REGULATION	Valid from 2017-10-05	Reference number V-2023-0322 3.2.3
Decision-maker President	Revised as of 2023-09-05	Entity responsible for supervision and questions School of Engineering Sciences

General syllabus for education at third-cycle level in the subject Applied Physics

This regulatory document has been decided by the President (V-2023-0322) pursuant to chapter 6 sections 26-27 of the Higher Education Ordinance. The regulatory document is valid with effect from 10/05/2017 and was last modified on 05/09/2023 (reference number V-2023-0322). The regulatory document regulates the main content of the education, requirements for special qualifications and the other regulations that are needed. The School of Engineering Sciences is responsible for review and questions about the governing document.

1 Content of the education

1.1 Tillämpad Fysik Applied Physics

1.2 Subject description

Physics is the science that describes the structure of matter and the fundamental processes of nature. Physics plays a crucial role in all the natural sciences. Applied Physics encompasses the aspects of physics that can lead to new technologies that meet society's needs, such as telecommunications, electricity and energy supply, water and air purification, transformation and refinement processes of materials and chemicals, development of new medical technologies. Applied Physics borders and overlaps many research domains and has links to research in all KTH schools.

The doctoral programme in Applied Physics has four main specialisations - Materials and Nanophysics, Optics and Photonics, Biological and Biomedical Physics and Quantum Technology - which are described in detail below. These domains and specialisations reflect the divisions of the Department of Applied Physics at KTH. Other specialisations within the subject may also be considered, and the programme is designed to dynamically include new main specialisations with time. Third-cycle education and research in Applied Physics is provided by the Department of Applied Physics at the School of Engineering Sciences.

1.3 Specialisations

Materials and Nanophysics

Materials physics describes the electrical, electronic, chemical, optical, thermal and magnetic properties of materials, usually based on a detailed atomic description of their structure and composition. Nanophysics describes how these properties are affected/changed as material dimensions shrink down to the nanometre scale. Third-cycle research and education concerns the development of new magnetic materials for data storage and spintronics, superconductivity and its applications, new materials for batteries, sensors, solar cells and catalysts, materials for water and air purification, materials for the conversion of thermal energy into electricity, quantum materials and new electronics. Basically, the specialisation seeks a deeper understanding of how structure and composition lead to different material properties and how we can tailor materials for different applications.

Optics and Photonics

Optics and photonics describe the properties of light and how it propagates in and interacts with materials. Optics and photonics have many applications in the development of communication technologies, solar cells, sensors, visual aids, light sources, etc. Third-cycle

research and education concerns the development of lasers and materials for manipulating laser light, fibre optics, molecular systems for sensing and generating light, systems for detecting molecules in liquids and gases, new materials for optronics, solar cells, optics of the eye and light sources.

Biological and Biomedical Physics

Biological physics includes the development and application of physical methods, both experimental and theoretical, to investigate, describe and understand biological systems and processes. Biomedical physics describes biological physics with a focus on medical issues, either of a more fundamental or an applied/clinical nature. Third-cycle research and education concerns the development of new sensitive and high-resolution spectroscopic and microscopic methods and their application to fundamental biophysical studies, as well as for new diagnostics, at the molecular, cellular, tissue and organism level. It also includes methods for manipulating the samples in question, and the development and application of theoretical methods and models for fundamental studies of similar biological systems, as well as for diagnostics and drug development.

Quantum Technology

Quantum technology deals with the control and measurement of physical systems when the balance between disturbance and response approaches the limit of uncertainty set by Planck's constant. Despite this uncertainty, the deterministic equations of quantum physics allow one to predict with certainty the time evolution of the quantum state. Quantum technology seeks to design devices, measurement schemes and control protocols that exploit the unique quantum or non-classical properties of these developments (such as superposition and entanglement) for information processing, secure communication and improved sensing.

1.4 Organisation of the education

Third-cycle courses and study programmes consist of a course component and a thesis component and must lead to a doctoral or licentiate degree. The Degree of Doctor corresponds to four years of full-time study (240 credits) and the Degree of Licentiate to two years of full-time study (120 credits). During the programme, the doctoral student is supervised by a principal supervisor and one or more assistant supervisors. The principal supervisor is appointed at the time of admission and is responsible, together with the doctoral student, for ensuring that course studies and thesis work progress according to plan. In connection with admission, an individual study plan must be prepared in accordance with the internal directions and guidelines specified in KTH's overall regulatory framework. The individual study plan is to be revised regularly with a maximum of one year between revisions.

