PENDING APPROVAL

Curriculum for the Master's Programme in

Innovative Communication Technologies
and Entrepreneurship

(ICTE)

Version 13
20 March 2014

The Faculties of Engineering, Science and Medicine
Aalborg University
2014
Preface

Pursuant to Act 367 of May 22, 2013 on Universities (the University Act) with subsequent changes, the following curriculum for the Master's program in Innovative Communication Technologies and Entrepreneurship is stipulated. The program also follows the Framework Provisions and the Examination Policies and Procedures for the Faculties of Engineering, Science and Medicine.

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Chapter 1: Legal Basis of the Curriculum, etc.

1.1 Basis in ministerial orders
The Master’s programme in Innovative Communication Technologies and Entrepreneurship is organised in accordance with the Ministry of Science, Innovation and Higher Education’s Order no. 814 of June 29, 2010 on Bachelor’s and Master’s Programs at Universities (the Ministerial Order of the Study Programs) and Ministerial Order no. 666 of June 24, 2012 on University Examinations (the Examination Order) with subsequent changes. Further reference is made to Ministerial Order no. 241 of March 15, 2013 (the Admission Order) and Ministerial Order no. 250 of March 15, 2007 (the Grading Scale Order) with subsequent changes.

1.2 Faculty affiliation
The Master’s programme falls under the Faculty of Engineering and Science, Aalborg University (AAU).

1.3 Board of Studies affiliation
The Master’s programme falls under the Board of Studies for Electronics and Information Technology.

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

2.1 Admission
Admission to the Master’s programme in IT, Communication and Entrepreneurship requires a Bachelor’s degree in
- IT, Communication and New Media (AAU)
- Medialogy (AAU)
- Electronics and IT (AAU)
- Internet Technologies and Computer Systems (AAU)
- Software Technology (DTU)
- IT & Communication Technology (DTU)
- Internet Technology & Economy (DTU) (BEng (diplom) degree)
- IT (DTU) (BEng (diplom) degree)
- IT & Communication (DTU, formerly IHK) (BEng (diplom) degree)
- Computer Science

or the like.

Students with another Bachelor’s degree, upon application to the Board of Studies, will be admitted after a specific academic assessment, if the applicant is deemed to have 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 innovativ kommunikationsteknik og entrepreneurskab

The English designation is:
- Master of Science (MSc) in Engineering (Innovative Communication Technologies and Entrepreneurship)
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
The programme includes three specialisations (tracks):
- Service development (SD)
- Business development (BD)
- Telecom infrastructures (TI)

Depending on the chosen specialization, the graduate of the Master’s programme:

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>SD</th>
<th>BD</th>
<th>TI</th>
</tr>
</thead>
<tbody>
<tr>
<td>has knowledge on information and communication technologies (ICT) that, in selected areas, is based on the highest international research</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>has in-depth knowledge and understanding of issues within one of the areas: service development; business development; or cognitive radio</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>can understand the importance of innovation, creativity and entrepreneurship for ICT solutions and services</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>can identify scientific problems within the field of ICT</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>has a holistic understanding of the environment of ICT services and solutions: Scenarios of use, target users, stakeholders, business aspects, state-of-the-art technologies, etc.</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>can understand and, on a scientific basis, reflect on the technical, organizational and market-related drivers in the convergence of ICT as well as the interplay between technology, market and user issues</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>can understand the relevance of the needs of the end users, their use of ICT, and the mechanisms that influence the user experience and the acceptance of new technologies</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>has knowledge on the significance of standardization from a commercialization and market perspective</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>has knowledge on the significance of standardization and IPR including patents from a commercialization and market perspective</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skills</th>
<th>SD</th>
<th>BD</th>
<th>TI</th>
</tr>
</thead>
<tbody>
<tr>
<td>excels in scientific methods, tools and general skills related to employment within the field of ICT</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>can evaluate and select among scientific theories, methods, tools and general skills and, on a scientific basis, advance new analyses</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
and solutions within applied ICT

<table>
<thead>
<tr>
<th>Competencies</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>can communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>excels in scientific writing: Articles, reports, documentation, etc.</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>can identify and select among relevant standards, technologies and methods for development of ICT solutions and services</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>can assess and compare different technologies for optimal technology selection, strategic decisions and business development</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>can assess the market, ethical and regulatory framework for application of the technologies.</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>can develop innovative services, applications and solutions at a conceptual level, which are relevant in a user perspective.</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>develop prototypes or demonstrators of viable ICT solutions and services, based on in-depth analysis of user requirements, technology and market issues, using state-of-the-art methods, technologies and tools, and addressing privacy protection and identity management</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>assess the implications and business potential of new ICT solutions and services and develop viable business models and strategies</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>identify IPRs within an application area or technology and utilize this from a market point of view as well as to assess the possible IPRs for the developed solution</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>develop technical viable solutions based on cognitive radio to address sensing, flexible usage and management of spectrum as well as routing, security and regulatory aspects</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>can manage work and development situations that are complex, unpredictable and require new solutions.</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>can independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility.</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>can independently take responsibility for own professional development and specialization</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>has competencies in project work and problem based learning in a global/multicultural environment</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>has competencies in innovation and entrepreneurship that can be used to explore and exploit the potential of new ICT and media technologies with an engineering approach</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>has competencies in business development with a holistic perspective, based on a thorough understanding of the interplay between technology, market and users in ICT and media</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>can contribute creatively and innovatively to identify and propose new business opportunities and develop services/solutions, which can empower the users and assist them in solving their current and future tasks on a daily basis</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>can mediate collaboration and exchange between development- and business-related functions in organizations.</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 3: Content and Organization of the Programme

The programme is structured in modules and organized 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. Examinations are defined in the curriculum.

The programme is based on a combination of academic, problem-oriented and interdisciplinary approaches and organized 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

Problem-based learning and scientific methods

In order to ensure a common basis for all students, the first semester project includes a mandatory part on project-organized problem-based learning (POPBL) and scientific methods.

IMPORTANT: The sub-module “POPBL and scientific methods” is a mandatory part of the semester project for all students on their 1st semester. These students MUST complete and pass a partial exam in this sub-module before taking the final exam in the semester project. In total, the semester project accounts for 15 ECTS.

Overview of the programme

The programme includes three specialisations (tracks):

- Service development
- Business development
- Telecom infrastructures

The first 2 specializations are offered at AAU Copenhagen, and the third specialization is offered at AAU Aalborg.

The two locations have separate intakes¹, but the educations are closely coordinated. There is a common semester theme on “Services and platforms” for the first fall semester, and one course is offered jointly for students at the two locations. The remaining courses and the semester structures are different.

In Copenhagen, students must choose one of the two tracks and depending on the track different sets of courses are mandatory and elective on the other semesters. This gives students some degree of freedom in composing their studies, even though they are obliged to choose one of the tracks. Semester projects and themes will also depend on the chosen track.

For clarity and easy reading, the following description is divided into two separate parts for Copenhagen and Aalborg, respectively.

The programme has two yearly intakes, September and February. Students admitted in February follow a modified semester structure as explained below.

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 by assessment by the supervisor only).

An overview of the ECTS credit breakdown for the various semesters by modules is shown in the tables below. The first part describes the curriculum for students admitted on the September intake, and after that the modified curriculum for students admitted on the February intake is presented.

Elective courses may generally be chosen from the programme as specified in the tables below, or from other related MSc programmes within the School of ICT, after consultation with the programme coordinator and approval from the Board of Studies.

