*The Technical Faculty of IT and Design*
The Study Board for Electronics and IT

AALBORG UNIVERSITY
DENMARK

# Master of Science (MSc) in Engineering (Robotics)

Aalborg University
September 2019

Campus Aalborg

**Preface**

Pursuant to Act 261 of March 18, 2015 on Universities (the University Act) with subsequent changes, the following curriculum is established. The programme also follows the Joint Programme Regulations and the Examination Policies and Procedures for The Faculty of Engineering and Science, The Faculty of Medicine and The Technical Faculty of IT and Design.

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# Chapter 1: Legal Basis of the Curriculum, etc.

## 1.1 Basis in ministerial orders

The Master's programme is organised in accordance with the Ministry of Higher Education and Science's Order no. 1328 of November 15, 2016 on Bachelor's and Master's Programmes at Universities (the Ministerial Order of the Study Programmes) and Ministerial Order no. 1062 of June 30, 2016 on University Examinations (the Examination Order). Further reference is made to Ministerial Order no. 111 of January 30, 2017 (the Admission Order) and Ministerial Order no. 114 of February 3, 2015 (the Grading Scale Order) with subsequent changes.

## 1.2 Faculty affiliation

The Master's programme falls under *The Technical Faculty of IT and Design*, Aalborg University.

## 1.3 Board of Studies affiliation

The Master's programme falls under the Board of Studies for Electronic and IT

## 1.4 External Examiners Corps

The Master's programme is associated with the body of external examiners for engineering educations: electro (In Danish: censorkorps for Ingeniøruddannelsernes landsdækkende censorkorps; elektro).

## Chapter 2: Admission, Degree Designation, Programme Duration and Competence Profile

### 2.1 Admission

**Applicants with a legal right of admission (retskrav):**

Applicants with one of the following degrees are entitled to admission:

- Bachelor of Science in Robotics, Aalborg University

**Applicants without legal right of admission:**

Students with another Bachelor degree may, upon application to the Board of Studies, be admitted following a specific academic assessment if the applicant is considered as having comparable educational prerequisites. The University can stipulate requirements concerning conducting additional exams prior to the start of study.

### 2.2 Degree designation in Danish and English

The Master's programme entitles the graduate to the designation civilingeniør, cand.polyt. (candidatus/candidata polytechnices) i Robotteknologi. The English designation is: Master of Science (MSc) in Engineering (Robotics).

### 2.3 The programme's specification in ECTS credits

The Master's programme is a 2-year, research-based, full-time study programme. The programme is set to 120 ECTS credits.

### 2.4 Competence profile on the diploma

The following competence profile will appear on the diploma:

**A Candidatus graduate has the following competency profile:**

A Candidatus graduate has competencies that have been acquired via a course of study that has taken place in a research environment.

A Candidatus graduate is qualified for employment on the labour market on the basis of his or her academic discipline as well as for further research (PhD programmes). A Candidatus graduate has, compared to a Bachelor, developed his or her academic knowledge and independence so as to be able to apply scientific theory and method on an independent basis within both an academic and a professional context.

### 2.5 Competence profile of the programme:

<u>The graduate of the Master's programme:</u>

| | |
|---|---|
| Knowledge | • Has a comprehensive base of knowledge of scientific foundations and technological principles within robotics. |

- Has knowledge about mobile robots and human robot collaboration.
- Has knowledge of and can reflect upon the interaction between the various components of a robotic system and a broader systems-oriented context
- Has an understanding of the interaction between various engineering domains and other competencies in connection with solving specific engineering problems.

Skills

- Can utilize up-to-date scientific methodologies, theories and tools to analyse and solve complex problems in robotics
- Can evaluate theoretical and practical problems, as well as describe and select relevant solution strategies
- Is able to implement solution strategies and evaluate their success in a systematic manner
- Is able to communicate and discuss research-based knowledge, both orally and in writing, to specialists as well as non-specialists
- is familiar with and can seek out leading international research within his/her specialist area

Competencies

- Is able to handle technical problem solving at a high level and has the capacity to work with and manage all phases of a project
- Is able to develop and test robotics hardware and software and integrate them into a broader systems-oriented context
- Can work independently as well as in collaboration with others, both within and across technical fields, in an efficient and professional manner
- Is able to work independently and to identify his/her own learning needs and structure his/her own learning, academic development and specialization

## Chapter 3: Content and Organisation of the Programme

The programme is structured in modules and organised as a problem-based study. A module is a programme element or a group of programme elements, which aims to give students a set of professional skills within a fixed time frame specified in ECTS credits, and concluding with one or more examinations within specific exam periods. The examinations are defined in the curriculum.

