General syllabus for third-cycle studies in the subject Machine Design

1 This governance document was adopted by the Faculty Board of the School of Industrial Engineering and Management (registration number M-2024-0018) with reference to Chapter 6, Sections 26–27 of the Higher Education Ordinance. This governance document is in force as of 9 December 2024. This governance document regulates the main content of the programme, specific entry requirements, and other necessary regulations. The Faculty Board of the School of Industrial Engineering and Management is responsible for reviewing the governance document and answering questions about it.

2 Programme content

2.1 The name of the subject in Swedish and English

Maskinkonstruktion

Machine Design

2.2 Description of the subject

The subject *Machine Design* at KTH deals with the development and design of machines and products in a broad, interdisciplinary perspective. The aim is to educate students for effective and innovative product development, which is of strategic importance to Swedish industry. Product development involves many different activities and takes into account considerations of a scientific and technical nature, as well as issues of an economic and social character. The combination of these different aspects is often necessary for successful product development.

Of key importance to machine design is knowledge and engineering skills relating to the development of complex mechanical and mechatronic interfaces, components and systems. As product development usually takes place in an organisational context with the aim of generating economic gain, strategy, organisation and working methods for these activities are important components. The role of humans in technical systems, for example as clients, developers and users, is extremely important for product development and is therefore also a natural part of the subject. Research in machine design primarily covers the following areas:

- High-performance mechanical and mechatronic interfaces, components and systems.
- Physical, chemical and biological phenomena that may limit or enable new surface layers, components and systems.
- Design methodology and development methods for composite physical and cyber-physical products.
- Product development processes with technical, economic, environmental and organisational considerations.
- Tools and computer support for development and design.
- Design principles that can generate new functions and new products.

2.3 Specialisation(s)

Within this subject, there is an optional specialisation for doctoral projects in the field of innovation and design.

This specialisation involves research with significant elements of social science and design science, which is reflected in the use of theory and research methodology. The challenges in design and innovation work are far more than purely technical and are of such a diverse nature as identifying user and customer needs, designing business models and related business decisions, and design and innovation for sustainable development. These decision-making areas are dependent on and influence networks of actors and therefore require appropriate coordination and collaboration.

Innovation is a very central issue in the subject and concerns the ability of organisations and individuals to work innovatively. The development of innovative products and services requires a holistic approach that encompasses a range of aspects, such as functionality, ease of production, user-friendliness, market opportunities, environmental impact, etc. This holistic approach requires integration between functions and disciplines within an organisation, but also between individuals and organisations. Research in this area is often conducted in close collaboration with companies and other relevant stakeholders, and often has significant elements of change and action research. Research questions are usually developed based on the current needs of the participating parties, and research methods are selected based on the direct applicability of the results. A frequently adopted perspective is that of the engineer, designer or product developer, with the aim of generating knowledge that can influence working methods in product development. The research questions are varied and include support methods in product development, environmentally adapted product development, product planning, project work, functional sales, organisation and management of development activities, disruptive innovation, business model innovation, and idea and knowledge management. Of particular relevance are work in interdisciplinary complex product development, project portfolio management, procedures for concept development, integrated product, service and business development, and innovation and design work aimed at the sustainable transformation of complex socio-technical systems.

Central to the subject are interdisciplinary and multidisciplinary approaches and various types of generative methods that can be used generally in creative and innovative activities. The subject therefore also has strong links to human-computer interaction, architecture, aesthetics, ergonomics and work science. Like these, design and innovation research rests on a broad foundation in which scientific depth is not synonymous with professional boundaries, but rather is based on an ability to dynamically interact between the parts and the whole, between experiment and analysis, and between practice and theory.

2.4 Organisation of the programme

The programme consists of a course component and a thesis component. The course component may consist of lectures, literature surveys and problem solving, as well as active participation in seminars and conferences. Courses may be taken at KTH or at other Swedish or foreign research institutions. The programme includes active participation in research seminars in the subject area, which involves the student regularly presenting their own texts. Where applicable, the doctoral student shall also participate in national and international conferences and research networks within the field of knowledge.

The programme is conducted under the supervision of a principal supervisor, together with at least one assistant supervisor, as set out in the individual study plan. Courses shall be studied in accordance with the agreement between the student and the principal supervisor as documented in the individual study plan. The doctoral student's individual study plan shall be adapted to the doctoral student's prior knowledge and to the focus of the thesis. The doctoral student's progress shall be assessed at least once per calendar year in connection with the review of the individual study plan which is to be carried out by the doctoral student and the principal supervisor. The principal supervisor is responsible for ensuring that the individual study plan is drawn up and revised at appropriate time points. The study plan is then approved by the director of third cycle education-

2.4.1 Activities for achieving the intended learning outcomes of the programme according to the Higher Education Ordinance

The activities required for the doctoral student to achieve the intended learning outcomes for the award of third-cycle qualification pursuant to the Higher Education Ordinance and KTH's objectives are described below. The activities for each individual doctoral student are specified in the individual study plan.

