REGULATION	Valid from 13/12/2016	Reference number V-2021-0367, 3.2.3
Decision-maker President	Revised as of 19/10/2021	Entity responsible for supervision and questions School of Electrical Engineering and Computer Science (EECS)

General syllabus for education at third-cycle level in the subject computer science

This governing document has been decided by the President (V-2021-0686) pursuant to chapter 6 sections 26-27 of the Higher Education Ordinance. The governing document is valid with effect from 13/12/2016 and was last modified on 19/10/2021 (reference number V-2021-0367). The governing document regulates the main content of the education, requirements for special qualifications and the other regulations that are needed. The School of Electrical Engineering and Computer Science is responsible for review and questions about the governing document.

1 The content of the education

1.1 The name of the subject in Swedish and in English translation

Datalogi (Computer Science)

1.2 Subject description

In computer science, the question is what types of calculations is it possible to introduce in computer-based systems. The issue can be tackled at a basic level where one seeks general principles and fundamental boundaries for what is possible, but also based on a certain family of intended areas of application or with inspiration of how living organisms can be thought to function. One of the reasons for studying the area is to clarify the conditions for creating sustainable computer technology infrastructures in society. The application areas that are particularly relevant at KTH are biology, information systems, internet technology, robotics, vision systems and language technology.

Computer science is the methodology for the design of software and other representations of calculations. The subject has a practical and a theoretical side. The component areas of computer science include:

- analysis and development of fundamental computer science algorithms
- analysis and classification of calculation problems in terms of complexity
- artificial intelligence
- autonomous systems
- image processing and computer vision
- software design
- modelling and analysis of computer-based systems
- neural network modelling, neural calculations
- parallelisation
- software technology, programme semantics and programme languages
- security and integrity

- computational biology and biomodelling
- data security and cryptography
- didactics
- graphic data processing and human-machine communication
- high performance calculations
- applications in the field of data processing of mathematics and logic
- visualisation
- machine learning
- internet and grid technology

1.3 Specialisations

The education at third-cycle level in computer science has the following specialisations:

1. Theoretical Computer Science
2. Robotics, Perception, and Learning
3. Computational Biology
4. High-Performance Computing and Visualization
5. Network and Systems Engineering

These are described in more detail below.

Theoretical computer science

Theoretical computer science is the area that touches on the more abstract and mathematical aspects of computer science. Among other things, the area focuses on approximation, evidence complexity, SAT solution, cryptography, language technology, software security, programme logic and semantics, as well as programme testing and verification.

Great emphasis is placed on relevance in the industry, and there are several partnerships with companies. This is especially the case in the areas of software and platform security and learning-based software testing.

Robotics, perception, and learning

In the field of robotics, perception, and learning, we research areas such as robotic grasping, machine learning, robot arms, mobile robots, human-robot interaction, automatic recognition of objects and movements and analysis of data from sensors in the form of cameras, 3D cameras, laser scanners and tactile sensors (which detect touch). This is done in application areas such as self-driving cars, rescue robots, service robots, automatic analysis of video sequences, industrial assembly, underwater robots, 3D scanning and flying robots. The research is often carried out in close collaboration with industry and international academic partners.

Computational biology

In the field of computational biology, we work on developing mathematical models for analysing and understanding biological systems. In particular, research is conducted on computational processing of genetic data and understanding of evolution, computational modelling of the function of the biological brain and development of theories, algorithms and software for building computer systems that perform brain-like functions.

Focus areas are research on biological brain functions including sensory perception (sight, hearing, smell and pain), cognition (decision processes, memory and learning) and motor functions at different levels of biological detail modelling (molecular, cellular, network) and mathematical / functional description. Focus areas for our research on brain-like functions include methods for analysing sensory signals and brain activity data (eg fMRI, PET and EEG), learning for autonomous agents and development of computational architectures (software and hardware) for brain-like neural networks.

Collaborative projects are conducted with biologists to validate and refine our computational models and provide mechanistic explanations for biological phenomena. Doctors who have graduated with us go to both academia and industry and typically work on analysis and advanced calculations.

High-performance computing and visualization

This specialisation focuses on meeting today's and tomorrow's challenges in terms of efficient use of large-scale computing resources, efficient and varied analysis of massive amounts of data and method and model development that utilises the new possibilities provided by modern computing infrastructure and access to large amounts of data. The area has a number of challenges that require multidisciplinary approaches with expertise in parallel calculations, computational modelling, computer simulation, visualisation, data analysis and optimisation.

Network and systems engineering

The specialisation network and systems technology includes research that aims to contribute knowledge to develop efficient, robust and secure network-based and large-scale computer systems. The area includes methods for design, development and management of systems, methods for analysing security, personal integrity, robustness, reliability and performance in systems and also methods for project management and management of system technology. Computer systems for the operation of critical societal infrastructure, as well as computer and telecommunication systems are of particular interest. Important theories and methods used in the research are stochastic modelling, queue theory, game theory, optimisation, distributed systems, machine learning, software design, prototype development and experiments.