The programme is based on a combination of academic, problem-oriented and interdisciplinary approaches and organised based on the following work and evaluation methods that combine skills and reflection:

- lectures
- classroom instruction
- project work
- workshops
- exercises (individually and in groups)
- teacher feedback
- reflection
- portfolio work

### 3.1 Overview of the programme

All modules are assessed through individual grading according to the 7-point scale *or* Pass/Fail. All modules are assessed by external examination (external grading) or internal examination (internal grading or assessment by the supervisor only).

| Semester | | P= Project module C= Course modules | Module | ECTS | Assessment | Exam |
|---|---|---|---|---|---|---|
| 1st | | | | | | |
| | | C | Robot navigation | 5 | Pass/Fail | Internal |
| | | C | Robot mobility | 5 | 7-point scale | Internal |
| | | C | Advanced robotic perception | 5 | 7-point scale | Internal |
| | | P | Advanced mobile robotics *) | 15 | 7-point scale | Internal |
| | | | | | | |
| 2nd | | | | | | |
| | | C | Object manipulation and task planning | 5 | Pass/Fail | Internal |
| | | C | Human robot interaction | 5 | 7-point scale | Internal |
| | | C | Human bionics | 5 | Pass/Fail | Internal |
| | | P | Collaborative robotics | 15 | 7-point scale | External |
| | | | | | | |
| 3rd | | | | | | |
| | Choose A or | C | Readings in robotics | 5 | Pass/Fail | Internal |
| | | C | Innovation and entrepreneurship | 5 | Pass/Fail | Internal |
| | | P | Contextual robotics | 20 | 7-point scale | Internal |
| | B or | C | Readings in robotics | 5 | Pass/Fail | Internal |
| | | C | Innovation and entrepreneurship | 5 | Pass/Fail | Internal |
| | | P | Entrepreneurial practice | 20 | Pass/Fail | Internal |
| | C or | P | Academic Internship | 30 | Pass/Fail | Internal |
| | D or | P/C | Study at another university | 30 | Transfer of credits | Transfer of credits |
| | E | C | Readings in robotics | 5 | Pass/Fail | Internal |
| | | C | Innovation and entrepreneurship | 5 | Pass/Fail | Internal |
| | | P | Long Master's Thesis[1] | +20 | 7-point scale | External |
| | | | | | | |
| 4th | | | | | | |
| | | P | Master's Thesis | 30, possible 50 | 7-point scale | External |
| SUM | | | | 120 | | |

*) A compulsory course in Problem Based Learning (PBL) is offered as an integrated part of the project module to non-AAU bachelors. If non-AAU students get credit transfer for the 1st Semester project module, then it has to be ensured that they get the PBL competences in others ways.

[1] The Long Master's Thesis is equivalent to 50 ECTS credits. If choosing to do a long master's thesis, it has to include experimental work and has to be approved by the study board. The amount of experimental work must reflect the allotted ECTS-credits.

**3.2 Descriptions of modules**

**1st Semester**

**Title:** **Avanceret mobilrobotik / advanced mobile robotics**

Objective: An important class of robots are mobile robots. A mobile robotic system needs sensing, decision making and propulsion. To this end, this project-module will teach the students how to analyse and implement these capabilities into a mobile robotic application.

Students who complete the module:

Knowledge

- Must have knowledge of terminology within mobile robotics
- Must have knowledge of different categories of mobile robotic systems
- Must be able to understand how a particular mobile robotic system e.g. the semester project of the student, relates to similar systems
- Must demonstrate knowledge of common strategies for sensing, guidance and control of mobile robotic systems

Skills

- Must be able to analyse a problem and suggest a solution that uses relevant theories and methods from mobile robotics
- Must be able to analyse a mobile robotic system and identify relevant constraints and assessment criteria
- Must be able to analyse and implement algorithms (e.g., sensing, path planning, localization, control etc.) of relevance to the chosen mobile robotic system
- Must be able to synthesize, i.e., design and implement, a system (or parts hereof) using relevant theories and methods from mobile robotics
- Must be able to evaluate a mobile robotic system (or parts hereof) with respect to specific assessment criteria

Competencies

- Must be able to communicate the above knowledge and skills both orally and in a written report
- Must be able to select relevant mobile robotic theories, methods, and tools, and synthesize them in a new context to produce new knowledge and solutions

Type of instruction: Project work

Examination format: Oral examination based on written documentation including: a scientific article, slides from the oral presentation at the student conference (SEMCON), a poster and edited worksheets.