Depending on student demand and staff availability, not all specializations or elective courses may be offered in a given semester.
A: September intake

The semester structure is shown in Table 1. The first semester consists of mandatory courses only. For semesters 2-4 students must choose one of the 2 specializations:

- Service development
- Business development

containing a mix of mandatory and elective courses.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Module</th>
<th>Service development</th>
<th>Business development</th>
<th>ECTS</th>
<th>Assessment</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Communication and broadcast networks</td>
<td>Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Entrepreneurship, innovation and business models</td>
<td>Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internet technologies and service architectures</td>
<td>Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Services and platforms</td>
<td>Mandatory</td>
<td>15</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>Development of ICT and media services</td>
<td>Mandatory Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identity and access management</td>
<td>Mandatory Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green ICT – Sustainable business development</td>
<td>Elective Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Managerial economics</td>
<td>Elective Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interaction design</td>
<td>Elective Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Application development</td>
<td>Mandatory</td>
<td>15</td>
<td>7-point scale</td>
<td>External</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design and markets</td>
<td>Mandatory</td>
<td>15</td>
<td>7-point scale</td>
<td>External</td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>Content and media management</td>
<td>Mandatory Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internet economics and governance</td>
<td>Elective Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standardization</td>
<td>Elective Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cyber security and trust</td>
<td>Elective Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smart sensor data processing</td>
<td>Elective Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advanced ICT solutions</td>
<td>Mandatory</td>
<td>15</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Governance and strategies</td>
<td>Mandatory</td>
<td>15</td>
<td>7-point scale</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>4th</td>
<td>Master’s thesis</td>
<td>Mandatory</td>
<td>Mandatory</td>
<td>30-55</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Complete semester structure (September intake).

2 Students on the business development track MUST choose one of these 2 courses.
Students may choose between different options for the 3rd and 4th semester:

<table>
<thead>
<tr>
<th>3rd semester</th>
<th>4th semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1 A regular semester with 3 courses and a 15 ECTS semester project</td>
<td>30 ECTS thesis project</td>
</tr>
<tr>
<td>Option 2 Academic internship in Denmark or abroad (25 ECTS)</td>
<td>30 ECTS thesis project</td>
</tr>
<tr>
<td>The 5 ECTS mandatory course must still be completed.</td>
<td></td>
</tr>
<tr>
<td>Option 3 Study abroad (30 ECTS)</td>
<td>30 ECTS thesis project</td>
</tr>
<tr>
<td>The 5 ECTS mandatory course may be waived.</td>
<td></td>
</tr>
<tr>
<td>Option 4 A long thesis project of 35, 40, 45, 50, 55 or 60 ECTS, extending</td>
<td></td>
</tr>
<tr>
<td>over 2 semesters, if necessary supplemented by courses on the 3rd semester.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Options for 3rd and 4th semester of the programme (September intake).

Different sizes of semester or thesis projects share the same learning objectives, but if the number of ECTS exceeds the default size (15 or 30 ECTS, respectively), the increased workload must be clearly reflected in the report, e.g. in terms of the difficulty, the scientific level, the obtained results, and the number of pages.

For thesis projects of more than 35 ECTS the student must supplement the thesis learning objectives according to the additional credits. The modified description must be approved by the programme coordinator and the Board of Studies.

The curriculum contains the following number of elective courses:

1. 1st semester: No elective courses
2. 2nd semester: 1 course, 5 ECTS
3. 3rd semester: 2 courses, 10 ECTS

B: February intake

The semester structure is shown in Table 3. Students must choose one of the two specializations:

- Service development
- Business development

already from the 1st semester.
<table>
<thead>
<tr>
<th>Semester</th>
<th>Module</th>
<th>Service development</th>
<th>Business development</th>
<th>ECTS</th>
<th>Assessment</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>Development of ICT and media services</td>
<td>Mandatory</td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Identity and access management</td>
<td>Mandatory</td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Green ICT – Sustainable business development</td>
<td>Elective</td>
<td>Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Managerial economics</td>
<td>Elective</td>
<td>Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Interaction design</td>
<td>Elective</td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Application development</td>
<td>Mandatory</td>
<td></td>
<td>15</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td>Design and markets</td>
<td></td>
<td></td>
<td>15</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>Communication and broadcast networks</td>
<td>Mandatory</td>
<td></td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Entrepreneurship, innovation and business models</td>
<td>Mandatory</td>
<td></td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Internet technologies and service architectures</td>
<td>Mandatory</td>
<td></td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Content and media management</td>
<td>Mandatory</td>
<td></td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Internet economics and governance</td>
<td>Mandatory&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Standardization</td>
<td>Mandatory&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Services and platforms</td>
<td>Mandatory</td>
<td></td>
<td>15</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>Identity and access management</td>
<td></td>
<td>Elective&lt;sup&gt;4&lt;/sup&gt;</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Development of ICT and media services</td>
<td></td>
<td>Elective&lt;sup&gt;4&lt;/sup&gt;</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Green ICT – Sustainable business development</td>
<td>Elective&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Managerial economics</td>
<td>Elective&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Interaction design</td>
<td>Elective&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Elective&lt;sup&gt;4&lt;/sup&gt;</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Advanced ICT solutions</td>
<td>Mandatory</td>
<td></td>
<td>15-25</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Governance and strategies</td>
<td>Mandatory</td>
<td></td>
<td>15-25</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Content and media management</td>
<td></td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Internet economics and governance</td>
<td>Elective</td>
<td>Elective&lt;sup&gt;5&lt;/sup&gt;</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Standardization</td>
<td>Elective</td>
<td>Elective&lt;sup&gt;5&lt;/sup&gt;</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Cyber security and trust</td>
<td>Elective</td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Smart sensor data processing</td>
<td>Elective</td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Master’s thesis</td>
<td>Mandatory</td>
<td>Mandatory</td>
<td>30-55</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>120</td>
<td></td>
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</tr>
</tbody>
</table>

Table 3. Complete semester structure (February intake).

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<sup>3</sup> Students on the business development track MUST choose one of these 2 courses.

<sup>4</sup> If not already chosen on the 1st semester.

<sup>5</sup> If not already taken on the 2nd semester.
Students may choose between different options for the 3\textsuperscript{rd} and 4\textsuperscript{th} semester:

<table>
<thead>
<tr>
<th>Option</th>
<th>3\textsuperscript{rd} semester</th>
<th>4\textsuperscript{th} semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>15, 20 or 25 ECTS semester project, supplemented by courses as specified in Table 2B below.</td>
<td>30 ECTS thesis project</td>
</tr>
<tr>
<td>Option 2</td>
<td>Academic internship in Denmark or abroad (25 ECTS)</td>
<td>30 ECTS thesis project</td>
</tr>
<tr>
<td>Option 3</td>
<td>Study abroad (25 ECTS)</td>
<td>30 ECTS thesis project</td>
</tr>
<tr>
<td>Option 4</td>
<td>A long thesis project of 30, 35, 40, 45, 50, 55 or 60 ECTS, extending over 2 semesters, if necessary supplemented by elective courses on both 3\textsuperscript{rd} and 4\textsuperscript{th} semester. At least 20 ECTS of the thesis project must be placed in the 4\textsuperscript{th} semester.</td>
<td>30 ECTS thesis project</td>
</tr>
</tbody>
</table>

Table 4. Options for 3\textsuperscript{rd} and 4\textsuperscript{th} semester of the programme (February intake).

All mandatory courses will be completed in semester 1 and 2, leading to a higher workload of 35 ECTS in semester 2 and a reduced workload of 25 ECTS in semester 3.

NOTE: If students wish to make room for elective courses in semester 4, they must start on their thesis project in semester 3, but at least 20 ECTS of the thesis project must be placed in semester 4 (Option 4 in Table 4).

Different sizes of semester or thesis projects share the same learning objectives, but if the number of ECTS exceeds the default size (15 or 30 ECTS, respectively), the increased workload must be clearly reflected in the report, e.g. in terms of the difficulty, the scientific level, the obtained results, and the number of pages.

For thesis projects of more than 35 ECTS the student must supplement the thesis learning objectives according to the additional credits. The modified description must be approved by the programme coordinator and the Board of Studies.

The curriculum contains the following number of elective courses:

- 1\textsuperscript{st} semester: 1 course, 5 ECTS
- 2\textsuperscript{nd} semester: No elective courses
- 3\textsuperscript{rd} semester: 0-2 courses, 0-10 ECTS
- 4\textsuperscript{th} semester: Maximum 2 courses, 10 ECTS
Module: POPBL and scientific methods
(POPBL og videnskabelige metoder)

IMPORTANT: This module is a mandatory part of the semester project for all students on their 1st semester!