Outcomes: Knowledge and understanding

For the Degree of Doctor, the doctoral 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.

The outcome is achieved through the following:

The doctoral student has authored original scientific papers in which their own contributions are significant and identifiable. The papers are of such quality that they have been published, or are expected to be published, in peer-reviewed international scientific journals.

The doctoral student has demonstrated both broad and specialised knowledge in the research area by writing a thesis in which the research results were positioned and discussed in a broader perspective, and presented a reference list of other researchers' results that spans the relevant breadth of the research area.

The doctoral student has actively participated in seminar activities and has been assessed in the courses Seminar Course for PhD Students at MMK, Part I and Part II, in which their own results were presented and discussed, and asked questions and provided feedback on the presentations on other doctoral students and researchers.

- Demonstrate familiarity with research methodology in general and the methods of the specific field of research in particular.

The outcome is achieved through the following:

The doctoral student has been assessed with a passing grade for the intended learning outcomes in the compulsory methodology courses (FAK3014 The Theory and Methodology of Science – Minor Course, 3.0 credits, FAK3148 Introduction to Research Ethics for PhD Students, 1.5 credits, FLF3019 Introduction to Research Studies at the ITM School, 6 credits).

In their doctoral thesis, the doctoral student has justified their choice of method and execution in relation to the research question and to alternative methods.

In their thesis, the doctoral student has demonstrated an ability to independently perform, interpret and critically examine the results in order to clarify whether the method and its execution were appropriate to obtain credible results that answer the scientific question.

For the Degree of Licentiate, the doctoral 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.

The outcome is achieved through the following:

The doctoral student has authored original scientific papers in which their own contributions are significant and identifiable. The papers are of such quality that they have been published, or are expected to be published, in peer-reviewed international scientific journals.

The doctoral student has demonstrated both broad and specialised knowledge in the research area by writing a thesis in which the research results were positioned and discussed in a broader perspective, and presented a reference list of other researchers' results that spans the relevant breadth of the research area.

The doctoral student has actively participated in seminar activities and has been assessed in the course Seminar Course for PhD Students at MMK, Part I, in which their own results were presented and discussed, and asked questions and provided feedback on the presentations on other doctoral students and researchers.

Outcomes: Competence and skills

For the Degree of Doctor, the doctoral student shall:

- Demonstrate the capacity for scientific analysis and synthesis as well as to review and assess new and complex phenomena, issues and situations autonomously and critically.

The outcome is achieved through the following:

In their doctoral thesis, the doctoral student has demonstrated the ability to independently formulate and critically analyse both existing and new complex phenomena.

In their thesis, the doctoral student has presented concrete examples of scientific questions and problems of a complex nature from their own research, and described how these were tested and how the results were analysed.

In their thesis, the doctoral student has described the interpretation of the results and how these were combined with existing knowledge to give rise to a new explanatory model.

- Demonstrate the ability to identify and formulate issues with scientific 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.

The outcome is achieved through the following:

The doctoral student has actively participated in seminar activities and has been assessed in the courses Seminar Course for PhD Students at MMK, Part I and Part II, in which they presented examples of independently conducted experiments/simulations/investigations preceded by detailed time planning.

Where applicable, the doctoral student has presented examples of their own hypotheses that have been tested within the framework of their own research project and described the choice of method and outcome. If any results were not as expected, the doctoral student shall have explained the possible sources of error and the measures taken to move the project forward.

In their doctoral thesis, the doctoral student has presented examples of and described and argued for the choice of methods for individual research tasks.

- Demonstrate through a dissertation the ability to make a significant contribution to the formation of knowledge through their own research.

The outcome is achieved through the following:

The doctoral student has authored original scientific papers in which their own contributions are significant and identifiable. The papers are of such quality that they have been published, or are expected to be published, in peer-reviewed international scientific journals.

The doctoral student has authored a thesis, based on the scientific papers, of good scientific and linguistic quality, which has been authoritatively defended and discussed at a public defence, and assessed with a passing grade by an independent examining committee.

- 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 scientific community and society in general.

The outcome is achieved through the following:

Where applicable, the doctoral student has participated in national and international conferences and presented their own research results in speech or poster form, and participated in scientific discussions with other researchers in the research area.

The doctoral student has actively participated in seminar activities and has been assessed in the courses Seminar Course for PhD Students at MMK, Part I and Part II, in which they presented their research results in a pedagogical manner to other students, doctoral students and researchers.

The doctoral student has been assessed in one of the elective third-cycle courses in scientific communication (FLS3107 Communicating Research Beyond the Academy, FLS3104 Visualize Your Science, FDS3102 Writing Scientific Articles).