Evaluation criteria: Are stated in the Joint Programme Regulations. It is a precondition for students, with a non-AAU bachelor's degree that they have passed the course in Problem Based Learning (PBL) at Aalborg University prior to the project examination.

**Problem Based Learning (PBL) at Aalborg University**

*Problembaseret læring på Aalborg Universitet*

**Prerequisites:**
None, but the course is compulsory for non-AAU bachelors.

**Learning outcomes:**
After completion of the course the student should

**Knowledge**

- know how to describe in own words some of the fundamental principles of Problem Based Learning (PBL) as implemented in the Aalborg PBL model at the Faculty of Engineering and Science.
- Know how to identify similarities and differences between the Aalborg PBL study environment and previous study environments, incl. strengths and weakness in both environments.

**Skills**

- be able to structure project management activities based on a well-formulated problem statement.
- be able to assess project documentation based on scientific codes of conduct.

**Competences**

- be able to plan for effective collaborative learning in an intercultural environment and manage group conflicts.
- be able to reflect on, plan and manage a study project in a PBL learning environment.

**Content:**
Lectures, discussions and group work.

**Assessment:**
Internal assessment during the course/class participation according to the rules in the Examination Policies and Procedures, Addendum to the Joint Programme Regulations of the Technical Faculty of IT and Design, Aalborg University. In this case the assessment is primarily based on the oral performance during the course. This means that the student has to be active during the course time and participate in discussions. The course is an integrated part of the project and a precondition for participation in the project examination for non-AAU bachelors
Consequently, no diploma will be issued for the course nor will it appear on the academic transcripts.

**Grading:**
Passed/Failed

**Assessment criteria:**
As stated in the Joint Programme Regulations.

**Title:** **Robot navigation / Robot navigation**

Objective: A mobile robotic system needs to be able to navigate in its environment. This course will teach the students how to self-localize using a combination of sensors, and plan paths and trajectories in order to avoid obstacles.

Students who complete the module:

Knowledge

- Must have knowledge of sensors for self-localization and obstacle avoidance
- Must have knowledge of map building, internal representations of maps and interpretation of maps
- Must be able to understand the principles of simultaneous localization and mapping

Skills

- Must be able to select appropriate sensors or combination of sensors for a specific robot task
- Must be able to combine noisy and imperfect sensor data into a robot pose estimate
- Must be able to implement algorithms for generating paths and/or trajectories towards specified goals
- Must be able to decompose mission objectives into subtasks using state-diagrams or similar and implement algorithms for executing tasks

Competencies

- Must be able to localize and plan a path or trajectory for a specific robot in a complex dynamic environment

Type of instruction: See the general description of the types of instruction described in the introduction to Chapter 3.

Examination format: Oral or written examination. Exam format is decided on by start of the semester.

Evaluation criteria: Are stated in the Joint Programme Regulations

**Title:** **Robot mobilitet / Robot mobility**

Objective: Mobile robots use their motors and sensors to move around. This course focuses on theories and methods relating to modelling, simulating and controlling mobile robotic systems.

Students who complete the module:

Knowledge

- Must have knowledge about mobile robot models, including holonomic and non-holonomic constraints
- Must have knowledge of different categories of mobile robots, such as unmanned aerial vehicles, autonomous boats, omnidirectional vehicles, car-like robots, powered wheelchairs etc.
- Must be able to understand principles of motion coordination between mobile robots
- Must have knowledge of common guidance and control strategies for mobile robots

Skills

- Must be able to build and simulate kinematic and dynamic models of mobile robots
- Must be able to follow generated paths or trajectories towards a goal
- Must be able to formulate multivariable control problems in the context of robot mobility

Competencies

- Must be able to model and simulate systems of mobile robots in an environment populated with obstacles
- Must be able to design control systems for mobile robots

Type of instruction: See the general description of the types of instruction described in the introduction to Chapter 3.

Examination format: Oral or written examination. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Joint Programme Regulations

**Title:** **Avanceret robot perception / Advanced robotic perception**

Objective: A robotic system needs an awareness of its context, i.e. objects and people in its vicinity. To this end, this course will teach the students how to use computer vision and pattern recognition methods to estimate the type of objects in the surroundings and the whereabouts of people nearby.