Prerequisites: None

Objectives:
Students who complete the module:

Knowledge
- Must have knowledge about Problem Based Learning
- Must have knowledge about conflict handling
- Must be able to understand the challenges of inter-cultural group work
- Must be able to plan group work using project planning tools (such as Gantt chart)
- Must have knowledge about the concept of process analysis
- Must have knowledge about different learning styles
- Must have knowledge about scientific methods and the applicability in engineering educations
- Must have knowledge about science theory in relation to hypothesis, theories, inductivism vs. deductivism, models vs. reality
- Must understand the difference between qualitative and quantitative methods
- Must understand the principles for citing other people’s work properly and understand the consequences of plagiarism

Skills
- Must be able to apply the principles of Problem Based Learning in practice
- Must be able to apply a Gantt chart to the first semester project
- Must be able to prepare a process analysis and use it for evaluation of the group work
- Must be able to discuss the concept of scientific methods
- Must be able to cite other people’s work properly
- Must be able to structure a project report
- Must be able to apply different scientific methods for a particular problem

Competencies
- Must have competencies in group work and project-organized learning
- Must have competencies in communication in a group
- Must have competencies in use of scientific methods
- Must have competencies in setting up a report as a scientific document

Type of instruction:
Types of instruction are listed at the start of Chapter 3.
An integral part of the semester project on the 1st semester.

Exam format:
Individual oral or written examination.

All students on their 1st semester MUST complete and pass the sub-module in “POPBL and scientific methods” as a partial exam before the final exam in the semester project.

Semester project: Services and platforms (Services og platforme)

Prerequisites: All students on their 1st semester MUST pass the partial exam in “POPBL and scientific methods” before the final exam in the semester project.

Objectives: Students who complete the module:

Knowledge
- Must have knowledge about the key Internet technologies and standards for content networking: representation, identification and transport
- Must have knowledge about the characteristics of different networks and the technologies that are important to provide a good user experience for a service
- Must be able to understand the service architectures, platforms and business models that are needed to provide future services and applications

Skills
- Must be able to carry out a detailed analysis of a service, an application or a technical design and develop a well-founded requirement specification for the service
- Must be able to identify service enablers and the specific requirements imposed by the service(s)
- Must be able to assess networks characteristics and limitations
- Must be able to discuss the technical and business-related aspects of service architectures
- Must be able to conceptually construct relevant business models

Competencies
- Must have competencies within at least one of the following areas:
  - Transforming an identified user need into a conceptual design of a realistic ICT service
  - Analysing the viability and potential of different technologies, applications and services in order to make well-founded choices of technologies and strategies
- Must be able to take advantage of combining networks and technologies in innovative ways for development of services and solutions

Type of instruction: Project work.

Exam format: Oral examination based on a written report.

Course module: Communication and broadcast networks (Kommunikations- og broadcast-net)

Prerequisites: None

Objectives:
Students who complete the module:

Knowledge
- Must have knowledge about digital broadcast networks (radio and TV):
  - Cable, satellite and terrestrial
- Must have knowledge about wired (broadband) networks:
  - xDSL, cable TV- and fibre-based infrastructures
- Must have knowledge about mobile and wireless networks:
  - 3G, 4G and beyond 4G
  - Including SDN, ICN, CDN
- Must have knowledge about development of networks leading to ‘future networks’ and ‘future Internet’
  - Including SDN, ICN, CDN
- Must be able to understand spectrum limitations and spectral efficiency
- Must have knowledge about advanced modulation and multiplexing techniques
- Must have knowledge about channel capacity, channel coding and compression techniques
- Must be able to understand converged infrastructures:
  - Combinations of distributive and communicative network platforms
- Must be able to understand the structural and service-oriented parameters that influence the development

Skills
- Must be able to explain the technical parameters, which drive the development of future networks
- Must be able to evaluate to what extent the future mobile and fixed networks complement or substitute each other
- Must be able to evaluate the strengths and weaknesses in the use of traditional mobile networks, wireless or broadcast networks for mobile TV/radio transmission.

Competencies
- Must have the competency to identify and discuss the key technologies and standards for broadband and broadcast networks and the properties of networks that are essential for supporting services
- Must have the competency to analyse and assess the potential and limitations of existing and future broadband and broadcast networks, technologies and services and help develop new solutions and initiatives

Type of instruction: Types of instruction are listed at the start of Chapter 3.

Exam format: Individual oral or written examination.

**Course module:**
**Entrepreneurship, innovation and business models**  
(Entrepreneurskab, innovation og forretningsmodeller)

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>None</th>
</tr>
</thead>
</table>

**Objectives:**  
Students who complete the module:

**Knowledge**
- Must have knowledge on theories regarding business development based on communication, media and information technologies, including network economics, information economics, transaction costs analysis, and business ecosystems  
- Must be able to understand theories on innovation and entrepreneurship

**Skills**
- Must be able to apply theories and methodological tools on specific company and technology cases  
- Must be able to evaluate the application of business models in different business areas

**Competencies**
- Must have the competencies to discuss the links between different design elements of business models: customer value, organization, technology and financial issues  
- Must have acquired the knowledge and skills to explain the key linkages between the different theories of the course, and use these critically in an analysis of market trends and business models  
- Must have acquired the ability to combine knowledge on technological solutions with business development and business potential  
- Must master theories and methodological tools to analyse and suggest appropriate and innovative business models for companies, which are offering communication, media and information services and products and using these solutions in their business operations

<table>
<thead>
<tr>
<th>Type of instruction:</th>
<th>Types of instruction are listed at the start of Chapter 3.</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Exam format:</th>
<th>Individual oral or written examination.</th>
</tr>
</thead>
</table>

|----------------------|----------------------------------------|
Course module:
Internet technologies and service architectures
(Internet-teknologier og tjenestearkitekturer)

Prerequisites: None

Objectives:
Students who complete the module:

Knowledge
- Must have knowledge about the structure of the Internet and its design principles
- Must have knowledge about the key Internet technologies for content networking: representation, identification and transport
- Must have knowledge of mark-up languages and AJAX technologies, e.g. XML, JSON, HTML5, and JavaScript
- Must have knowledge about programming models and interfaces for Internet services, in particular REST, SOAP and Web Services
- Must have knowledge about the main protocols for messaging and streaming media, including session initiation and management
- Must be able to explain the concepts of “service”, “service enablers” and “service architectures”
- Must be able to understand the principles of Web 2.0 and their implications for services
- Must have knowledge of different methods for “enrichment” of services: User involvement, personalization, use of context information, extracting value from large amounts of data, etc.
- Must have knowledge of the main standardization bodies and the process of developing specifications and standards for Internet technologies
- Must have knowledge of common service architectures, e.g. Service Delivery Platforms, Service-Oriented Architecture (SOA), and cloud architectures

Skills
- Must be able to analyse and discuss the relation between user needs and different types of services
- Must be able to analyse the requirements that a given service imposes on servers, networks and terminals and their relation to the user experience provided by the service
- Must be able to design ICT services with distributed content, including controlled exposure of resources and access to these, and making use of state-of-the-art Internet technologies
- Must be able to design services for real-time messaging and streaming media
- Must be able to analyse and discuss the characteristics of different service architectures

Competencies
- Must have the competency to assess the potential and applicability of state-of-the-art Internet technologies, programming models and architectures in order to realize a given functionality
- Must be able to apply user-centric service development and stakeholder analysis in setting up the requirements specification for a service

Type of instruction: Types of instruction are listed at the start of Chapter 3.

Exam format: Individual oral or written examination.

Semester project:  
**Application development**  
*(Anlægsvudvikling)*  
Specialization in Service Development

**Prerequisites:**  
All students on their 1st semester MUST complete and pass the sub-module in “POPBL and scientific methods” as a partial exam before the final exam in the semester project.