- Demonstrate the ability to identify the need for further knowledge.

The outcome is achieved through the following:

In their doctoral thesis, the doctoral student has demonstrated the ability to question, evaluate and adapt their perception of their own level of knowledge and ability in relation to the prevailing knowledge front.

- 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.

The outcome is achieved through the following:

The doctoral student has actively participated in seminar activities and has been assessed in the courses Seminar Course for PhD Students at MMK, Part I and Part II, in which they presented their research results in a pedagogical manner to other students, doctoral students and researchers.

The doctoral student has been assessed in the compulsory higher education pedagogy course FLH3000 Basic Communication and Teaching, 3.0 credits.

For the Degree of Licentiate, the doctoral student shall:

- Demonstrate the ability to identify and formulate issues with scientific 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.

The outcome is achieved through the following:

The doctoral student has actively participated in seminar activities and has been assessed in the course Seminar Course for PhD Students at MMK, Part I, in which they presented examples of independently conducted experiments/simulations/tasks preceded by detailed time planning.

Where applicable, the doctoral student has presented examples of their own hypotheses that have been tested within the framework of their own research project and described the choice of method and outcome. If any results were not as expected, the doctoral student shall have explained the possible sources of error and the measures taken to move the project forward.

In their doctoral thesis, the doctoral student has presented examples of and described and argued for the choice of methods for individual research tasks.

- Demonstrate the ability in both national and international contexts to present and discuss research and research findings clearly in speech and writing and in dialogue with the scientific community and society in general.

The outcome is achieved through the following:

Where applicable, the doctoral student has participated in national and international conferences and presented their own research results in speech or poster form, and participated in scientific discussions with other researchers in the research area.

The doctoral student has actively participated in seminar activities and has been assessed in the course Seminar Course for PhD Students at MMK, Part I, in which they presented their research results in a pedagogical manner to other students, doctoral students and researchers.

- Demonstrate the skills required to participate autonomously in research and development work and to work autonomously in some other qualified capacity.

The outcome is achieved through the following:

The doctoral student has authored original scientific papers in which their own contributions are significant and identifiable. The papers are of such quality that they have been published, or are expected to be published, in peer-reviewed international scientific journals.

The doctoral student has authored a licentiate thesis based on their own studies of good scientific and linguistic quality, which has been defended and discussed at a licentiate seminar, and assessed with a passing grade by an independent examiner.

Outcomes: Judgement and approach

For the Degree of Doctor, the doctoral student shall:

- Demonstrate intellectual autonomy and disciplinary rectitude as well as the ability to make assessments of research ethics.
  This outcome only applies for the Degree of Doctor.

The outcome is achieved through the following:
The doctoral student has been assessed in the compulsory third-cycle courses FAK3148 Introduction to Research Ethics for PhD Students, 1.5 credits, and FLF3019 Introduction to Research Studies at the ITM School, 6 credits.

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.

The outcome is achieved through the following:

By writing a doctoral thesis in which the doctoral student reflects on how their own research results can contribute to sustainable societal development, and can, where relevant, also link these to the prioritised global sustainability goals.

For the Degree of Licentiate, the doctoral student shall:

- Demonstrate the ability to make assessments of ethical aspects of their own research.

The outcome is achieved through the following:

The doctoral student has been assessed in the compulsory third-cycle courses FAK3148 Introduction to Research Ethics for PhD Students, 1.5 credits, and FLF3019 Introduction to Research Studies at the ITM School, 6 credits.

- Demonstrate insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used.

The outcome is achieved through the following:

By writing a licentiate thesis in which the doctoral student reflects on how their own research results can contribute to sustainable societal development, and can, where relevant, also link these to the prioritised global sustainability goals.

- Demonstrate the ability to identify the personal need for further knowledge and take responsibility for their ongoing learning.

The outcome is achieved through the following:

In their licentiate thesis, the doctoral student has demonstrated the ability to question, evaluate and adapt their perception of their own level of knowledge and ability in relation to the prevailing knowledge front.

KTH's intended learning outcomes in sustainable development

For *both the Degree of Licentiate and the Degree of Doctor*, the doctoral student shall:

- Demonstrate the ability to use knowledge and skills to contribute to sustainable development towards an equal, inclusive and climate-neutral society.

The outcome is achieved through the following:

The doctoral student has written a licentiate thesis or doctoral thesis in which the doctoral student reflects on how their own research results can contribute to sustainable development towards a gender-equal, inclusive and climate-neutral society.

2.4.2 Compulsory courses

The following courses are compulsory for all doctoral students. These courses can be replaced with other courses of equivalent content.