The course component may consist of courses organised within the programme or at other universities or summer schools and must comprise at least 30 credits for the licentiate degree and at least 60 credits for the doctoral degree. For the Degree of Doctor, at least 45 credits must be third-cycle credits, and no more than 10 may be first-cycle credits. For the Degree of Licentiate, at least 15 credits must be third-cycle credits, and no more than 10 may be first-cycle credits.

During the course of the programme, the doctoral student is encouraged to actively participate in research seminars in the subject. To gain international experience, the doctoral student should, if possible, spend part of his/her research studies abroad through international research co-operation.

Doctoral students are recommended to devote a certain amount of time (maximum 20 per cent of full-time) to teaching undergraduate students or other institutional duties. Such efforts are to be included in the individual study plan. This activity can be used to justify an extension of the programme length.

1.4.1 Activities for fulfilment of outcomes for the education according to the Higher Education Ordinance (HF)

Below are described activities for the doctoral student's fulfilment of the learning outcomes for third-cycle education according to the Higher Education Ordinance (HF) and KTH's goals. The individual study plan specifies the activities for each individual doctoral student.

Below are *general suggestions* on how the goals can be achieved. Also note that more *suggestions* can be found in the appendix (taken from the KTH template) which can be found at the end of this document. Students are encouraged to use these in the annual updating of the eISP document.

Learning outcomes: Knowledge and understanding

For the Degree of Doctor the doctoral student shall:

- Demonstrate broad knowledge and a systematic understanding of the research field as well as advanced and up-to-date specialist knowledge in a limited area of this field.

This outcome can be achieved by the doctoral student continuously training and developing their ability to plan and carry out their own research; acquiring both broad and specialised knowledge from scientific literature relevant to the research domain; actively presenting their own research results in the form of scholarly publications, and at national and international conferences, seminars or workshops; being assessed in courses and participating in workshops and scientific seminars relevant to the subject and the research domain; satisfying the breadth requirement for the course component, which includes critical review of scientific literature; and writing and defending a doctoral thesis.

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

This outcome can be achieved by the doctoral student continuously training and developing this ability to identify and justify relevant issues and the choice of appropriate methods; being assessed on courses and participating in workshops and scientific seminars with a methodological focus relevant to the subject and the research domain; acquiring knowledge and thoroughly and critically reviewing scientific work in their own research domain; deploying different methodologies; and completing courses in, e.g., philosophy of science and research methodology.

For a 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 in particular.

This outcome can be achieved by the doctoral student continuously training and developing the ability to plan and carry out their own research; acquiring knowledge from scientific literature relevant to the research domain; actively presenting their own research results in the form of scholarly publications, and at national and international conferences, seminars or workshops; participating in courses relevant to the research domain; satisfying the breadth requirement for the course component, which includes critical review of scientific literature; and writing and defending a licentiate thesis.

Learning outcome: Competence and skills

For the Degree of Doctor the doctoral 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.

This outcome can be achieved by the doctoral student continuously training and developing their ability to independently interpret, analyse, discuss and compile research results; actively reflect on possible sources of error and alternative approaches to deal with complex issues; perform interdisciplinary activities and engage in interdisciplinary reasoning; independently evaluate reasons why experiments have not yielded expected results and, based on these insights, propose new ways to advance the research or issue; and test scientific hypotheses.

- 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.

This outcome can be achieved by the doctoral student continuously training and developing their ability to independently plan and carry out relevant studies and experiments with clear objectives in a timely and reliable way within time frames adequate for the task; formulating new scientific questions, hypotheses and approaches to be answered and tested based on existing literature as well as experience from and consideration of their own results; and compiling their own results and relating these to the published results of others.

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

This outcome can be achieved by the doctoral student: independently planning and carrying out experimental or theoretical studies on a sound and proven scientific basis and with scientific research methodology relevant to the research subject; analysing and critically reviewing his/her own results and compiling these in written form for publication in peer-reviewed international scientific journals or in manuscript or monograph form of sufficient quality that they can be considered published in peer-reviewed international scientific journals; summarising their own research results in a doctoral thesis where these are related to existing knowledge in the research domain; and defending and discussing the results in a meritorious manner at a public defence of their doctoral thesis.