**Objectives:**  
Students who complete the module:

**Knowledge**
- Must have knowledge about appropriate methods for analysis, design and test of applications or services based on current or future ICT platforms
- Must have knowledge about the necessary tools to develop ICT or media applications and services
- Must have knowledge about mobile platforms, devices, and peripherals (sensors, tags, etc.) and their connectivity
- Must understand the implications for the user experience of the application/services
- Must have knowledge of the capabilities and functionalities of relevant software and hardware tools for application development
- Must have knowledge of state-of-the-art methods and technologies for privacy protection, security and trust

**Skills**
- Must be able to analyse user needs and identify relevant usage scenarios
- Must be able to make a well-founded requirement specification for an ICT service or solution, taking into account the target users, stakeholders, business aspects, state-of-the-art and technical constraints
- Must be able to design a full-scale service and realize a more limited prototype of proof-of-concept in the project
- Must be able to design a Graphical User Interface (GUI) with good usability
- Must be able to reflect on the application development process
- Must be able to develop and test applications and services that can be deployed on ICT and media platforms and infrastructures
- Must be able to develop services with mobile and interactive media and context-awareness
- Must be able to apply privacy-by-design principles, security, and state-of-the-art technologies for fine-grained control of personal information in application development

**Competencies**
- Must have the competency to identify user needs in a wide variety of contexts and turn them into innovative concepts, applications and services building on state-of-the-art within the field of ICT
- Must have the competency to position ICT applications in a user, technology and market perspective
- Must have the competency to explore and apply the potential of ICT for innovative services and new business opportunities

**Type of instruction:**  
Project work.

**Exam format:**  
Oral examination based on a written report.

**Evaluation criteria:**  
Are stated in the Framework Provisions.
| Semester project: | Design and markets  
(Design og markeder)  
Specialization in Business Development |
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Prerequisites:</strong></td>
<td>All students on their 1st semester MUST complete and pass the sub-module in “POPBL and scientific methods” as a partial exam before the final exam in the semester project.</td>
</tr>
<tr>
<td><strong>Objectives:</strong></td>
<td>Students who complete the module:</td>
</tr>
</tbody>
</table>
| **Knowledge** | • Must be able to understand technology as socio-technical systems where the context of use is pivotal for the value of communication, media and information (CMI) technologies  
• Must have knowledge on new organizational forms, new business concepts and changes in the market conditions together with new methods for involving users in the design of communication, media and information technology solutions |
| **Skills** | • Must be able to identify and apply relevant theories for the synthesis and evaluation of the studied situation  
• Must be able to apply knowledge of green ICT and managerial economics as presented in the mandatory semester courses  
• Must be able to identify situations of CMI technology related implications for the market  
• Must be able to analyse the conditions and implications of use of communication, media and information technologies for individual users, groups, organizations and society by drawing on technical, organizational and techno-economic perspectives |
| **Competencies** | • Must have the competencies to distinguish between design and market implications at individual, group, organizational or societal level  
• Must have the competencies to perform and analysis of the conditions and implications of communication, media and information technologies in a specific market context  
• Must have the competencies to combine theories from different technology, organizational and socio-technical areas to create a multi-faceted understanding of the “problem”  
• Must have the competencies to focus on a particular situation of use or a new phenomenon related to new CMI technologies; it could be the conditions and implications related to an organization engaging in outsourcing, or it could be the conditions and needs for new standards |
| **Type of instruction:** | Project work. |
| **Exam format:** | Oral examination based on a written report. |
| **Evaluation criteria:** | Are stated in the Framework Provisions. |
Course module:  
**Development of ICT and media services**  
(Udvikling af IKT- og medietjenester)

**Prerequisites:**  
None

**Objectives:**
Students who complete the module:

**Knowledge**
- Must be able to understand architectural issues such as the division of functions between terminal, server and networks.
- Must have knowledge about Internet of Things.
- Must have knowledge about smart sensors and smart actuators.
- Must understand general sensor architecture, structure and communication.
- Must have knowledge about basic artificial intelligence and pattern recognition algorithms and principles.
- Must have knowledge about platform programming and scripting e.g. tablets, Raspberry Pi, Arduino, or Smart TV
- Must understand interface and communication concepts in relation to external servers, databases, and cloud-based services.
- Must have knowledge about software technologies for development (e.g. Python, Java, MySQL).
- Must have knowledge about different Software Development Toolkits (SDK), simulators, emulators and Integrated Development Environment (IDE).

**Skills**
- Must be able to design and implement platform services/applications using high-level programming languages and development platforms.
- Must be able to perform platform programming and scripting (Raspberry Pi, Arduino, IoS, Smart TV, etc.).
- Must be able to use sensors and actuators to implement Internet of Things-related systems and devices.
- Must be able to use simple artificial intelligence algorithms in platform services and applications.
- Must be able to interface to, communicate with and use external servers, databases, and cloud-based services.
- Must be able to design, develop and evaluate platform software components.
- Must be able to produce technical documentation.

**Competencies**
- Must have the competency to design and develop viable ICT and media services that can address a wide range of user needs and provide a good user experience.
- Must have the competency to compose more advanced service functionality using state-of-the-art software tools, Internet of Things, cloud architectures, sensors and simple artificial intelligence algorithms.

**Type of instruction:**  
Types of instruction are listed at the start of Chapter 3.

**Exam format:**  
Individual oral or written examination.

**Evaluation criteria:**  
Are stated in the Framework Provisions.
| Course module: | Identity and access management  
(Identitets- og adgangshåndtering) |
<table>
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<tbody>
<tr>
<td>Prerequisites:</td>
<td>None</td>
</tr>
<tr>
<td>Objectives:</td>
<td>Students who complete the module:</td>
</tr>
</tbody>
</table>

**Knowledge**
- Must be able to explain the concepts of security, privacy and trust
- Must be able to explain the concepts of attributes, claims, assertion and claims-based identities
- Must have knowledge about the principles and methods for access control, authentication, authorization and identification
- Must be able to explain the key concepts and principles of identity management
- Must have knowledge of key management, certificates, tokens and credentials
- Must have knowledge about state-of-the-art principles and guidelines for protecting users' privacy
- Must have knowledge of state-of-the-art technologies and frameworks for fine-grained management of personal attributes
- Must be able to understand the concepts of linkability and unlinkability and state-of-the-art principles for establishing trust
- Must have knowledge about security architectures, including policies and policy management
- Must have knowledge of national identity management frameworks such as NemID

**Skills**
- Must be able to discuss the differences between physical identities and online digital, virtual and partial identities
- Must be able to identify the personal attributes that are needed to perform a given task
- Must be able to apply methods for privacy protection, encryption, access control, authentication and authorization as a part of service development, including privacy by design principles
- Must be able to apply state-of-the-art technologies for realizing advanced services with privacy protection, e.g. OAuth and OpenID Connect
- Must be able to analyse and design information flow and architectures for secure ICT services and solutions
- Must be able to design applications and services incorporating security elements (e.g. payment, authentication), different assurance levels, and management of user identities (authentication, authorization, privacy protection)

**Competencies**
- Must have the competency to design secure services and security architectures with controlled exchange of attributes between stakeholders and minimal disclosure of personal information
- Must be able to discuss and reflect on management of personal information for access to resources and for personalization of services

**Type of instruction:** Types of instruction are listed at the start of Chapter 3.

**Exam format:** Individual oral or written examination.

**Evaluation criteria:** Are stated in the Framework Provisions.
**Course module:**
*Interaction design (Interaktionsdesign)*

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>None</th>
</tr>
</thead>
</table>

**Objectives:**
Students who complete the module:

**Knowledge**
- Must understand the concepts of and relation between human computer interaction, interaction design and user experience
- Must be able to identify tensions between different visions for – and interests in - the design of an interactive system
- Must know of different input and output modes for interactive systems, also in a historical perspective
- Must be able to discuss user cognitive models and other descriptions of users
- Must know different methods for designing interaction of ICT systems
- Must know different strategies for planning the interaction design of ICT systems

**Skills**
- Must be able to apply the concepts of usability and user experience both to screen-based and non-screen-based interactive systems
- Must master different design methods and techniques for creating and testing interactive systems, including non-screen-based systems.
- Must be able to analyse different types of data from and about users
- Must be able to design the interaction of a given system based on data from and about users
- Must be able to reflect critically on methodological challenges in data from and about users as source for design
- Must be able to evaluate interactive systems using techniques from interaction design and Human Computer Interaction