FLF3019 Introduction to Research Studies at the ITM School, 6 credits

FAK3014 The Theory and Methodology of Science – Minor Course, 3.0 credits

FAK3148 Introduction to Research Ethics for PhD Students, 1.5 credits

FMF3042 Seminar Course for PhD Students at MMK, Part I, 1.5 credits

FLH3000 Basic Communication and Teaching, 3.0 credits

All doctoral students shall take at least one of the following three courses. These courses can be replaced with other courses of equivalent content.

FDS3102 Writing Scientific Articles, 5.0 credits

FLS3107 Communicating Research Beyond the Academy, 5.0 credits

FLS3104 Visualize Your Science, 4.0 credits

Additional compulsory courses are required for the specialisation Innovation and Design.

For doctoral students pursuing a Degree of Doctor, the following course is also compulsory. This course can be replaced with other courses of equivalent content.
FMF3043 Seminar Course for PhD Students at MMK, Part II, 1.5 credits

Conditionally elective
Doctoral students in the specialisation Innovation and Design must take at least one of the following courses/course combinations:
Seminar Course in Design Research, 6 credits, and Literature Course in Design Research, 6 credits
or
Innovation Management, 7.5 credits

2.4.3 Recommended courses

FMF3044 Machine Design – Literature Survey and Thesis Analysis 15.0 credits

FMF3045 Machine Design – High Risk Project Course 15.0 credits

FMF3010 Research Methods in Mechatronics 3.0 credits

FMF3011 Literature Course in Mechatronics 7.5 credits

FMF3012 Literature Course in Real-time Systems 7.5 credits

FMF3013 Literature Course in Applied Control 7.5 credits

FMF3014 Literature Course in Real-time Systems II 15 credits

FMF3015 Modelling and Simulation of Machine Elements 10.5 credits

FMF3016 Machine Dynamics 9.0 credits

FMF3017 Graduate School in Tribology 9.0 credits

FMF3018 Gear Technology 6.0 credits

FMF3019 Applied Experimental Methodology 7.5 credits

FMF3020 Design and Product Development Methodology, Literature Course 7.5 credits

FMF3027 Systems Thinking and its Application in Embedded Systems 7.5 credits

FMF3028 Robust and Probabilistic Design 6.0 credits

FMF3029 Research Methodology in Machine Design for PhD Students 9.0 credits

FMF3032 Cyber-Physical Systems' Safety and Security 7.5 credits

FMF3033 Innovation Management 7.5 credits

FMF3034 Introduction to Research Studies in Machine Design 7.5 credits

FMF3035 System Thinking and Modelling of Complex Dynamic Systems 6.0 credits

FMF3036 Reviewing Scientific Articles 3.0 credits

FMF3037 Literature course on Artificial Intelligence 7.5 credits

FMF3038 Team-building for a Collaborative and Inclusive Culture in Large Research Projects/Centres 4.5 credits

FMF3402 Internal Combustion Engines, Experimental Work and Measurements 9.0 credits

FMF3404 Internal Combustion Engines, Research Questions 9.0 credits

FMF3605 EcoDesign – Product Design for Sustainability 7.5 credits

2.4.4 Qualification requirements

Degree of Doctor

The Degree of Doctor comprises 240 credits. The thesis shall comprise at least 120 credits (normally 180 credits)

Thesis

Quality requirements and any other requirements for the thesis.

The doctoral thesis should normally be written in English. It should take the form of a compilation of scientific articles, together with a special written summary.

A doctoral thesis should normally include at least three articles that can be published in internationally recognised peer-reviewed journals. Normally, at least two articles are already published in scientific journals with the doctoral student as first author.

For texts with multiple authors that are included in the thesis, it must be possible to distinguish the doctoral student's contribution.

The doctoral thesis can build on a previous licentiate thesis. The licentiate degree may be obtained as part of the doctoral degree. Courses and thesis work included in the licentiate degree may also be credited towards a doctoral degree.

Courses

The doctoral student must have completed courses totalling at least 45 credits, of which at least 30 credits must be at the third-cycle level and a maximum of 10 credits may be at the first-cycle level.

Degree of Licentiate

The Degree of Licentiate comprises at least 120 credits. The thesis shall comprise at least 60 credits (normally 90 credits).

Licentiate thesis

Quality requirements and any other requirements for the licentiate thesis.

The licentiate thesis should normally be written in English. It should take the form of a compilation of scientific articles, together with a special written summary.

A licentiate thesis should normally include at least one article that can be published in internationally recognised peer-reviewed journals. Normally, one article is already published in a scientific journal with the doctoral student as first author.

For texts with multiple authors that are included in the thesis, it must be possible to distinguish the doctoral (licentiate) student's contribution.

Courses

The doctoral student must have completed courses totalling at least 30 credits, of which at least 15 credits must be at the third-cycle level and a maximum of 10 credits may be at the first-cycle level.