- 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.

This outcome can be achieved by the doctoral student continuously training and developing their ability to take personal responsibility for writing scientific papers; to present their research results to both experts in the field and to a broader audience; to relate their own research results to the current state of knowledge in the research domain; to present their own research results with authority and in an instructive manner to other researchers and students at academic seminars; and to be assessed in courses where presentation and discussion of their own research results are included as compulsory elements.

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

This outcome can be achieved by the doctoral student continuously training and developing their ability to stay informed and updated about national and international developments in their research domains and neighbouring domains; reflect critically on how their own theoretical and methodological approaches relate to the overall knowledge base and frontier research and whether their own knowledge and methodology are adequate or require development; identify and formulate questions requiring investigation in order to further develop their own research project from a basic-or applied-research perspective, and which methods are suitable for that purpose; and develop the ability to adapt their own perceptions based on the acquisition of new knowledge.

- 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.

This outcome can be achieved by the doctoral student continuously training and developing their ability to identify issues that can benefit society at large; communicate their own research results in writing as well as presenting them to, and discussing them with, other researchers at academic seminars; collaborate with other researchers and interact with actors within and outside academia; teach and supervise students at first- and second-cycle level in a pedagogical way; and present their own research results to society at large, e.g., in industry journals, at meetings with industry actors, in popular-science journals or to primary and secondary school students.

For a Degree of Licentiate, the doctoral 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.

This outcome can be achieved by the doctoral student continuously training and developing their ability to independently plan and carry out limited research tasks with clear objectives and within time frames adequate for the task; formulating scientific questions, hypotheses and approaches to be answered and tested based on existing literature as well as experience from and consideration of their own results; and compiling their own results and relating these to the published results of others.

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

This outcome can be achieved by the doctoral student continuously training and developing their ability to take personal responsibility for writing scientific papers; to present their research results to researchers in the research domain; to relate their own research results to the current state of knowledge in the research domain and present their own research results pedagogically to other researchers and students at academic seminars; and to be assessed in courses where presentation and discussion of their own research results are included as compulsory elements.

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

This outcome can be achieved by the doctoral student continuously training and developing their ability to communicate their own research results in writing in the form of scientific publications and a licentiate thesis; pedagogically present to and discuss with other researchers within or outside academia; and discuss and critically review their own and others' research results within the framework of courses where this is included as a course objective.

Learning 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.

For the achievement of this outcome, assessment in the obligatory breadth-course, which includes an ethics component, is required. In addition, other courses with specific intended learning outcomes in ethics can contribute to further progression towards achievement of the outcome. Progression towards this outcome is also achieved by the doctoral student continuously training and developing their ability to independently formulate and critically review their own and others' research; carry out research tasks in an honest and ethical manner; make ethical assessments by reflecting on and dealing with any ethical dilemmas that may arise in their own research domain and in research in general; demonstrate intellectual integrity by critically justifying and defending their own positions based on experience and science.

- 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.

This outcome can be achieved by the doctoral student continuously training and developing their ability to reflect on both expected and unexpected results and to handle the results adequately; to reflect on the opportunities and limitations of their own research project, as well as on the opportunities and limitations of their own research in a broader social science perspective.

For a Degree of Licentiate, the doctoral student shall:

- Demonstrate the ability to make assessments of ethical aspects of his or her own research.

This outcome can be achieved by the doctoral student continuously training and developing their ability to: independently formulate and critically review their own research results; carry out research tasks in an honest and ethical manner; make ethical judgements by reflecting on and dealing with issues that may arise in their own research and its execution.

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

This outcome can be achieved by the doctoral student continuously training and developing their ability to reflect on both expected and unexpected results and to handle the results adequately; to reflect on the opportunities and limitations of their own research project, as well as on the opportunities and limitations of their own research in a broader social science perspective.

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

This outcome can be achieved by the postgraduate student continuously training and developing their ability to stay informed and updated about national and international developments in their research domains and neighbouring domains; reflect critically on how their own theoretical and methodological approaches relate to the overall knowledge base and frontier research and whether their own knowledge and methodology are adequate or require development; identify and formulate questions requiring investigation in order to further develop their own research project from a basic- or applied-research perspective, and which methods are suitable for that purpose; and develop the ability to adapt their own perceptions based on the acquisition of new knowledge.