**Competencies**
- Must be able to reflect on the implications of using different methods and techniques for interaction design, including user involvement
- Must be able to reflect on the implications of using different methods and techniques for evaluating systems
- Must be able to analyse the social context in which the use of ICT takes place
- Must be able to discuss concepts of privacy, user sovereignty and personalization in relation to design dilemmas involved the design of interactive systems
- Must be able to position the field of interaction design in the professional context of ICT development

**Type of instruction:**
Types of instruction are listed at the start of Chapter 3.

**Exam format:**
Individual oral or written examination.

**Evaluation criteria:**
Are stated in the Framework Provisions.
## Course module:
**Green ICT – Sustainable business development**  
(Grøn IKT – Bæredygtig forretningsudvikling)

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>None</th>
</tr>
</thead>
</table>

### Objectives:
Students who complete the module:

#### Knowledge
- Must be able to understand the concept of sustainability
- Must be able to define the concept of “Green ICT” and be able to identify existing, new and emerging hardware, software and communication technologies for energy saving
- Must have knowledge about various levels of ICT effects on the environment
- Must have knowledge and understanding of “linked life cycles concept”
- Must have knowledge about the role of ICT in energy consumption and energy efficiency
- Must have knowledge about methods for assessing the potential environmental impacts of ICT products and services
- Must be able to evaluate the rebound and induction effect in the ICT field

#### Skills
- Must be able to recognize the possible application area in which the deployment of ICT is expected to lead to better energy efficiency and to estimate their relative importance
- Must be able to apply the green ICT strategies
- Must be able to evaluate the rebound effect within the ICT field
- Must be able to determine which ICT products/services are relevant for inducing energy efficiency in other economic sectors
- Must be able to judge the usefulness of the used different scientific methods for analysis of the ICT related energy efficient systems

#### Competencies
- Must have the ability to apply and integrate sustainability in an interdisciplinary way, considering user, technology and market aspects.
- Must be able to independently define and analyse scientific problems within the area of Green ICT

<table>
<thead>
<tr>
<th>Type of instruction:</th>
<th>Types of instruction are listed at the start of Chapter 3.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam format:</td>
<td>Individual oral or written examination.</td>
</tr>
<tr>
<td>Course module:</td>
<td>Managerial economics (Erhvervsøkonomi)</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>None</td>
</tr>
<tr>
<td>Objectives:</td>
<td>Students who complete the module:</td>
</tr>
</tbody>
</table>
| Knowledge     | Must have knowledge about the basic elements in a business plan  
|               | Must be able to understand different cost concepts and different methods for investment analysis  
|               | Must be able to understand how a pricing strategy can be prepared  
|               | Must have knowledge about the specific cost elements in an ICT project  
|               | Must have knowledge about the cost elements in a communication network  
| Skills        | Must be able to apply a life-cycle cost analysis of a specific ICT project  
|               | Must be able to explain and apply different cost estimation methods for hardware and software  
|               | Must be able to evaluate cost and benefits of an ICT service in a specific context  
|               | Must be able to apply economic analysis as a tool for investment decisions and preparation of a business plan  
| Competencies  | Must have competencies in preparing a business plan including a detailed financial analysis of a project  

| Type of instruction: | Types of instruction are listed at the start of Chapter 3. |
| Exam format:         | Individual oral or written examination. |
| **Semester project:** | **Advanced ICT solutions**  
| **(Avancerede IKT-løsninger)**  
| **Specialization in Service Development**  
| **Prerequisites:** | Degree students must have completed their first two semester projects. Other students must have acquired similar knowledge, skills and competences otherwise.  
| **Objectives:** | Students who complete the module:  
| **Knowledge** |  
| • Must have knowledge about design and development of advanced ICT solutions, including knowledge about how the institutional and market-related circumstances interact with technology development so as to take it into account in the design process  
| • Must have knowledge of algorithms for data processing and semantic analysis  
| • Must have knowledge about how ICT applications and solutions can be deployed in order to address specific needs in different application areas and improve efficiency  
| **Skills** |  
| • Must be able to design and develop an ICT service or solution, including one or more of the following elements:  
| o Handling of converged media content and digital rights management (DRM)  
| o Acquisition and processing of sensor information, e.g. bio-signals  
| o Handling of large amounts of data to extract relevant information, e.g. latent semantic analysis, machine learning techniques, or cluster analysis  
| o Recommender systems  
| o Advanced programming tools, e.g. graph databases, Ruby on Rails, or Hadoop  
| o Complex usage scenarios including resource management and privacy protection  
| • Must be able to develop advanced ICT services and solutions targeting a specific application domain and considering scalability, state-of-the-art technologies and the use of different devices, networks and platforms.  
| • Must be able to identify, select and apply suitable programming languages and software development strategies and justify their choices  
| • Must be able to undertake a thorough analysis of the chosen application for technology choices, strategic decisions, innovation and entrepreneurship  
| **Competencies** |  
| • Must have the competency to clearly identify relevant problems within different application areas, which can be solved by the use of ICT technologies and methods  
| • Must have competency to develop innovative and viable services/solutions based on solid engineering knowledge and skills and involving both technical, commercial and user aspects  
| **Type of instruction:** | Project work.  
| **Exam format:** | Oral examination based on a written report.  
| **Evaluation criteria:** | Are stated in the Framework Provisions.  

23
Semester project:  
**Governance and strategies**  
*(Regulering og strategier)*  
Specialization in Business Development

**Prerequisites:**  
Degree students must have completed their first two semester projects. Other students must have acquired similar knowledge, skills and competences otherwise.

**Objectives:**  
Students who complete the module:

**Knowledge**
- Must have knowledge about the importance of the social and business environment in which technologies are used  
- Must be able to understand the role of standardization processes for innovation and in market developments

**Skills**
- Must be able to apply theories, methodologies and empirical knowledge for analysing market developments and governance  
- Must be able to apply knowledge on technology, business and regulatory developments for analysing and developing appropriate business models and business strategies  
- Must be able to analyse industry sectors and markets using and producing communication, media and information technologies  
- Must be able to assess the main regulatory issues in relation to ICT infrastructures, services, and content

**Competencies**
- Must have competencies in applying an interdisciplinary approach using theories, methodologies and empirical knowledge for analysing specific issues with relation to communication, media and information technologies  
- Must be able to analyse the interaction between technologies, institutions, organisations and markets in a system perspective

**Type of instruction:** Project work.

**Exam format:** Oral examination based on a written report.

**Evaluation criteria:** Are stated in the Framework Provisions.
### Course module:
**Content and media management**
(Indholds- og medieorganisation)

### Prerequisites:
The courses on “Internet technologies and service architectures” and “Development of ICT and media services” or similar qualifications. The former course may be taken in parallel in the same semester.

### Objectives:
Students who complete the module:

#### Knowledge
- Must have knowledge of the key standards of media formats and representation of digital content
- Must have knowledge of standards for metadata and annotation
- Must have knowledge of methods for dealing with Digital Rights Management (DRM)
- Must have knowledge of methods for indexing and handling of unstructured content, e.g. user generated content, in combination with structured media content
- Must be able to understand how to manage and optimize content adaptation and delivery to meet the limitations of various types of networks and terminals and dynamic context

#### Skills
- Must be able to discuss strategies for organising and searching in large quantities of digital content
- Must be able to prepare and integrate multimedia content in a service, including associated metadata
- Must be able to analyse the role and interests of content producers, aggregators and providers in the value chain or value network of a service
- Must be able to analyse problems and solutions for the distribution of digital media content and select appropriate strategies for media distribution

#### Competencies
- Must be able to analyse and evaluate systems and solutions for content and media management
- Must be able to advice content providers and other non-technical persons on content and media management systems
- Must be able to analyse technical aspects of content and media management in a larger political-social-economical context

### Type of instruction:
Types of instruction are listed at the start of Chapter 3.

### Exam format:
Individual oral or written examination.

### Evaluation criteria:
Are stated in the Framework Provisions.
**Course module:**
**Internet economics and governance**  
*(Internet-økonomi og regulering)*

**Prerequisites:** None

**Objectives:**
The student shall have knowledge about the economics of electronic communication infrastructures and how they are governed.