1.4 The structure of the education

Education at third-cycle level is regulated in the guideline on education at third-cycle level and the admission regulations at KTH

Teaching on courses at third-cycle level can be given in the form of lectures, seminars, literature courses and project assignments. The courses for each individual doctoral student are determined individually in consultation with the supervisor and are introduced into the doctoral student's individual study plan.

During their education, doctoral students must take part in and contribute to the scientific activity conducted at the school / KTH by attending seminars and normally giving one seminar per year about their thesis work. Doctoral students are recommended to devote a certain amount of time (maximum 20% of full-time) to first and second-cycle education or other departmental service. Such activities are to be included in the individual study plan. The activity is a basis for extending the study period.

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 learning outcome is achieved, for example, in that the doctoral student has participated in research seminars and has taken a number of courses in computer science that are inside and outside the field of specialisation.

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

This learning outcome is achieved through the compulsory course in scientific methodology FDD3001 and additional activities such as reading, discussing and presenting research articles in the field of research.

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 learning outcome is achieved, for example, by the doctoral student having taken the compulsory course in scientific methodology FDD3001 and a number of courses in computer science inside and outside the field of specialisation as well as additional activities, such as reading, discussing and presenting research articles in the field of research.

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 learning outcome is achieved through participation in research and in research seminars, including presenting results themselves, as well as reviewing others' research, for example through so-called peer review of results.

- 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 learning outcome is achieved by the supervisor gradually delegating to the doctoral student a growing part in the role of proposing questions and conducting research activities, and by participation in peer review.

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

The doctoral student writing a thesis achieves this learning outcome.

- 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 learning outcome is achieved, for example, by the doctoral student presenting their research at a number of international conferences and local seminars. Publication in specialist and popular science journals shall also be encouraged, especially during the latter part of the doctoral studies. The goal of written presentation of research is achieved through publication of peer-reviewed articles.

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

This learning outcome is achieved by the doctoral student independently reading the research literature needed to solve problems and relate solutions to previous research.

- 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 learning outcome is achieved by the doctoral student participating in some form of teaching, such as teaching assistant, laboratory assistant or degree project supervisor. If participation in GRU activities is made impossible by the form of funding (such as scholarships), guest lectures and degree project supervision shall be encouraged, as well as participation in activities to attract young people and minorities to technical education.

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 learning outcome is achieved by the supervisor gradually delegating to the doctoral student a growing part in the role of proposing questions and conducting research activities, and by participation in peer review.

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

This learning outcome is achieved, for example, by the doctoral student presenting their research at a number of international conferences and local seminars. Publication in specialist and popular science journals shall also be encouraged, especially during the latter part of the doctoral studies.

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

This learning outcome is achieved by the doctoral student contributing significantly to original scientific works that are published, or are expected to be published, in international scientific journals or conferences that apply peer review. The goal can also be achieved through a licentiate thesis based on the doctoral student's own studies of good 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.

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.

This learning outcome is achieved through the compulsory course in scientific methodology FDD3001, as well as through participation in peer review (see above). Issues related to ethical assessments are naturally inherent in many of the research projects in which doctoral students are involved. The goal is also achieved through participation in continuous discussions within their own research group and through a reflection in the thesis on ethical aspects of their own research project.

- 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 learning outcome is achieved through the compulsory course in scientific methodology FDD3001 and participation in continuous discussions within their own research group.

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 learning outcome is achieved by participating in continuous discussions with supervisors and within other research groups about their own research.

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

This learning outcome is achieved through the compulsory course in scientific methodology FDD3001 and participation in continuous discussions within their own research group.

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

This learning outcome is achieved by the doctoral student independently reading the research literature needed to solve problems and relate solutions to previous research.

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.

This learning outcome is achieved through the compulsory course in scientific methodology FDD3001 and sustainability courses such as FAK3127, as well as through participation in continuous discussions in their own research group and through a reflection in the thesis on sustainability aspects of their own research project.

1.4.2 Compulsory courses

The course component must include elements of scientific theory and research methodology corresponding to the course FDD3001 Research: Theory, Method, Practice.

1.4.3 Recommended courses

All doctoral students are recommended to take a basic course in communication and teaching of approximately 3 credits, such as FLH3000 Basic Communication and Teaching. Although this course is only compulsory for third-cycle students who participate in teaching at KTH, industrial doctoral students and third-cycle research students with a scholarship are also encouraged to take this or a similar course.