KTH's outcome in sustainable development

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

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

For the achievement of this outcome, assessment in a course where sustainable development is discussed in relation to the subject and is included in an assessed intended course-learning outcomes is required. This outcome also includes assessment in a course with intended learning outcomes on gender equality, diversity and equal conditions. As further progression towards the outcome, the doctoral student should continuously train and develop their ability to explain how their own research, behaviour and approach considers the concept of sustainability; critically evaluate and reflect on how their own research can be conducted in a sustainable manner by taking into account its direct or indirect economic, social or environmental consequences and

impact on their immediate or remote surroundings; and, on their own initiative, acquire knowledge and reflect on sustainable development in a broader global perspective.

1.4.2 Compulsory courses

To promote the fulfilment of the qualitative targets, a compulsory course is included: FSH3900 *Physics, the PhD student and Society*, 9 credits. The course consists of five modules: Research ethics and the role of research in society, sustainability and DEI aspects in physics, critical review and evaluation, broad knowledge of physics, and presentation. The course supports progression towards the qualitative targets of the Higher Education Ordinance by providing broad as well as specialised knowledge within its own and the overall subject area, and provides skills in presentation and critical review of one's own and others' research results, research premises, academic authorship, peer review and publication strategies relevant to the research subject. The course is normally taken over a longer period of the doctoral programme in order to progress in terms of presentation of one’s own results and critical review of others' scientific manuscripts and published articles.

1.4.3 Recommended courses

Recommended courses include established courses in the third-cycle subject area with a relevant research focus, courses in research methodology, presentation techniques, scientific writing and communication, and literature studies. Examples of relevant courses can be found in the programme description and in Appendix 2.

1.4.4 Conditional elective courses

The subject area does not include any conditional elective courses.

1.4.5 Requirements for the degree

Degree of Doctor

A Degree of Doctor comprises 240 credits. At least 120 credits must consist of the doctoral thesis

Thesis

Quality requirements and possible other requirements for the thesis.

Theses can either be in the form of a compilation thesis or a monograph, as described below.

Compilation theses

Theses should be based on research results of such quality that they can be, or have been, published in peer-reviewed scientific journals. The scope should correspond to at least 4 articles.

If a compilation thesis is based solely on papers not yet published or accepted for publication in international peer-reviewed scientific journals, the thesis must be reviewed by two additional independent researchers with good knowledge of the research domain and by the director of third-cycle education, in addition to the supervisor and the mandatory advance reviewer.

Monograph thesis

A doctoral thesis can also be written as a monograph, which is a relatively comprehensive, coherent scientific publication. A monograph may include previous publications as appendices. Monographs must be of such scientific quality that all or most of their content can be considered suitable for publication in peer-reviewed scientific journals of high international quality. A monograph is written by the doctoral student and must cover a scientific work of four years less the time corresponding to the course component.

A monograph must be reviewed in advance by the principal supervisor, a formally appointed advance reviewer, two independent researchers with good knowledge of the research area, and the director of third-cycle education.

Courses

The doctoral student shall have completed courses of at least 60 credits, of which 45 credits must be at third-cycle level and no more than 10 credits can be at first-cycle level.

The course component shall include compulsory and conditionally optional courses to at least the extent specified in 1.4.2 and 1.4.4. Credit from previous courses and study programmes may be transfer to the third-cycle programme provided that they are not required for the third-cycle student to gain entry to the programme.

Degree of Licentiate

A Degree of Licentiate comprises at least 120 credits. At least 60 credits must consist of the academic paper.

Thesis

Quality requirements and possible other requirements for the licentiate thesis.

Compilation thesis

The thesis should be based on research results of such quality that they can be, or have been, published in peer-reviewed scientific journals. The scope should correspond to about 2 articles, but the number of articles may vary depending on the breadth, scientific height and dignity, and the contribution of the doctoral student to the paper in question.

According to KTH's guidelines for third-cycle education, a licentiate thesis must be reviewed by a formally appointed advance reviewer in addition to the principal supervisor.

In cases where a licentiate thesis is based solely on original work that has not yet been published, or accepted for publication, in international peer-reviewed scientific journals, the thesis shall, in addition to the supervisor and the mandatory advance reviewer, also be reviewed by an additional independent researcher with good knowledge of the research domain and the director of third-cycle education.