Students who complete the module:

**Knowledge**
- Shall have knowledge about the techno-economics of Internet infrastructures
- Shall be able to demonstrate insight into governance structures of the Internet
- Shall have knowledge about convergence and its impact on regulation and governance
- Shall have obtained knowledge about regulation of competition, user access, and scarce resources
- Must have knowledge about Internet organisations and the standardization process for internet technologies
- Must have knowledge about unbundling and vertical separation of Internet infrastructures
- Must have knowledge about consumer issues in relation to provision of Internet infrastructures

**Skills**
- Must be able to analyse the economic and technological conditions which influence governance and market structure of electronic communication infrastructures
- Must be able to apply economic theory for analysis of market conditions for provision of Internet services
- Must be able to analyse drivers and barriers towards investments in electronic infrastructures
- Must be able to discuss and evaluate Internet policies at the national and international Must be able to determine linear dependence or linear independence of small sets of vectors

**Competencies**
- Shall demonstrate development of his/her knowledge, understanding, and ability to make use of socio-economic methods within the fields of Internet economics and governance
- Shall be able to understand the importance and implications of different governance models for the Internet

**Type of instruction:** Types of instruction are listed at the start of Chapter 3.

**Exam format:** Individual oral or written examination.

**Evaluation criteria:** Are stated in the Framework Provisions.
<table>
<thead>
<tr>
<th>Course module:</th>
<th>Standardization (Standardisering)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites:</td>
<td>None</td>
</tr>
<tr>
<td>Objectives:</td>
<td>Students who complete the module:</td>
</tr>
<tr>
<td></td>
<td><strong>Knowledge</strong></td>
</tr>
<tr>
<td></td>
<td>• Must have knowledge on different types of standards, including open and closed standards and de facto and de jure standards</td>
</tr>
<tr>
<td></td>
<td>• Must be able to understand the importance and role of standards, standardization strategies, and standardization processes</td>
</tr>
<tr>
<td></td>
<td>• Must have knowledge on standardization organizations in the area of communication, media and information technologies</td>
</tr>
<tr>
<td></td>
<td>• Must have knowledge on the relationships between innovation and standardization</td>
</tr>
<tr>
<td></td>
<td><strong>Skills</strong></td>
</tr>
<tr>
<td></td>
<td>• Must be able to apply theories on network economics, information economics, and transaction costs analysis on standardization issues</td>
</tr>
<tr>
<td></td>
<td>• Must be able to analyse and evaluate the importance and role of standards, particularly within the area of communication, media and information technologies</td>
</tr>
<tr>
<td></td>
<td>• Must be able to appraise the role of standards in relation to processes of transaction between market players</td>
</tr>
<tr>
<td></td>
<td><strong>Competencies</strong></td>
</tr>
<tr>
<td></td>
<td>• Must have competencies to interpret the interests which underlie the development of standards</td>
</tr>
<tr>
<td></td>
<td>• Must have competencies to outline the role of standards in business development for companies in the communication, media and information technology area as well as companies using these technologies</td>
</tr>
<tr>
<td></td>
<td>• Must have competencies to compare standardization strategies</td>
</tr>
<tr>
<td>Type of instruction:</td>
<td>Types of instruction are listed at the start of Chapter 3.</td>
</tr>
<tr>
<td>Exam format:</td>
<td>Individual oral or written examination.</td>
</tr>
</tbody>
</table>
**Course module:**
**Cyber security and trust**  
*(Cyber-sikkerhed og tillid)*

| Prerequisites: | Basic understanding of network security. |

**Objectives:**
Students who complete the module:

**Knowledge**
- Must have knowledge of standards addressing top cyber security challenges
- Must have knowledge of effective measures that cyber security programs should take
- Must have knowledge of trusted and open architectures
- Must have an understanding of device security trends and threats associated with “Bring your own device” (BYOD)
- Must have knowledge of (mobile) device management and integrity factors for trusted and untrusted devices
- Must have knowledge of strong user and machine authentication based on valuable assets
- Must have knowledge of hardware-based encryption (“Security on chip”) for higher performance
- Must have a knowledge of technologies already embedded in enterprise endpoints
- Must have knowledge of cyber attacks
- Must have knowledge of behavioural profiling and intrusion prevention tools for layer defences
- Must have knowledge of security services and policies within public and private cloud networks

**Skills**
- Must be able to identify requirements and create policies to establish a consistent architecture
- Must be able to monitor, detect and respond to anomalies in the cyber-space
- Must be able to analyse the integrity of the platform to ensure that no unauthorized use has occurred.
- Must be able to design and implement different levels of trust in open architectures.

**Competencies**
- Must have the competency to design cyber security measures for enterprises
- Must have the competency to discuss end-to-end standards to enable seamless security in an open ecosystem.
- Must have the competency to discuss the business potential and implications of trusted ecosystems

| Type of instruction: | Types of instruction are listed at the start of Chapter 3. |
| Exam format: | Individual oral or written examination. |
| Course module: | Smart Sensor Data Processing  
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Databehandling for smart sensors)</td>
</tr>
</tbody>
</table>

| Prerequisites: | Basic knowledge of linear algebra and statistics.  
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Course on “Development of ICT and media services” or similar qualifications.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objectives:</th>
<th>Students who complete the module:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td></td>
</tr>
</tbody>
</table>
| - Must have knowledge about high level smart sensors (e.g. cameras, 3D sensors, EEG sensors)  
| - Must have knowledge about artificial intelligence algorithms.  
| - Must have knowledge about artificial intelligence in the context of data mining.  
| - Must have knowledge about pattern recognition and machine learning techniques.  
| - Must have knowledge about detection and recognition of humans and objects.  
| - Must have a clear understanding of the smart sensor processing technology |

| Skills |  
|--------|--------------------------|
| - Must be able to use various high level smart sensors to acquire data.  
| - Must be able to apply data mining techniques to acquired data.  
| - Must be able to assess and use various pattern recognition and machine learning techniques.  
| - Must be able to design and develop human and object detection/recognition systems.  
| - Must be able to program smart sensor applications (e.g. Matlab, C++) |

| Competencies |  
|-------------|--------------------------------------------------|
| - Must have the competency to choose the most relevant high-level smart sensor for a given application.  
| - Must have the competency to assess the use and apply various pattern recognition and machine learning techniques for a given application.  
| - Must have the competency to process 2D/3D visual data or bio signals to detect and recognize humans or objects. |

<table>
<thead>
<tr>
<th>Type of instruction:</th>
<th>Types of instruction are listed at the start of Chapter 3.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam format:</td>
<td>Individual oral or written examination.</td>
</tr>
</tbody>
</table>
**Semester project:**
*Master's thesis*  
*(Speciale)*

| **Prerequisites:**  
| 3rd semester project. |

| **Objectives:**  
| Students who complete the module: |

**Knowledge**
- Must be able to understand the relevance of the chosen problem in relation with telecommunication, infrastructure, entrepreneurship and innovation that includes specific knowledge for the kernel of the problem and the technical context
- Must be able to understand at synthesis level relevant theories and methods in a way that underlines important properties, and thus document the knowledge about the applied theories, methods and delimitations within the problem field

**Skills**
- Must be able to design, develop or analyse a comprehensive service or solution that is solidly technically founded, meets end-user requirements and is validated from a market and business perspective
- Must be able to undertake a thorough analysis of specific applications for technology choices, strategic decisions and innovation
- Must be able to analyse the possible methods to solve the problem, describe and assess the application of the chosen methods and how these influence the project results

**Competencies**
- Must be able to synthesize and describe the chosen problem and apply relevant theories, methods and experimental data
- Must have competencies in innovation and entrepreneurship within the field of ICT
- Must be able to contribute to the creative use of technologies to resolve user needs and improve organizational processes

If the project is carried out as a long thesis project the learning objectives include those defined for the 3rd semester of the specialization. If the number of ECTS exceeds the default size (30 ECTS), the increased workload must be clearly reflected in the report, e.g. in terms of the difficulty, the scientific level, the obtained results, and the number of pages.

| **Type of instruction:**  
| The project is run individually or in small groups of maximum three members. At least one internal supervisor is assigned, who works with the primary subject within his/her research. Moreover, additional supervisors e.g. from industry can be involved in the project. |

| **Exam format:**  
| Oral examination based on a written thesis. |

| **Evaluation criteria:**  
| Are stated in the Framework Provisions. |
Chapter 3, Part II: Aalborg

The programme has one yearly intake in September and students follow the specialization

- Telecom infrastructures

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 by assessment by the supervisor only).