2.4.5 Other elements of the programme to promote and ensure goal attainment

Planning, mid-way and final seminars for the Degree of Doctor. Planning seminar for the Degree of Licentiate.

3 Admission to third-cycle programmes (entry requirements, etc.)

Admission to third-cycle programmes is regulated in Chapter 7, Section 40 of the Higher Education Ordinance and in KTH's admission regulations. KTH's regulations on specific entry requirements and other abilities needed to benefit from the third-cycle programme in the subject in question are set out below.

3.1 Specific entry requirements

The subject falls under technological sciences in nature, but different subject backgrounds are possible. To be admitted to a third-cycle programme in Machine Design, the applicant must have passed at least 60 credits worth of courses at no lower than the second-cycle level in subjects deemed relevant to the focus of the thesis. These requirements are also deemed to be met by those who have acquired essentially equivalent knowledge in other ways.

Doctoral candidates are also expected to be able to read and write scientific English and to speak English unhindered.

3.2 Criteria for assessing the ability to succeed in the programme

When assessing the ability to succeed in the programme, the following assessment criteria are used:

Admission to a third-cycle programme is based on assessed ability to succeed in the programme. The assessment of ability is primarily based on qualifying education. The following are given special consideration:

1. Knowledge and skills relevant to the thesis work and the subject.
   These can be demonstrated through attached documents and an interview, if applicable.

2. Assessed ability to work autonomously
    a. ability to formulate and address scientific problems
    b. written and oral communication skills
    c. maturity, judgement and capacity for independent critical analysis

   The assessment can, for example, be based on the degree project and a discussion of this at a possible interview.
3. Other experience relevant to the third-cycle programme, such as professional experience.

4 Other necessary regulations

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4.1 Transitional provisions

Doctoral students who were admitted under a previous syllabus are entitled to follow either the new syllabus or the syllabus under which they were admitted. Requests to follow the new syllabus are made to the director of third cycle education.

4.2 Co-authorship

KTH's ethical rules for co-authorship apply. In the case of co-publications, its four criteria for authorship must all be met:

1. Substantial contributions to the conception and design, collection of data or analysis and interpretation of data;

2. Writing of the first draft of the article or critical revision of it for important intellectual content;

3. Final approval of the version intended for publication; and

4. The person can be held accountable for all aspects of the article, ensuring that questions of accuracy are appropriately investigated and resolved.

Appendix: Qualitative targets and assessment criteria

Intended learning outcomes pursuant to the System of Qualification, Annex 2 to the Higher Education Ordinance, plus requirements specified by KTH, with examples of assessment criteria that can determine whether the doctoral student has achieved the outcome in question. *The assessment criteria in the table are examples and were developed as support and inspiration for activities described in Section 1.4.*

Degree of Doctor

Knowledge and understanding	
Intended learning outcomes	**Assessment criteria with reference to numbering in eISP**

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.	The outcome has been achieved through the doctoral student having **A1.1:** authored original scientific papers in which their own contributions are significant and identifiable. The papers are of such quality that they have been published, or are expected to be published, in peer-reviewed international scientific journals or conferences. **A1.2:** demonstrated both broad and specialised knowledge in the research area by writing a thesis in which the research results were positioned and discussed in a broader perspective, and presented a reference list of other researchers' results that spans the relevant breadth of the research area. **A1.3:** in a seminar, course or a thesis or its public defence, demonstrated a good ability to account for how their own research results relate to the research front within the research area, and justify how their own results advance this. **A1.4:** actively participated in seminar activities in which their own results were presented and discussed, and asked questions and provided feedback on the presentations on other students and researchers.
Demonstrate *familiarity* with research methodology in general and the methods of the specific field of research in particular.	The outcome has been achieved through the doctoral student having **A2.1:** assessed with passing result regarding intended learning outcomes in scientific methodology, which may be a course or equivalent learning element at the third-cycle level. **A2.2:** described basic theories in scientific theory and correctly applied one or more of these in their own research. **A2.3:** practically applied methods appropriate to the research area and developed the ability to independently perform, interpret and critically examine the results in order to clarify whether the method and its execution were appropriate to obtain credible results that answer the scientific question. **A2.4:** justified their choice of method and execution in relation to the research question and to alternative methods. **A2.5:** described the advantages and disadvantages of different scientific methods used in their own research area, as well as the methods used in the broader definition of the research area.
Competence and skills	
Intended learning outcomes	**Assessment criteria with reference to numbering in eISP**
Demonstrate the capacity for scientific analysis and synthesis as well as to review and assess new and complex phenomena, issues and situations autonomously and critically.	The outcome has been achieved through the doctoral student having **B1.1:** demonstrated the ability to independently formulate and critically analyse both existing and new complex phenomena. **B1.2:** presented concrete examples of scientific questions and problems of a complex nature from their own research, and described how these were tested and how the results were analysed. **B1.3:** described the interpretation of the results and how these were combined with existing knowledge to give rise to a new explanatory