Students who complete the module:

Knowledge

- Must be able to explain the principles behind robust feature point algorithms
- Must have knowledge of feature selection and reduction methods
- Must have knowledge of motion analysis principles
- Must be able to understand tracking frameworks
- Must be able to understand how advanced perception is integrated into robotic systems (e.g visual servoing, obstacle avoidance)

Skills

- Must be able to apply sliding window approaches based on advanced features to detect objects
- Must be able to apply stereo vision to generate 3D data from two or more cameras
- Must be able to apply model-based approaches to estimate the 3D pose of objects and people
- Must be able to apply pattern recognition methods to classify object types and activities
- Must be able to integrate advanced perception into robotic systems

Competencies

- Must be able to analyse a specific problem within mobile robotics and based upon this select, implement and evaluate an appropriate computer vision approach

Type of instruction: See the general description of the types of instruction described in the introduction to Chapter 3.

Examination format: Oral or written examination. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Joint Programme Regulations

**2nd Semester**

**Title:** **Samarbejdende robotter / Collaborative robotics**

Objective: Collaborative robots, are robots that are designed to work with humans or together. The objective of this project is to provide students with core competencies within the field of collaborative robotics and hereby enabling them to analyse, design and implement robotic systems that interact and/or integrate with humans.

Students who complete the module:

Knowledge

- Must have knowledge about the terminology within collaborative robotics
- Must be able to understand how a particular collaborative robotic system e.g. the semester project of the student, relates to similar systems and, if relevant, to the human body and/or the surrounding society

Skills

- Must be able to analyse a problem and suggest a solution that uses relevant theories and methods from collaborative robotics
- Must be able to analyse a collaborative robotic system and identify relevant constraints and assessment criteria
- Must be able to synthesize, i.e., design and implement, a system (or parts hereof) using relevant theories and methods from collaborative robotics
- Must be able to evaluate a collaborative robotic system (or parts hereof) with respect to the aforementioned assessment criteria

Competencies

- Must be able to communicate the above knowledge and skills (using proper terminology) both orally and in a written report
- Must be able to select relevant collaborative robotic theories, methods, and tools, and synthesize them in a new context to produce new knowledge and solutions

Type of instruction: Project work

Examination format: Oral examination based on a written report

Evaluation criteria: Are stated in the Joint Programme Regulations

**Title:** **Objekt manipulation og task planlægning / Object manipulation and task planning**

Objective: A robotic system may manipulate objects in its environment in order to carry out a given task. This course will go into details with methods for modelling, planning and control of such tasks. This include robots collaborating. A special focus will be on force-torque and impedance control. The course will also present methods for automatic planning of sequences of elementary operations to enable the robot to achieve higher level task goals.

Students who complete the module:

Knowledge

- Must have knowledge of principles for decomposing robotic tasks into elementary operations
- Must have knowledge of methods for force-torque and impedance control
- Must have knowledge of methods for modelling of object manipulation activities for feedforward control
- Must have knowledge of principles for planning robotic tasks based on elementary operations
- Must have knowledge of task-driven automatic offline programming

Skills

- Must be able to design basic force-torque and impedance control systems
- Must be able to represent a task as a composition of elementary operations using formal methods
- Must be able to realize systems for automatic task planning

Competencies

- Must be able to model and control object manipulation activities
- Must be able to select relevant methods and tools for task decomposition and planning and synthesize them into a system for automatic task execution

Type of instruction: See the general description of the types of instruction described in the introduction to Chapter 3.

Examination format: Oral or written examination. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Joint Programme Regulations

**Title:** **Menneske-robot interaction / Human robot interaction**

Objective: The interaction between human and robot is critical for successful collaborative robotics. This course focuses on understanding the fundamentals of human perception, interaction behavior and how to apply this together with technology to successfully solve tasks in collaborative robotics.