An overview of the ECTS credit breakdown for the various semesters by modules is shown in the table below.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Module</th>
<th>ECTS</th>
<th>Assessment</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Entrepreneurship, Innovation and Business Models</td>
<td>Mandatory 5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Communication Networks and Ambient Intelligence</td>
<td>Mandatory 5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>PHY and MAC Fundamentals</td>
<td>Mandatory 5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Services and platforms</td>
<td>Mandatory 15</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td>2nd</td>
<td>Advanced Telecommunication and its Applications</td>
<td>Mandatory 5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Standardization, IPR, Patenting and Technology Transfer</td>
<td>Mandatory 5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Distributed Network Management and Security</td>
<td>Mandatory 5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Development of ICT-based Applications</td>
<td>Mandatory 15</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td>3rd</td>
<td>Techniques and Aspects for Cooperative and Cognitive Radio</td>
<td>Mandatory 5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Techniques and Aspects for eHealth</td>
<td>Elective 5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Machine Learning</td>
<td>Elective 5</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Cognitive Radio Systems Design</td>
<td>Mandatory 15-20</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td>4th</td>
<td>Master’s Thesis</td>
<td>30, possibly 60</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Complete semester structure.

The curriculum contains the following number of elective courses:

- 1st and 2nd semester: No elective courses
- 3rd semester: 1 course, 5 ECTS
Module: POPBL and scientific methods (POPBL og videnskabelige metoder)

IMPORTANT: This module is a mandatory part of the semester project for all students on their 1st semester!

Prerequisites: None

Objectives: Students who complete the module:

Knowledge
- Must have knowledge about Problem Based Learning
- Must have knowledge about conflict handling
- Must be able to understand the challenges of inter-cultural group work
- Must be able to plan group work using project planning tools (such as Gantt chart)
- Must have knowledge about the concept of process analysis
- Must have knowledge about different learning styles
- Must have knowledge about scientific methods and the applicability in engineering educations
- Must have knowledge about science theory in relation to hypothesis, theories, inductivism vs. deductivism, models vs. reality
- Must understand the difference between qualitative and quantitative methods
- Must understand the principles for citing other people’s work properly and understand the consequences of plagiarism

Skills
- Must be able to apply the principles of Problem Based Learning in practice
- Must be able to apply a Gantt chart to the first semester project
- Must be able to prepare a process analysis and use it for evaluation of the group work
- Must be able to discuss the concept of scientific methods
- Must be able to cite other people’s work properly
- Must be able to structure a project report
- Must be able to apply different scientific methods for a particular problem

Competencies
- Must have competencies in group work and project-organized learning
- Must have competencies in communication in a group
- Must have competencies in use of scientific methods
- Must have competencies in setting up a report as a scientific document

Type of instruction:
Types of instruction are listed at the start of Chapter 3. An integral part of the semester project on the 1st semester.

Exam format:
Individual oral or written examination.

All students on their 1st semester MUST complete and pass the sub-module in “POPBL and scientific methods” as a partial exam before the final exam in the semester project.

### Semester project: Services and platforms (Services og platforme)

#### Prerequisites:
All students on their 1st semester MUST pass the partial exam in “POPBL and scientific methods” before the final exam in the semester project.

#### Objectives:
Students who complete the module:

**Knowledge**
- Must have knowledge about the key Internet technologies and standards for content networking: representation, identification and transport
- Must have knowledge about the characteristics of different networks and the technologies that are important to provide a good user experience for a service
- Must be able to understand the service architectures, platforms and business models that are needed to provide future services and applications

**Skills**
- Must be able to carry out a detailed analysis of a service, an application or a technical design and develop a well-founded requirement specification for the service
- Must be able to identify service enablers and the specific requirements imposed by the service(s)
- Must be able to assess networks characteristics and limitations
- Must be able to discuss the technical and business-related aspects of service architectures
- Must be able to conceptually construct relevant business models

**Competencies**
- Must have competencies within at least one of the following areas:
  - Transforming an identified user need into a conceptual design of a realistic ICT service
  - Analysing the viability and potential of different technologies, applications and services in order to make well-founded choices of technologies and strategies
- Must be able to take advantage of combining networks and technologies in innovative ways for development of services and solutions

#### Type of instruction:
Project work.

#### Exam format:
Oral examination based on a written report.

#### Evaluation criteria:
Are stated in the Framework Provisions.
<table>
<thead>
<tr>
<th>Course module:</th>
<th>Entrepreneurship, innovation and business models (Entreprerneurskab, innovation og forretningsmodeller)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites:</td>
<td>None</td>
</tr>
<tr>
<td>Objectives:</td>
<td>Students who complete the module:</td>
</tr>
<tr>
<td></td>
<td><strong>Knowledge</strong></td>
</tr>
<tr>
<td></td>
<td>• Must have knowledge on theories regarding business development based on communication, media and information technologies, including network economics, information economics, transaction costs analysis, and business ecosystems</td>
</tr>
<tr>
<td></td>
<td>• Must be able to understand theories on innovation and entrepreneurship</td>
</tr>
<tr>
<td>Skills</td>
<td>• Must be able to apply theories and methodological tools on specific company and technology cases</td>
</tr>
<tr>
<td></td>
<td>• Must be able to evaluate the application of business models in different business areas</td>
</tr>
<tr>
<td>Competencies</td>
<td>• Must have the competencies to discuss the links between different design elements of business models: customer value, organization, technology and financial issues</td>
</tr>
<tr>
<td></td>
<td>• Must have acquired the knowledge and skills to explain the key linkages between the different theories of the course, and use these critically in an analysis of market trends and business models</td>
</tr>
<tr>
<td></td>
<td>• Must have acquired the ability to combine knowledge on technological solutions with business development and business potential</td>
</tr>
<tr>
<td></td>
<td>• Must master theories and methodological tools to analyse and suggest appropriate and innovative business models for companies, which are offering communication, media and information services and products and using these solutions in their business operations</td>
</tr>
<tr>
<td>Type of instruction:</td>
<td>Types of instruction are listed at the start of Chapter 3.</td>
</tr>
<tr>
<td>Exam format:</td>
<td>Individual oral or written examination.</td>
</tr>
</tbody>
</table>
Course module:
PHY and MAC Fundamentals
(PHY og MAC grundbegreber)

Prerequisites:
A basic understanding of wireless communications fundamentals, mathematics and statistics corresponding to a BSc in Electrical Engineering.

Objectives:
Students who complete the module:

Knowledge
• Must have knowledge about the following:
  o Wireless channel
    ▪ Radio propagation elements
    ▪ Channel modelling
    ▪ Imperfect channel, impact of noise
  o Basic channel access
    ▪ Fundamental single carrier access schemes
    ▪ Modulation
    ▪ Coding
  o Transceiver operation
    ▪ Transceiver structures and synchronization
    ▪ Channel estimation
    ▪ Equalization
    ▪ Link adaption
  o Capacity and advanced antenna systems
    ▪ Channel capacity – multiple users
    ▪ Multi-antennas systems
      ▪ Diversity
      ▪ Space multiplexing
  o Advanced Access
    ▪ Multi-carrier access
    ▪ Spread spectrum
    ▪ Resource allocation

Skills
• Must be able to:
  o Establish a link budget
  o Illustrate the information flow on a block level
  o Perform basic simulations of parts of the communication chain

Competencies
• Must be able to set up a basic model and/or simulation of the relevant parts of the communication chain and identify important parameters

Type of instruction: Types of instruction are listed at the start of Chapter 3.

Exam format: Individual oral or written examination.

