to the third-cycle subject area</p>	<p>Programme elements for promoting goal attainment</p>
<p><i>Demonstrate knowledge and understanding in the research domain (current specialist knowledge in a delimited part of this included therein) and specialised knowledge of scientific methodology in general and the specific research domain's methods in particular.</i></p>	<p>It is considered that this goal is attained via: taking part in third-cycle courses; monitoring relevant scientific literature; and, identifying and using current methods.</p>	<p>Participation in: third-cycle courses; and, relevant third-cycle courses dealing with research methodology. Writing scientific papers, conference submissions and the licentiate dissertation. Presenting and discussing own and others' research results at conferences and seminars.</p>
<p><i>Demonstrate an ability to critically, independently, creatively and with scientific precision identify and formulate issues as well as plan and use appropriate methods to conduct a limited research project and other advanced assignments within given time frames and, thereby, to contribute to knowledge development and to evaluate this work.</i></p>	<p>It is considered that this goal is attained and checked via: critical examination of earlier work in the area (as summarised in literature studies written by the doctoral student and in the licentiate dissertation); new research issues proposed; and, based on the foregoing knowledge, continuation recommendations.</p>	<p>By studying recommended and optional courses. Writing conference and journal submissions. Making literature studies. Presenting research results at seminars. Writing the licentiate dissertation.</p>
<p><i>Demonstrate an ability, in both national and international contexts, to present and discuss, orally and in writing, research and research results in dialogues with the scientific community and society in general.</i></p>	<p>It is considered that this goal is attained via, for example, presentations at scientific conferences and seminars. It is considered that it is checked via an academic paper that is discussed at a licentiate seminar and approved by an examiner.</p>	<p>By presenting: research results at scientific conferences and seminars; and, the licentiate dissertation at the licentiate seminar.</p>
<p><i>Demonstrate the skills necessary to independently participate in research and development work and to work independently in other advanced operations.</i></p>	<p>It is considered that this goal is attained via, for example: identifying the need for new knowledge and formulating proposals for new research; and, the transferring of knowledge to any industrial partners. This is documented in scientific papers and should be discussed in the licentiate dissertation.</p>	<p>By presenting: own research results at scientific conferences and industrial partners; and, the licentiate dissertation at the licentiate seminar.</p>
<p><i>Demonstrate an ability to assess</i></p>	<p>It is considered that this goal is</p>	<p>Discussion of the structuring of</p>

<p>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</p> <p><i>For a Degree of Licentiate, doctoral students shall:</i></p>	<p>Concretisation and adaptation of targets to the third-cycle subject area</p>	<p>Programme elements for promoting goal attainment</p>
<p><i>research ethicality in own research.</i></p>	<p>attained by discussing, with supervisors, ethicality aspects of research.</p>	<p>research projects, publications.</p>
<p><i>Demonstrate insight into the possibilities and limitations of the discipline, its societal role and the responsibility people bear for how it is used.</i></p>	<p>By taking part in and monitoring discussions and debates in the local scientific environment at the department and in a wider context.</p>	<p>Discussions and debates in the academic environment. Recommended courses on the theory of science and research methodology (or equivalent).</p>
<p><i>Demonstrate an ability to identify his or her need for further knowledge and take responsibility for his or her own knowledge development.</i></p>	<p>It is considered that this goal is attained by formulating proposals for new research or taking part in third-cycle courses or workshops. This is documented in scientific papers and should be discussed in the licentiate dissertation.</p>	<p>Through presentations of his/her research results at conferences and seminars, the need for new knowledge can be identified and lead to proposals for new research.</p>
<p><i>(KTH's objectives for ESD) Demonstrate knowledge of, and an ability to make, relevant environmental and ethical decisions in order to be able to contribute to sustainable societal development.</i></p>	<p>Doctoral students shall be aware of how knowledge in materials science and engineering can be used to contribute to the development of an ecologically, technically, socially and economically sustainable society. As an element in the third-cycle programme, each doctoral student shall acquire knowledge and insights of and into sustainability issues, in particular: questions regarding the definition and implications of sustainability; and, the links to various relevant factors when planning, financing and managing various materials-based processes and industries.</p>	<p>It is recommended that doctoral students study courses in sustainable development. Doctoral students are encouraged, to participate in external conferences and seminars where sustainable development issues are discussed.</p>