Students who complete the module:

Knowledge

- Must be able to describe the human perceptual system
- Must be able to describe basic social communication aspects like proxemics, turn-taking, etc.
- Must be able to describe how the interaction between robot and human is influenced by design aspects such as the degree of autonomy, the design of social perception, embodiment, and input/output modalities
- Must have an overview over different types of human-robotic interfaces
- Must be able to describe potential safety issues in collaborative robotics

Skills

- Must be able to analyze collaborative situations and design and implement human-robot interaction based on this analysis
- Must be able to define success criteria for human robot interaction in a given context
- Must be able to evaluate systems of interacting robots and humans
- Must be able to perform usability studies

Competencies

- Must be able to demonstrate an understanding of and critically discuss the need to consider technical, personal, safety, ethical, and societal demands and requirements within the area human-robot interaction
- Must be able to select relevant human-robot-interaction theories, methods, and tools, and synthesize them into an appropriate solution for a given problem

Type of instruction: See the general description of the types of instruction described in the introduction to Chapter 3.

Examination format: Oral or written examination. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Joint Programme Regulations

**Title:** **Menneskelig bionics / Human bionics**

Objective: Controllable bio-mechanical devices added to or merge with the human body have the potential to enhance and enrich the everyday life of people. This course focuses on understanding how such systems can be designed, implemented and evaluated. The student will be equipped with knowledge and skills within bionics focusing on human assistive and rehabilitative robotics.

Students who complete the module:

Knowledge

- Must have knowledge about bionics and the human neural system
- Must have knowledge about human sensory motor control of movement
- Must have knowledge about invasive and non-invasive human-machine interfacing
- Must have knowledge about neural interfaces
- Must have knowledge of neural integration with external devices, e.g., prosthetics
- Must have an understanding of biologic robotic control
- Must have knowledge about robotic empowerment, e.g., exoskeleton systems, prostheses, assistive robots and their control

Skills

- Must be able to apply and understand human-robot interfacing methods and advanced biomechanics
- Must be able to to process biological signals for robotic control
- Must be able to close the control loop in systems within human bionics
- Must be able to apply biological signals in control of prostheses and assistive robotics

Competencies

- Must be able to select relevant theories, methods, and tools, to design new solutions

Type of instruction: See the general description of the types of instruction described in the introduction to Chapter 3.

Examination format: Oral or written examination. Exam format is decided on by start of semester.

Evaluation criteria: Are stated in the Joint Programme Regulations

**3rd Semester**

The student can select one of five options within this semester, each with a different focus (A-E). Each option has different learning objectives that are described below.

The options are:
A: Contextual Robotics (20 ECTS project + 2x5 ECTS courses)
B: Entrepreneurial practice (20 ECTS project + 2x5 ECTS courses)
C: Academic Internship (30 ECTS)
D: Study at another university (30 ECTS)
E: Long Master's Thesis (20 ECTS project + 2x5 ECTS courses)

**Title:** **Kontekstuelle robotter / Contextual robotics**

Objective: An advanced robotic system will always be integrated into a particular context. The focus of this semester is to expose the students to different contexts and hereby encourage a more holistic mindset. This project will teach the student to select relevant state-of-the-art methods from the field of contextual robotics and synthesize them in a new context to produce new knowledge and solutions.

Students who complete the module:

Knowledge

- Must have knowledge about the terminology within contextual robotics
- Must be able to understand the notion of innovation and how it relates to contextual robotics

Skills

- Must have a solid overview over research within selected subfields of contextual robotics and be able to critically analyze the subfield
- Must be able to analyze a problem and (if possible) suggest a solution that uses relevant theories and methods from contextual robotics
- Must be able to analyze a contextual robotic system and identify relevant constraints and assessment criteria
- Must be able to evaluate a contextual robotic system (or parts hereof) with respect to the aforementioned assessment criteria

Competencies

- Must be able to communicate the above knowledge and skills (using proper terminology) both orally and in a written report
- Must be able to select relevant state-of-the-art methods from the field of contextual robotics and synthesize them in a new context to produce new knowledge and solutions

Type of instruction: Project work

Examination format: Oral examination based on a written report

Evaluation criteria: Are stated in the Joint Programme Regulations

**Title:** **Praktisk entreprenørskab / Entrepreneurial practice**

Objective: This project will teach students to develop entrepreneurial practice and develop conceptual solution by combining innovation and/or entrepreneurship theories with empirical insight.

