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The Faculty of Health, Science and Technology

Programme Syllabus for Doctoral Studies in Materials Engineering

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Curriculum approval

The curriculum was approved by the Faculty Board of Health, Science and Technology on 1 July 2015. Revised by the Faculty Board of Health, Science and Technology on 28 October 2021 and applies from the decision date.

General stipulations for PhD programmes are provided in the Higher Education Act and in the Higher Education Ordinance. The PhD programme is offered to the extent permitted by available resources.

1. General Information

Materials Engineering is a knowledge domain within materials science and engineering subject in which the properties of structural and functional materials are described. The domain focuses especially on the connection between the microstructure and mechanical properties of materials and their technical application.

There is established cooperation with other institutions of higher education, both nationally and internationally. The technical application aspect means that there are also well-established industrial partnerships at the regional, national and international levels. At Karlstad University, the subject participates in multidisciplinary research groups in, or in related areas of, materials science. Sharing research results and subject knowledge yielded through contract research projects is encouraged and constitutes an experience-based environment for the doctoral students.

Research in materials engineering is carried out in the form of theoretical and experimental studies, varying from basic character to industrially practice-related applications. Numerical modelling and advanced experimental equipment are important tools in doctoral studies. These are used for studying the structure of materials, mechanical and tribological properties, surface modification and the use of materials in engineering applications.

The doctoral programme is primarily designed for students with engineering qualifications. Career opportunities on completion may include expert or research leader in research and development at universities, research institutes or industry, teacher in higher education or other functions in industry.

2. Learning Outcomes

The general outcomes of licentiate or doctoral studies in terms of knowledge and understanding, competence and skills, and judgement and approach are specified as follows in the System of Qualifications (Higher Education Ordinance, Annex 2):

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*

- *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.*

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 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 dissertation 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.*

Subject-specific outcomes
The objectives of doctoral studies in Materials Engineering apply in accordance with the general objectives stated above. The students shall also develop abilities to carry out research and project planning, disseminating information through articles in scientific and industry-related journals and oral presentations. In addition, the students should conduct research in national or international networks consisting of research organisations and industries.

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

3.1 General Entry Requirements
To meet the general entry requirements, the applicant must have been awarded a master level qualification; satisfied the requirements for courses comprising at least 240 credits of which at least 60 credits were at master level; or acquired substantially equivalent knowledge in some other way in Sweden or abroad. The faculty board may permit an exemption from the general entry requirements for an individual applicant, if there are special grounds. (Higher Education Ordinance, Chap. 7 Sect. 39)

3.2 Specific Entry Requirements
To meet the specific entry requirements for the PhD programme in Materials Engineering, the applicant must have been awarded a Degree of Master of

Science in Engineering with a major in Mechanical Engineering or a Degree of Master (60 or 120 ECTS credits) in the main field of Mechanical Engineering or adjacent academic fields such as Materials Engineering/Materials Science, Physics, or Chemistry. An applicant who does not meet the specific entry requirement but has acquired equivalent knowledge in some other way may be deemed eligible following a special assessment.

4. Admission

Applications for admission to doctoral studies are processed in accordance with the procedures prescribed by Karlstad University's admission regulations.

5. Selection

Candidates will be selected based on their assessed capacity to successfully complete a programme at the doctoral level.

The selection will be based on the applicant's previous study records, with an emphasis on the quality of independent written work of a scholarly and investigatory nature, particularly at Master's level, previous research and investigatory work and work experience of relevance to the doctoral programme, ability to communicate verbally and in writing in English, and the extent to which the applicant is able to be a physically present and active member of the research environment.

6. Content and Outline

The doctoral programme can lead to a licentiate or doctoral degree. A Degree of Licentiate comprises 120 ECTS credits. A Degree of Doctor comprises 240 ECTS credits. The studies include course work as well as an independent project (licentiate or doctoral thesis).

Students are required to complete an independent project (a thesis). The formulation and planning of the project is carried out and described in the individual study plan and can be presented and discussed in the seminar series within the department. Students publish science articles and present papers at national and international conferences. The research project is often carried out as a project in collaboration with several parties, e.g. university and industry partners. The students discuss with and report research results to the supervisors and project group. This also includes the need to independently and actively conduct work within a project.