Monograph thesis

A licentiate thesis can also be written as a monograph, which is a relatively comprehensive coherent scientific publication. A monograph may include previous publications as appendices. Monographs should be avoided, and the decision to write such a thesis is made by the director of third-cycle education. If a monograph is considered suitable, its content must be of such a scientific level that the content as a whole, or most of it, can be considered to meet the requirements for publication in peer-reviewed scientific journals of good international quality.

A monograph thesis must be reviewed in advance by the principal supervisor, a formally appointed advance reviewer, another independent researcher with good knowledge of the research domain, and the director of third-cycle education.

Courses

The doctoral student shall have completed courses of at least 30 credits, of which 15 credits must be at third-cycle level and no more than 10 credits can be at first-cycle level

The course component shall include conditional elective courses to at least the extent specified in 1.4.4. Credit from previous courses and study programmes may be transferred to the third-cycle programme provided that they are not required for the third-cycle student to gain entry to the programme.

1.4.6 Other elements in the education to promote and ensure goal fulfilment

Monitoring of the individual study plan. It is mandatory for supervisors and doctoral students to jointly monitor the individual study plan regularly and at least once a year. The individual study plan shall be designed to ensure that the qualitative targets of the Higher Education Ordinance and KTH's outcomes can be fulfilled within the specified time. The general syllabus is to be used to support the design and monitoring of the individual study plan. Progression towards achievement of the outcomes and targets shall be evaluated by supervisors and doctoral students at the mandatory monitoring of the individual study plan. The doctoral student reflects on, exemplifies and justifies how completed and ongoing study activities have promoted progression since the last monitoring interval. Written justification of their progress should be provided in the appropriate section of the electronic individual study plan, preferably by the

doctoral student. All elements of the courses and study programmes - thesis work, courses, workshops, conferences, outreach activities etc. - should be taken into account.

The choice of optional courses and learning activities is agreed upon between the doctoral student and the supervisor. Planned courses and learning activities are entered into the individual study plan for the coming year at the annual monitoring meeting.

Scientific exchange and communication. Active participation in scientific exchange by presenting one's own research results at international conferences, major national conferences, workshops, summer schools or gatherings organised by companies. Active participation here means a scientific lecture, an oral research presentation in 'pitch' format, or poster-presentation to a scientific audience.

2 Admission to education at third-cycle level (qualification etc.)

Admission to education at third-cycle level is regulated in Chapter 7, Section 40 of the Higher Education Ordinance and in the admission regulations at KTH. KTH's regulations on specific prerequisites and such abilities in other respects as are needed to assimilate the education in the relevant subject at the doctoral level are set out below.

2.1 Specific prerequisites

To be admitted to third-cycle courses and study programmes in the subject of Applied Physics, the applicant must have earned at least 60 higher-education credits at no less than second-cycle level in the subject of Physics or other subjects deemed to be directly relevant to the specialisation in question. These requirements are also considered to be fulfilled by those who have acquired substantially equivalent knowledge through other means.

To be admitted to third-cycle courses and study programmes in the subject of Applied Physics, the applicant must have knowledge of English equivalent to English 6.

2.2 Assessment criteria for testing the ability to assimilate the education

The following assessment criteria apply for testing the ability to assimilate the education:

Selection for third-cycle education is based on assessed ability to assimilate such education. The ability assessment is primarily based on having passed courses and programmes that satisfy the entry requirements. Particular consideration is given to the following:

1. Knowledge and skills relevant for thesis work and the subject.
   These can be shown through attached documents and a possible interview
2. Assessed ability to work independently
    a. ability to formulate and tackle scientific problems
    b. ability to communicate well in speech and writing
    c. maturity, judgement and ability to analyse critically and independently

The assessment may be based, for example, on degree projects and discussion of these at a possible interview.

3. Other experience relevant for third-cycle education, e.g. professional experience. These can be demonstrated through attached documents and, potentially, an interview.

3 The other regulations needed

3.1 Transitional regulations

Third-cycle students admitted under a previous programme syllabus have the right to switch to the most recently adopted and valid general syllabus. Requests to change to a newer programme syllabus are made in writing to the director of third-cycle education. However, changing syllabi requires that the new syllabus can be achieved in time. If no change of syllabus occurs, the doctoral student follows the programme syllabus under which they have been admitted.