	model. **B1.4:** where applicable, presented concrete examples of results that have given rise to falsification of a hypothesis and revision of the hypothesis.
Demonstrate the ability to identify and formulate issues with scientific 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.	The outcome has been achieved through the doctoral student having **B2.1:** presented examples of independently performed experiments/simulations/tasks that were preceded by detailed time planning. **B2.2:** where applicable, presented examples of their own hypotheses that have been tested within the framework of their own research project and described the choice of method and outcome. If any results were not as expected, the doctoral student shall have explained the possible sources of error and the measures taken to move the project forward. **B2.3:** presented examples of and described and argued for the choice of methods for individual research tasks. **B2.4:** explained how it was ensured that the training could be completed on time, and whether there were obstacles to staying within the time frame, as well as what measures were taken and their outcome.
Demonstrate through a dissertation the ability to make a significant contribution to the formation of knowledge through their own research.	The outcome has been achieved through the doctoral student having **B3.1**: authored original scientific papers in which their own contributions are significant and identifiable. The papers are of such quality that they have been published, or are expected to be published, in peer-reviewed international scientific journals or conferences. **B3.2**: authored a thesis, based on the scientific papers, of good scientific and linguistic quality, which has been authoritatively defended and discussed at a public defence, and assessed with a passing grade by an independent examining committee.
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 scientific community and society in general.	The goal has been achieved through the doctoral student having **B4.1:** where applicable, participated in national and international conferences and presented their own research results in speech or poster form, and participated in scientific discussions with other researchers in the research area. **B4.2:** described how experience from conference or seminar presentations contributed to the development of their own ability to communicate and defend scientific results, how the presentations were received by other participants, and whether valuable information could be obtained that helped their own studies progress. **B4.3:** been assessed with a passing grade for the intended learning outcomes in communication or presentation techniques in an appropriate compulsory or elective third-cycle course **B4.4:** described basic concepts, tools and methods in presentation or communication techniques, as well as demonstrated the ability to put knowledge into practice by formulating different types of scientific presentation material of good quality. **B4.5:** presented their own research results in a pedagogical manner to other students and researchers at academic seminars, to a general

	audience or to another category of audience, where the formulation of presentation material and speech was based on pedagogical knowledge adapted to the audience's knowledge level, and also answered questions at an adequate level for the audience. **B4.6:** participated in outreach activities related to their own research in order to contribute to the dissemination and exchange of knowledge with relevant stakeholder groups, such as other higher education institutions, companies, authorities, schools, etc.
Demonstrate the ability to identify the need for further knowledge.	The outcome has been achieved through the doctoral student having **B5.1:** by means of concrete examples, described how the lack of essential knowledge needed to carry out a task was rectified and how this affected the possibility of carrying out the task. This may involve widely differing tasks and knowledge, with the proviso that the doctoral student him/herself must have realised that knowledge was lacking and handled this with measures relevant to the purpose. **B5.2:** demonstrated insight that the knowledge front in higher education and research is in constant change and development and that definitive answers cannot always be obtained, as well as the ability to determine whether certain knowledge already exists, for example by means of thorough and critical examination of existing scientific literature. **B5.3:** demonstrated the ability to question, evaluate and adapt their perception of their own level of knowledge and ability in relation to the prevailing knowledge front.
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.	The outcome has been achieved through the doctoral student having **B6.1:** presented their own research results in a pedagogical manner to other students and researchers at academic seminars, to a general audience or to another category of audience, where the formulation of presentation material and speech was based on pedagogical knowledge adapted to the audience's knowledge level, and also answered questions at an adequate level for the audience. **B6.2:** participated in outreach activities related to their own research in order to contribute to the dissemination and exchange of knowledge with relevant stakeholder groups, such as other higher education institutions, companies, authorities, schools, etc. **B6.3:** actively supervised other students in theoretical and/or practical projects. Doctoral students should, with examples, account for and reflect on various aspects of their own input, e.g. how the supervision was structured, whether pedagogical methodology was applied, how it was ensured that the person who was supervised understood the instructions, etc. The doctoral student should also reflect on different roles of teachers and students, and how personal dynamics and supervision techniques can affect the outcome of learning and interaction. **B6.4:** been assessed with a passing grade for the intended learning outcomes in higher education pedagogy in a suitable compulsory or elective course at the third-cycle level. The doctoral student is thus assumed to be able to describe basic concepts, materials and methods, as well as conditions for teaching and learning in higher education, and to be able to analyse, evaluate and develop teaching and learning. The doctoral student is thus also assumed to be able to demonstrate the ability to evaluate and analyse different methods