Courses are recommended in the various specialisations:

Theoretical computer science

Track Algorithms and Complexity:

- Complexity Theory (7.5 credits)
- Seminars on Theoretical Computer Science (7.5 credits)

Track Security, logic and semantics:

- Distributed Algorithms (6 credits)
- Program Semantics and Analysis (6 credits)

Robotics, perception, and learning

- System Integration for Robotics (7.5 credits)
- Machine Learning, Reading Group (6 credits)
- Computer Vision, Reading Group (6 credits)
- Topics in Computer Vision I (3 credits), II (6 credits), III (9 credits)
- Topics in Robotics I (3 credits), II (6 credits), III (9 credits)

Computational biology

- Artificial Neural Networks and Deep Architectures (7.5 credits)
- Computational Modeling in Current Neuroscience (3 credits)
- Deep Learning Methods for Biomedical Image Analysis (7.5 credits)
- Graduate Course in Mathematical Modeling of Biological Systems (9 credits)
- Brain-like Computing (7.5 credits)
- Neuroscience (7.5 credits)
- Systems Level Theories of Brain Function (3 credits)

High-performance computing and visualization

- Parallel Computing: Theory - Hardware - Software with Special Focus on Multi-Core Programming (7.5 credits)
- Introduction to Programming with GPGPU and Applications in Scientific Computing (7.5 credits)
- Introduction to High Performance Computing (7.5 credits)
- Recent Advances in Cloud Computing (5 credits)
- Information Visualization for Doctoral Students (7.5 credits)
- Interactive Entertainment Technologies (6 credits)
- Scientific Software Development Toolbox (5 credits)
- Advanced Computation in Fluid Mechanics (7.5 credits)
- High Performance Finite Element Modeling (7.5 credits)

Network and systems engineering

- Seminar on Advanced Topics in Communication Networks 1 (8.0 credits)
- Seminar on Advanced Topics in Communication Networks 2 (8.0 credits)

- Advanced Performance Analysis of Communication Networks (9.0 credits)
- Advanced Performance Analysis Project Course (3.0 credits)
- Fundamentals of Machine Learning Networks (10.0 credits)
- Game Theory (8.0 credits)
- Stochastic Models and the Theory of Queues (9.0 credits)
- Algorithms for Networks - Complexity and Approximations (8.0 credits)
- Advanced Ethical Hacking (8.0 credits)
- Conducting Systematic Literature Reviews in System Engineering (5.0 credits)
- Advanced Enterprise Modeling: Holistic Systems & Software Modeling (8.0 credits)

1.4.4 Conditional elective courses

Language courses shall be at university level (first or second cycle level) and should not exceed 6 credits.

1.4.5 Qualification requirements

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.

Work on the thesis should begin as soon as possible after the education at third-cycle level has started. The subject of the thesis shall be chosen in consultation with the Director of Third-Cycle Education and the principle supervisor, and should be linked to the research existing in the division.

The thesis shall contain new research results that the student has developed independently or in collaboration with others. The main scientific results shall meet the quality requirements for publication in internationally recognised peer-reviewed journals. The doctoral student's contribution to the texts with multiple authors included in the thesis shall be distinguishable.

The thesis shall normally be written in English. It can either be written as an compilation of scientific articles or as a monograph. In case of the former, there shall be a separately written summary. Regardless of whether the thesis is intended to be a monograph or a compilation thesis, the publication of achieved results in the form of peer-reviewed articles shall be sought during the doctoral student period. The requirements for the thesis are the same for all specialisations in computer science.

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.

Degree of Licentiate

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

Academic paper

Quality requirements and possible other requirements for the academic paper.

Work on the licentiate thesis should begin as soon as possible after the education at third-cycle level has started. The subject of the licentiate thesis shall be chosen in consultation with the Director of Third-Cycle Education and the principle supervisor, and should be linked to the research existing in the division.

The licentiate thesis shall contain new research results that the student has developed independently or in collaboration with others. The main scientific results shall meet the quality requirements for publication in internationally recognised peer-reviewed journals. The student's contribution to a licentiate thesis with texts that have multiple authors shall be distinguishable.

The licentiate thesis shall normally be written in English. It can either be written as an compilation of scientific articles or as a monograph. In case of the former, there shall be a separately written summary. Regardless of whether the licentiate thesis is intended to be a monograph or a compilation thesis, the publication of achieved results in the form of peer-reviewed articles shall be sought during the doctoral student period. The requirements for a licentiate thesis are the same for all specialisations in computer science.

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

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

It is recommended that doctoral students present interim seminars - at least three progress seminars including part-time seminars (50%).

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 the third-cycle education in Computer Science, the applicant must have passed courses resulting in at least 60 credits at minimum second-cycle level in Computer Science or other subjects deemed directly relevant to the chosen specialisation. These entry requirements can be also be considered fulfilled by an applicant who has acquired essentially equivalent knowledge in arrangement.

In order to be admitted to third-cycle education in Computer Science, 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 work samples, as well as through an 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 provisions

Doctoral students who have been admitted to a previous study plan have the right to follow either the new study plan or the study plan to which they have been admitted. Requests to follow previous study plans or requests to follow new study plans are made to the Director of Third-Cycle Education (FA). A change of general study plan, however, presupposes that the requirements for the new study plan can be achieved on time.

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.