To earn a licentiate degree, the candidate is required to complete 30 ECTS credits of course work and a thesis comprising 80 ECTS credits.

To earn a doctoral degree, the candidate must complete 60 ECTS credits of course work and a thesis comprising 170 ECTS credits.

6.1 Courses

The courses for a doctoral or licentiate degree are divided into a compulsory part, which is the same for all third-cycle students, and a subject-specific part.

Students can primarily choose courses from the range of courses that the university currently offers.

The optional courses are chosen in consultation with the supervisor and the examiner. The doctoral student's examiner decides whether a specific course can be included in the degree or not. This must be done, at the latest, when the requirements for a degree are to be approved, but it is recommended that the choice of courses is reviewed at the start of the studies in connection with the individual study plan. The individual study plan for each doctoral student includes which cross-faculty courses and which subject-specific courses the student intends to take.

Cross-faculty courses:
For the Degree of Licentiate: Information Retrieval (HS2014/527) and Research Ethics for Doctoral Students (HNT 2019/12), or equivalent. For the Degree of Doctor, students must also complete the following: Philosophy and Theory of Science for Doctoral Students (HS 2020/407), Communicating Science (HS 2017/142) or Innovative Applications of Research and Science (OUNI005), or equivalent. In total, a maximum of 10 credits of cross-faculty course work can be included in a degree of licentiate, and a maximum of 20 credits for a degree of doctor.

Subject-specific courses
Subject-specific courses are divided into mandatory and elective courses. Mandatory courses: Steels: properties and heat treatments (7MTT101), Phase transformations (7MTT102), Literature survey (7MTT103), or equivalent. Elective courses are offered by the faculty based on continuous assessments of the needs in current research projects. Students may also be asked to participate in national/international workshops/summer schools and similar events. Qualifications are assessed by the examiner. As a general rule, one week of study awards 1.5 credits. Participation in seminar series within the department where students present their own research as well as examples from current literature can also be included in the course requirements. As a general rule, two presentations award 1.5 credits.

Credit transfer is regulated by the latest version of "Regulations for Third-Cycle Studies at Karlstad University".

6.2 Licentiate and Doctoral Thesis

Third-cycle students are required to write a thesis for a doctoral or a licentiate degree, either as a monograph or as a compilation thesis. In Materials Engineering, students normally write a compilation thesis consisting of an introductory chapter, followed by several scientific articles suited for international publications in journals with peer-review procedure. The introductory chapter shall put the work presented in the thesis in its scientific context and identify the parts that the student perceives as contributions to the research domain. Candidates are required to defend their licentiate thesis at a seminar and their doctoral thesis at a public examination. Further information is available in Karlstad University's policy document: Regulations for Third-

Cycle Studies at Karlstad University. The topic of the licentiate or doctoral thesis is chosen in consultation with the supervisor and the examiner. As a general rule in Materials Engineering, students write a compilation thesis in English, with 4-6 scientific articles for a Degree of Doctor and 2-4 articles for a Degree of Licentiate.

6.3 Supervision

Doctoral students are entitled to a supervisor in accordance with the current admission regulations for third cycle education at Karlstad University.

6.4 Individual Study Plan

Each doctoral student must draw up an individual study plan in consultation with their supervisors at the start of their studies. The plan should include a realistic time plan for coursework, thesis work and supervision. The plan should also include an introduction to the proposed research field and relevant ethical considerations.

The individual study plan shall use the form or system approved by the university.

The individual study plan is subject to continual written revision (at least once a year). If this results in changes in terms of timetable or project plan, the individual study plan must be revised.

Goal attainment of the research programme shall be reviewed on two occasions during the course of the programme. After one year, an individual goal matrix shall be formulated and added to the research student's individual study plan as an appendix.

One year before the planned date for the licentiate degree and two years before the planned date for the doctoral degree, the outcome of the individual goal matrix is evaluated in connection with the revision of the individual study plan. If the evaluation shows that the goal attainment is not satisfactory, the plan for the continuing studies will be revised to ensure that the national goals are met by the time of examination. A revised goal matrix is attached to the revised individual study plan.

6.5 Examination

Doctoral students are examined in accordance with the requirements of each individual course syllabus. Licentiate and doctoral theses are examined in accordance with the Higher Education Ordinance (Chap. 6, Sect. 32-35), and Karlstad University's current regulations.