	and approaches in higher education, and to demonstrate the ability to take into account a student perspective. **B6.5:** demonstrated the ability to collaborate and communicate in writing and speech, undertaken tasks and assignments that were planned and completed on time, and demonstrated the ability to comply with applicable rules and directives and thereby acquired general knowledge and skills required in different societal functions.
Judgement and approach	
Intended learning outcomes	**Assessment criteria with reference to numbering in eISP**
Demonstrate intellectual autonomy and disciplinary rectitude as well as the ability to make assessments of research ethics.	The outcome has been achieved through the doctoral student having **C1.1:** demonstrated intellectual integrity in the sense that their own choices and positions have been justified and defended based on independent critical thinking in relation to proven experience and scientific basis. **C1.2:** described how they ensured that their own scientific procedure in theory and practice was carried out in an honest and ethical manner. **C1.3:** reflected on possible existing or hypothetical ethical dilemmas related to their own research area or to scientific research in general, and reported on their own ethically independent stance in the existing or hypothetical situation. **C1.4:** been assessed with a passing grade for the intended learning outcomes in ethics in a suitable compulsory or elective third-cycle course. The doctoral student is thus expected to be able to account for fundamental theories in research ethics and relate these to their own approach and research work.
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, and demonstrate the ability to contribute to sustainable societal development with knowledge and skills.	The outcome has been achieved through the doctoral student having **C2.1:** presented concrete examples of how their own research results, and the research area in general, can contribute new knowledge to the research front in the area and justify its societal relevance. **C2.2:** critically reflected on limitations of their own research results, and the research area in general, in order to contribute to solving societally relevant problems, as well as identify possible situations in which their own research results can be used in both a positive and a negative way. **C2.3:** demonstrated a good ability to reflect on how their own research results can contribute to sustainable societal development and can, where relevant, also link these to the prioritised global sustainable development goals. **C2.4:** described how their own actions and approach take the concept of sustainability into account. **C2.5:** been assessed with a passing grade for the intended learning outcomes in sustainable development in an appropriate compulsory

	or elective third-cycle course. The doctoral student is thus expected to be able to account for fundamental theories in sustainability and relate these to their own approach and research work.

Degree of Licentiate

Knowledge and understanding	
Intended learning outcomes	**Assessment criteria with reference to numbering in eISP**
Demonstrate *knowledge and understanding* in the field of research, including *current* specialist knowledge in a limited area of this field. *Main difference compared to the Degree of Doctor: For the Degree of Licentiate, it is sufficient to demonstrate "knowledge and understanding", as opposed to "broad knowledge and systematic understanding". In addition, "advanced and up-to-date specialised knowledge" is replaced with "current specialist knowledge".*	The outcome has been achieved through the doctoral student having **A1.1:** authored original scientific papers in which their own contributions are significant and identifiable. The papers are of such quality that they have been published, or are expected to be published, in peer-reviewed international scientific journals or conferences. **A1.2:** demonstrated both broad and specialised knowledge in the research area by writing a licentiate thesis in which the research results were positioned and discussed in a broader perspective, and presented a reference list of other researchers' results that spans the relevant breadth of the research area. **A1.3:** in a seminar, course or a licentiate thesis and its public defence, demonstrated a good ability to account for how their own research results relate to the research front within the research area, and justify how their own results advance this. **A1.4:** actively participated in seminar activities in which their own results were presented and discussed, and asked questions and provided feedback on the presentations on other students and researchers.
Competence and skills	
Intended learning outcomes	**Assessment criteria with reference to numbering in eISP**
Demonstrate the ability to identify and formulate issues with scientific 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. *Main difference compared to the Degree of Doctor: For the Degree of Licentiate, there is emphasis that the student is to undertake a "limited piece of research" that is to contribute to the formulation of knowledge, as opposed to the Degree of Doctor, which specifies that the student is to demonstrate the ability to "undertake research".*	The outcome has been achieved through the doctoral student having **B1.1:** demonstrated the ability to independently formulate and critically analyse both existing and new complex phenomena. **B1.2:** presented examples of their own questions that have been tested within the context of their own research project, and presented their choice of method and the outcome. If any results were not as expected, the doctoral student shall have explained the possible sources of error and the measures taken to move the project forward. **B1.3:** presented examples of independently conducted experiments/simulations/tasks preceded by detailed time planning. **B1.4:** presented examples of, and explained and argued for, the choice of methods for individual experiments. **B1.5:** explained how it was ensured that the training could be completed on time, and whether there were obstacles to staying within the time frame, as well as what measures were taken and their outcome.
Demonstrate the ability in both national and	The goal has been achieved through the doctoral student having