Students who complete the module:

Knowledge

- Must have knowledge of processes, methods, tools, and associated resources needed for people and companies to become and stay innovative with an emphasis on incubation processes
- Must apply specific tools and methods for supporting entrepreneurial processes
- Must apply theories of creative methodologies and creative mind-set

Skills

- Must be able to use sound research methods to identify and analyse a need or problem using various theoretical perspectives related to a business development processes with an emphasis on incubation processes
- Must be able to experiment with possible conceptual solutions or development in order to develop new business
- Must be able to facilitate creative processes and excel in communication of a business idea

Competencies

- Must be able to approach the field of robotics using scientifically sound methods and informed by experiment with conceptual solutions in relation to market/users, technology, organization, and resource
- Must be able to contribute to creative further development of a conceptual solution by combining innovation and/or entrepreneurship theories with empirical insight
- Must be able to critically evaluate own analysis and solutions
- Must be able to develop and evaluate a business case

Type of instruction: Project work

Examination format: Oral examination based on a written report

Evaluation criteria: Are stated in the Joint Programme Regulations

**Title:** **Projektorienteret forløb i en virksomhed / Academic internship**

Prerequisites for entering the module:

An academic internship agreement approved by the company, an AAU supervisor and the Study Board for Electronics and IT (ESN). The academic internship must have a scope that matches the stipulated ECTS load.

Students who complete the module:

Knowledge

- Has knowledge about the organization of the company and business procedures and policies
- Has knowledge about performance measures in the company
- Has developed a fundamental business sense
- Has knowledge of the competence profile of the program and how the academic internship contributes to the competence profile
- Has gained deepened knowledge into engineering theories and methods within the programme

Skills

- Can initiate and ensure the completion of an agreement for the academic internship, with learning objectives corresponding to the semester at the master's program
- Can apply analytic, methodological and/or theoretic skills to address advanced engineering problems in an industrial context
- Can contribute in a professional manner to company objectives as an individual and in teams in accordance with the project management model applied in the company
- Can collaborate and communicate with peers, managers and others
- Can document the academic internship in a report and defend it orally

Competencies

- Can discuss and reflect upon the learning outcomes of the academic internship.
- Can discuss the need for knowledge transfer between academia and industry.
- Has a deepened understanding of the academic interests to pursue in the master's thesis and possible job positions to aim at after graduation.

Type of instruction: Project work

Examination format: Oral examination based on a written report

Evaluation criteria: Are stated in the Joint Programme Regulations

**Title:** **Readings in robotics / Readings in robotics**

Objective: The goal of this course is to provide the foundations necessary to perform research within the field of robotics. The course takes a practical approach and focuses on the craftsmanship needed as a scientist. Students explore state of the art theories and techniques in a formalized manner by analyzing a selection of research texts fundamental to robotics through, e.g., paper presentation, reproduction of experiments, etc.

Students who complete the module:

Knowledge

- Must have knowledge about how to perform a state-of-art analysis
- Must have knowledge about the current research agenda within robotics

Skills

- Must be able to analyze specific research topics within robotics
- Must be able to perform critical annotation of relevant robotic literature
- Must be able to define taxonomies for relevant robotic literature

Competencies

- Must be able to critically evaluate a robotic system in relation to state-of-the-art robotic research

Type of instruction: See the general description of the types of instruction described in the introduction to Chapter 3.

Examination format: Class participation, min 90%.

Evaluation criteria: Are stated in the Joint Programme Regulations

**Title:** **Innovation og Entreprenørskab / Innovation and entrepreneurship**

Objective: Robotics is a subject area characterized by a high level of innovation and entrepreneurship. This course will teach students the basics of innovation-based entrepreneurial processes, business modelling, and enable them to make a business case for a start-up.

Students who complete the module:

Knowledge

- Must have knowledge of innovation-based entrepreneurial processes, including theories, methods and tools related to the generic innovation sub-processes discovery, incubation and acceleration.
- Must have knowledge of the concept of problem (re)framing and the prototyping process for developing a product/service/business concept
- Must have knowledge about business modeling, intellectual property and startups
- Must have knowledge of the role and impact of corporate entrepreneurship/(radical) innovation in organisations

Skills

- Must be able to make use of the theories and methods in entrepreneurial cases/project
- Must be able to collect, use and transform data on user/customer behavior in framing, specification and prototyping.
- Must be able to evaluate theoretic and practical needs for the development of a business/business area
- Must be able to make a business case for a new business area/startup

Competencies

- Must be able to select and use various relevant theoretical perspectives,
- methods and tools in relation to the planning and engaging in entrepreneurial business development processes
- Must be able to plan and execute a prototyping process that involves users, customers and other relevant stakeholders
- Must be able to contribute constructively and professionally in multidisciplinary innovation/entrepreneurship ventures
- Must able to evaluate the business case, including funding issues.
- Critically evaluate own analysis and solutions

Type of instruction: Teaching is organized as a series of lectures supplied with mini projects

Examination format: Oral exam based on submitted written mini project

Evaluation criteria: Are stated in the Joint Programme Regulations

**4th semester**

**Title:** **Kandidatspeciale / Master thesis**

The master thesis can be conducted as a long master thesis. If choosing to do a long master thesis, it has to include experimental work and has to be approved by the study board. The amount of experimental work must reflect the allotted ECTS.