KTH Appendix: Goals for qualification and assessment criteria

Goals according to Appendix 2 of the Degree Ordinance to the Higher Education Ordinance, including requirements specified by KTH with examples of assessment criteria that can determine whether the doctoral student has achieved the goals. *The assessment criteria in the table are examples and developed as a support and inspiration for activity descriptions in part 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 outecome has been achieved through the doctoral student having **A1.1:** authored original scientific works where their own contributions are significant and identifiable. The works are of such quality that they have been published, or are expected to be published, in international scientific journals or conferences that apply peer review. **A1.2:** demonstrated both broad and specialised knowledge in the research area by writing a thesis in which the research results were placed and discussed in a broader perspective, and presented a reference list of others' research results that spans the relevant breadth of the research area. **A1.3:** demonstrated, at a seminar, a course or in the thesis or its public defence, 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 where their own results were presented and discussed, as well as asked questions and provided feedback on other students' and researchers' presentations.
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:** been examined with an approved result regarding intended learning outcomes in scientific methodology, which may be a course or equivalent learning element at 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 to the research area appropriate methods 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 issue 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 scholarly 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:** in cases where it is 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 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.	The goal 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:** in cases where it is 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. In cases where the result did not turn out as expected, the research student shall have reported on possible sources of error and what measures were taken to move forward in the project. **B2.3:** presented examples of and described and argued for the choice of methods for individual research tasks. **B2.4:** described how it was ensured that the education 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 his or her own research.	The goal has been achieved through the doctoral student having **B3.1:** authored original scientific works where their own contributions are significant and identifiable. The works are of such quality that they have been published, or are expected to be published, in international scientific journals or conferences that apply peer review. **B3.2:** authored a thesis, based on the scientific work, of good scientific and linguistic quality that was authoritatively defended and discussed in a public defence of the doctoral thesis and been examined with a pass 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 academic community and society in general.	The goal has been achieved through the doctoral student having **B4.1:** in cases where it is applicable, participated in national and international conferences and presented their own research results in poster form or verbally, as well as participated in scientific discussions with other researchers in the research field. **B4.2:** described how experience from conference or seminar presentations contributed to developing their own ability to

	communicate and defend scientific results, as well as how the presentations were received by other participants and whether valuable information could be obtained that helped their own studies progress. **B4.3:** been examined with a pass grade for intended learning outcomes in communication or presentation technology in a suitable compulsory or optional course at third-cycle level. **B4.4:** described basic concepts, tools and methods in presentation or communication technology, as well as demonstrated the ability to put the knowledge into practice by formulating different types of scientific presentation material of good quality. **B4.5:** presented their research results in a pedagogical way for other students and researchers at academic seminars, for a general audience or for another category of recipients, 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 of knowledge and exchange of knowledge with relevant stakeholder groups such as other universities, 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 third-cycle students themselves 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 research results in a pedagogical way for other students and researchers at academic seminars, for a general audience or for another category of recipients, 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 of knowledge and exchange of knowledge with relevant stakeholder groups such as other universities, companies, authorities, schools etc. **B6.3:** actively supervised other students in theoretical and / or practical projects. Third-cycle students should, with examples,