international contexts to present and discuss research and research findings *clearly* in speech and writing and in dialogue with the scientific community and society in general. *Main difference compared to the Degree of Doctor: For the Degree of Licentiate, the requirement is for the student to communicate their research "clearly", as opposed to communicating "authoritatively".*	**B2.1:** where applicable, participated in national and international conferences and presented their own research results in speech or poster form, and participated in scientific discussions with other researchers in the research area. **B2.2:** described how experience from conference or seminar presentations contributed to the development of their own ability to communicate and defend scientific results, how the presentations were received by other participants, and whether valuable information could be obtained that helped their own studies progress. **B2.3:** been assessed with a passing grade for the intended learning outcomes in communication or presentation techniques in an appropriate compulsory or elective third-cycle course **B2.4:** described basic concepts, tools and methods in presentation or communication techniques, as well as demonstrated the ability to put knowledge into practice by formulating different types of scientific presentation material of good quality. **B2.5:** presented their own research results in a pedagogical manner to other students and researchers at academic seminars, to a general audience or to another category of audience, where the formulation of presentation material and speech was based on pedagogical knowledge adapted to the audience's knowledge level, and also answered questions at an adequate level for the audience. **B2.6:** participated in outreach activities related to their own research in order to contribute to the dissemination and exchange of knowledge with relevant stakeholder groups, such as other higher education institutions, companies, authorities, schools, etc.
Demonstrate the skills required to participate autonomously in research and development work and to work autonomously in some other qualified capacity. *Main difference compared to the Degree of Doctor: The doctoral student's future contribution to society through research and education is downplayed, and the focus is placed on the doctoral student's ability to work in areas that require research skills but not a doctoral degree.*	The outcome has been achieved through the doctoral student having **B3.1**: authored original scientific papers in which their own contributions are significant and identifiable. The papers are of such quality that they have been published, or are expected to be published, in peer-reviewed international scientific journals or conferences. **B3.2**: authored a licentiate thesis based on their own studies of good scientific and linguistic quality, which has been defended and discussed at a licentiate seminar, and assessed with a passing grade by an independent examiner.

Judgement and approach

Intended learning outcomes	Assessment criteria with reference to numbering in eISP
Demonstrate the ability to make assessments of ethical aspects *of their own research.* *Main difference compared to the Degree of Doctor: The ability to make assessments of research ethics is limited to the student's own research and not in general.*	The outcome has been achieved through the doctoral student having **C1.1:** demonstrated intellectual integrity in the sense that their own choices and positions have been justified and defended based on independent critical thinking in relation to proven experience and scientific basis. **C1.2:** described how they ensured that their own scientific procedure in theory and practice was carried out in an honest and ethical manner. **C1.3:** reflected on possible existing or hypothetical ethical dilemmas

	related to their own research area or to scientific research in general, and reported on their own ethically independent stance in the existing or hypothetical situation. **C1.4:** been assessed with a passing grade for the intended learning outcomes in ethics in a suitable compulsory or elective third-cycle course. The doctoral student is thus expected to be able to account for fundamental theories in research ethics and relate these to their own approach and research work.
Demonstrate insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used. *Main difference compared to the Degree of Doctor: For the Degree of Licentiate, only "insight" is required, as opposed to "specialised insight for the doctoral degree.*	The outcome has been achieved through the doctoral student having **C2.1:** presented concrete examples of how their own research results, and the research area in general, can contribute new knowledge to the research front in the area and justify its societal relevance. **C2.2:** critically reflected on limitations of their own research results, and the research area in general, in order to contribute to solving societally relevant problems, as well as identify possible situations in which their own research results can be used in both a positive and a negative way. **C2.3:** demonstrated a good ability to reflect on how their own research results can contribute to sustainable societal development and can, where relevant, also link these to the prioritised global sustainable development goals. **C2.4:** described how their own actions and approach take the concept of sustainability into account.
Demonstrate the ability to identify the personal need for further knowledge and take responsibility for their ongoing learning. *Main difference compared to the Degree of Doctor: Same requirement to be able to identify the need for further knowledge, with the addition of being able to take responsibility for one's own knowledge development, which is considered implicit in a doctoral degree.*	**C3.1:** by means of concrete examples, described how the lack of essential knowledge needed to carry out a task was rectified and how this affected the possibility of carrying out the task. This may involve widely differing tasks and knowledge, with the proviso that the doctoral student him/herself must have realised that knowledge was lacking and handled this with measures relevant to the purpose. **C3.2:** demonstrated insight that the knowledge front in higher education and research is in constant change and development and that definitive answers cannot always be obtained, as well as the ability to determine whether certain knowledge already exists, for example by means of thorough and critical examination of existing scientific literature. **C3.3:** demonstrated the ability to question, evaluate and adapt their perception of their own level of knowledge and ability in relation to the prevailing knowledge front.