Prerequisites for entering the module:

Passed semester 1-3.

Objective:

Knowledge

- Have knowledge, at the highest international level of research, of at least one of the core fields of the education
- Have comprehension of implications of research (research ethics).

Skills

- Can reflect upon the scientific basis on their knowledge.
- Can argue for the relevance of the chosen problem to the education, including giving a specific account for the core of the problem and the technical context in which it appears
- Can account for possible methods with which to solve the formulated problem of the project, describe and assess the applicability of the chosen method(s), and account for any delimitations made and the way these will influence on the results of the product
- Can analyse and describe the chosen problem applying relevant theories, methods and experimental data
- Can describe the relevant theories and methods in a way that highlights the characteristics and hereby document knowledge of the applied theories, methods, possibilities and delimitations within the relevant problem area
- Can analyse and assess experimental data, including the effect the assessment method has on the validity of the results.

Competencies

- Can communicate scientific problems in writing and orally to specialist and non-specialist
- Can dissect and manage situations that are complex, unpredictable and which require new solutions
- Can independently initiate and perform collaboration within the discipline and interdisciplinary as well, and is able to take professional responsibility
- Can independently take responsibility for his or her own professional development and specialization

Type of instruction: Project work individual or in groups of 2-3 persons

Examination format: Oral examination based on a written report

Evaluation criteria: Are stated in the Joint Programme Regulations

## Chapter 4: Entry into Force, Interim Provisions and Revision

The curriculum is approved by the dean and enters into force as of X19.

Students who wish to complete their studies under the previous curriculum from x20 must conclude their education by the x21 at the latest, since examinations under the previous curriculum are not offered after this time.

## Chapter 5: Other Provisions

### 5.1 Rules concerning written work, including the Master's Thesis

In the assessment of all written work, regardless of the language it is written in, weight is given to the student's formulation and spelling ability, in addition to the academic content. Orthographic and grammatical correctness as well as stylistic proficiency are taken as a basis for the evaluation of language performance. Language performance must always be included as an independent dimension of the total evaluation. However, no examination can be assessed as 'Pass' on the basis of good language performance alone; similarly, an examination normally cannot be assessed as 'Fail' on the basis of poor language performance alone.

The Board of Studies can grant exemption from this in special cases (e.g., dyslexia or a native language other than Danish).

The Master's Thesis must include an English summary.[2] If the project is written in English, the summary must be in Danish.[3] The summary must be at least 1 page and not more than 2 pages (this is not included in any fixed minimum and maximum number of pages per student). The summary is included in the evaluation of the project as a whole.

### 5.2 Rules concerning credit transfer (*merit*), including the possibility for choice of modules that are part of another programme at a university in Denmark or abroad

The Board of Studies can approve successfully completed (passed) programme elements from other Master's programmes in lieu of programme elements in this programme (credit transfer). The Board of Studies can also approve successfully completed (passed) programme elements from another Danish programme or a programme outside of Denmark at the same level in lieu of programme elements within this curriculum. Decisions on credit transfer are made by the Board of Studies based on an academic assessment. See the Joint Programme Regulations for the rules on credit transfer.

### 5.3 Rules for examinations

The rules for examinations are stated in the Examination Policies and Procedures published by X22 on their website.

[2] Or another foreign language (French, Spanish or German) upon approval by the Board of Studies.
[3] The Board of Studies can grant exemption from this.

**5.4 Exemption**

In exceptional circumstances, the Board of Studies study can grant exemption from those parts of the curriculum that are not stipulated by law or ministerial order. Exemption regarding an examination applies to the immediate examination.

**5.5 Rules and requirements for the reading of texts**

It is assumed that the student can read academic texts in his or her native language as well as in English and use reference works etc. in other European languages. X23

**5.6 Additional information**

The current version of the curriculum is published on the Board of Studies' website along with more detailed information about the programme, including exams.