	account for and reflect on various aspects of their own input, for example how the supervision was structured, whether pedagogical methodology was applied, how it was ensured that the person who was supervised understood the instructions etc. Third-cycle students 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 examined with a pass grade for intended learning outcomes in teaching and learning in higher education in a suitable compulsory or optional course at third-cycle level. The third-cycle 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, as well as to analyse, evaluate and develop teaching and learning. Third-cycle student is thus also assumed to be able to show the ability to evaluate and analyse different methods and approaches in higher education and to show the ability to take a student perspective into account. **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 on the basis of 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 examined with a pass grade for intended learning outcomes in ethics in a suitable compulsory or optional course at third-cycle level. The research student is thus assumed to be able to describe basic 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	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 where their own research results can be used in both a positive and negative way. **C2.3:** demonstrated 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 into account the concept of sustainability. **C2.5:** been examined with a pass grade for intended learning outcomes in sustainable development in a suitable compulsory or optional course at third-cycle level. The research student is thus assumed to be able to describe basic 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 his or her artistic field as well as specialised knowledge of research methodology in general and the methods of the specific field of research in particular.. *Main differences in relation to the doctoral degree: For the licentiate degree, it is enough to be able to show "knowledge and understanding", as opposed to "broad and systematic understanding". Also, "deep up-to-date specialist knowledge" is replaced by "up-to-date specialist knowledge".*	The outcome has been achieved through the doctoral student having **A1.1:** authored original scientific works where their own contributions are significant and identifiable. The works are of such quality that they have been published, or are expected to be published, in international scientific journals or conferences that apply peer review. **A1.2:** demonstrated both broad and specialised knowledge in the research area by writing a licentiate thesis in which the research results were placed and discussed in a broader perspective, and presented a reference list of others' research results that spans the relevant breadth of the research area. **A1.3:** demonstrated, at a seminar, a course or in the licentiate thesis and its public defence, 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 where their own results were presented and discussed, as well as asked questions and provided feedback on other students' and researchers' presentations.
Competence and skills	
Intended learning outcomes	**Assessment criteria with reference to numbering in eISP**
Demonstrate the ability to identify and formulate issues with scholarly precision	The goal has been achieved through the doctoral student having

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 differences in relation to the doctoral degree: For the licentiate degree, it is emphasized that this is "limited research work" that will contribute to the development of knowledge, in contrast to the doctoral degree where one must be able to show the ability to "conduct research".*	**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 were tested within the framework of their own research project, as well as described the choice of method and outcome. In cases where the result did not turn out as expected, the research student shall have reported on possible sources of error and what measures were taken to move forward in the project. **B1.3:** presented examples of independently performed experiments / simulations / tasks that were preceded by detailed time planning. **B1.4:** presented examples of and described and argued for the choice of methods for individual experiments. **B1.5:** described how it was ensured that the education 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 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. *Main differences in relation to the doctoral degree: The licentiate degree requires the student to communicate their research "clearly", as opposed to communicating "with authority".*	The goal has been achieved through the doctoral student having **B2.1:** in cases where it is applicable, participated in national and international conferences and presented their own research results in poster form or verbally, as well as participated in scientific discussions with other researchers in the research field. **B2.2:** described how experience from conference or seminar presentations contributed to developing their own ability to communicate and defend scientific results, as well as how the presentations were received by other participants and whether valuable information could be obtained that helped their own studies progress. **B2.3:** been examined with a pass grade for intended learning outcomes in communication or presentation technology in a suitable compulsory or optional course at third-cycle level. **B2.4:** described basic concepts, tools and methods in presentation or communication technology, as well as demonstrated the ability to put the knowledge into practice by formulating different types of scientific presentation material of good quality. **B2.5:** presented their research results in a pedagogical way for other students and researchers at academic seminars, for a general audience or for another category of recipients, 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 of knowledge and exchange of knowledge with relevant stakeholder groups such as other universities, 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 differences in relation to the doctoral degree: The doctoral student's future contribution to society through research and*	The goal has been achieved through the doctoral student having **B3.1:** authored original scientific works where their own contributions are significant and identifiable. The works are of such quality that they have been published, or are expected to be published, in international scientific journals or conferences that apply peer review. **B3.2**: authored a licentiate thesis based on their own studies of good

education is toned down and the focus is on the doctoral student being able to work on activities that require skills in research work but not a doctoral degree.	scientific and linguistic quality that have been defended and discussed at a licentiate seminar and examined and given a pass 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 his or her own research. *Main differences in relation to the doctoral degree: The ability to make ethical research assessments is limited to their own research and not in general.*	The goal 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 on the basis of 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 examined with a pass grade for intended learning outcomes in ethics in a suitable compulsory or optional course at third-cycle level. The research student is thus assumed to be able to describe basic 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 differences in relation to the doctoral degree: For the licentiate degree, only "insight" is required, as opposed to "in-depth insight" for the doctoral degree.*	The goal 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 where their own research results can be used in both a positive and negative way. **C2.3:** demonstrated 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 into account the concept of sustainability.
Demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning. *Main differences in relation to the doctoral degree: The same requirement to be able to identify the need for additional knowledge with the addition of being able to take responsibility for their own knowledge*	**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 third-cycle students themselves 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

development, which may be considered to be implied for a doctoral degree.	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.