### Semester project:
**Development of ICT-based Applications**  
(Udvikling af IKT-baserede applikationer)

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>None</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Objectives:</th>
<th>Students who complete the module:</th>
</tr>
</thead>
</table>
| Knowledge   | - Must have knowledge about methods to analyse and design applications based on a selected ICT technological platform (cognitive radio or eHealth)  
- Must have knowledge about market relations in relation to new media and ICT, and also development of relevant business models |
| Skills      | - Must be able to apply relevant methods to implementation and testing of systems or selected parts of them, based on an ICT technological platform  
- Must be able to analyse relevant ICT technologies such as cognitive radio, advanced spectrum management or eHealth in the scope of the following aspects:  
  o The underlying methodology and techniques  
  o The business model and the relation of market players including regulatory bodies |
| Competencies| - Must be able to apply and assess users’ needs and ICT influence in relation with design of new applications, software, mobile units, etc.  
- Must be able to develop an ICT-based application and account for the technological as well as the business and market aspects |

| Type of instruction: | Project work. |
| Exam format:         | Oral examination based on a written report. |
Course module:
**Advanced Telecommunication and its Applications**
(Avanceret telekommunikation og dets applikationer)

**Prerequisites:**
The courses on “PHY and MAC fundamentals” and “Communication networks and ambient intelligence” or an understanding of the communication fundamentals in wireless communications systems covering the topics of these two courses.

**Objectives:**
Students who complete the module:

**Knowledge**
- Must have knowledge about:
  - Software defined radio (SDR)
    - The motivation and purpose
    - Implementation scenarios and issues
    - Use cases
  - Cognitive radio
    - The motivation and purpose
    - Implementation scenarios and issues
    - Use cases
  - Cooperative communications
    - Basic techniques
    - Purpose, benefit and drawbacks
- Must have knowledge about the applications for advanced telecommunication systems along with the special requirements related to reliability, privacy and trust

**Skills**
- Must be able to establish a use case utilizing the learned concepts to execute a project in one of the areas or a combination of them
- Must be able to evaluate the taught techniques in relation to an application along with the benefits and drawbacks

**Competencies**
- Must be able to establish use cases for applications and apply SDR, cognitive radio and/or cooperative communication techniques in advanced telecommunication

**Type of instruction:**
Types of instruction are listed at the start of Chapter 3.

**Exam format:**
Individual oral or written examination.

**Evaluation criteria:**
Are stated in the Framework Provisions.
<table>
<thead>
<tr>
<th>Course module:</th>
<th>Standardization, IPR, Patenting and Technology Transfer (Standardisering, IPR, patentering og teknologioverførsel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites:</td>
<td>None</td>
</tr>
<tr>
<td>Objectives:</td>
<td>Students who complete the module:</td>
</tr>
<tr>
<td></td>
<td><strong>Knowledge</strong></td>
</tr>
<tr>
<td></td>
<td>• Must have knowledge about IPRs, the application process and the importance</td>
</tr>
<tr>
<td></td>
<td>• Must have knowledge about different standards, strategies and organizations for such</td>
</tr>
<tr>
<td></td>
<td>• Must be able to understand the importance of IPRs and standards from different business perspectives</td>
</tr>
<tr>
<td></td>
<td>• Must have knowledge about technology transfer, different processes and the advantages from an academic and industrial point-of-view</td>
</tr>
<tr>
<td></td>
<td><strong>Skills</strong></td>
</tr>
<tr>
<td></td>
<td>• Must be able to survey IPRs and assess the feasibility of applying such for a given invention</td>
</tr>
<tr>
<td></td>
<td>• Must be able to evaluate the organizational as well as competitive aspects of IPRs and standards</td>
</tr>
<tr>
<td></td>
<td><strong>Competencies</strong></td>
</tr>
<tr>
<td></td>
<td>• Must be able to assess strategies for applying standards and IPRs in a commercial perspective</td>
</tr>
<tr>
<td></td>
<td>• Must be able to assess the feasibility, impact and complications of IPRs and standards</td>
</tr>
<tr>
<td></td>
<td>• Must be able to assess technology transfer processes and the impact on different market players</td>
</tr>
<tr>
<td>Type of instruction:</td>
<td>Types of instruction are listed at the start of Chapter 3.</td>
</tr>
<tr>
<td>Exam format:</td>
<td>Individual oral or written examination.</td>
</tr>
</tbody>
</table>
| Course module: | Distributed Network Management and Security  
(Distribueret management af netværk og sikkerhed) |
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<tr>
<td>Prerequisites:</td>
<td>Students should have basic understanding of wireless and wired networks such as the one obtained through the course on “Communication networks and ambient intelligence”.</td>
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<tr>
<td>Objectives:</td>
<td>Students who complete the module:</td>
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</table>
| Knowledge      | Must have understanding of the aspects of distributed network management and security issues and solutions including knowledge of intrusion detection systems  
Must have understanding of the aspects of privacy, ethical and legal issues related to the management of advanced telecommunication systems  
Must have understanding of methods/concepts for privacy compliance with ethical and legal constraints to be used in management of advanced telecommunication systems |
| Skills         | Must be able to select and apply the taught methods and concepts to concrete use cases  
Must be able to evaluate privacy, ethics and legal issues for management systems |
<p>| Competencies   | Must be able to apply and integrate methods for management of networks considering fundamental system security (authentication, authorization/access control, policy), threats and vulnerabilities (threats analysis) |
| Type of instruction: | Types of instruction are listed at the start of Chapter 3. |
| Exam format:   | Individual oral or written examination. |</p>
<table>
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<tr>
<th>Semester project:</th>
<th>Cognitive Radio Systems Design</th>
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<td>(Design af kognitiv radio-systemer)</td>
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</table>

**Prerequisites:**
A thorough understanding of system design, innovation, commercialization and cognitive radio based communication systems.

**Objectives:**
Students who complete the module:

**Knowledge**
- Must have knowledge about specific cognitive radio technology and related theories, methodologies and empirical knowledge for analysing cognitive radio systems including:
  - 802.22, 802.11af and other standards, which apply part of the cognitive radio technology
- Must be able to understand design methods for cognitive radio based systems
- Must have a clear understanding of the holistic aspects of cognitive radio including business models and regulations

**Skills**
- Must be able to apply evaluation frameworks to cognitive radio based systems
- Must be able to understand commercialization and reimbursement (long-term sustainability) possibilities
- Must be able to apply relevant theories, methods and techniques used for cognitive radio systems
- Must be able to apply machine learning and other cognitive methodologies in the design of cognitive radio systems

**Competencies**
- Must be able to analyse, identify, predict and solve challenges in relation cognitive radio systems
- Must be able to design and, in parts, implement and test cognitive radio systems aimed at a single or a subset of applications

**Type of instruction:** Project work.

**Exam format:** Oral examination based on a written report.

**Evaluation criteria:** Are stated in the Framework Provisions.
Course module: Techniques and Aspects for Cooperative and Cognitive Radio (Teknikker og aspekter for samarbejdende og kognitiv radio)

Prerequisites: The course on “Advanced telecommunications and its applications” or an understanding of the communications fundamentals in wireless communications systems covering the topics of the same course.

Objectives: Students who complete the module:

Knowledge
- Must have knowledge about cognitive radio, namely its purpose, possible implementation issues or requirements in terms of advantages and drawbacks, deployment scenarios and use cases
- The acquired knowledge is focused in the following areas:
  - Spectrum Sensing
    - Detection theory fundamentals
    - Non-coherent detection
    - Coherent detection
    - Cooperative detection
    - Security and trust
  - Spectrum access
    - MAC for cognitive radio
    - Multichannel MAC
    - Security and trust
  - Cognitive Radio network layer design
    - Network topologies
    - Routing in ad-hoc networks
    - Self organized networks
    - Security and trust
  - Spectrum management
    - Spectrum sharing
    - Spectrum pricing
    - Regulatory issues

Skills
- Must be able to apply the taught concepts to execute a mini project, which focus in one of the above areas

Competencies
- Must have a clear understanding of holistic aspects of the lectured subjects and how they can be combined towards the creation of a cognitive radio based telecommunication system

Type of instruction: Types of instruction are listed at the start of Chapter 3.

Exam format: Individual oral or written examination.

**Course module:**
*Techniques and Aspects for eHealth*  
*(Teknikker og aspekter for eHealth)*

**Prerequisites:**
A basic understanding of design, innovation, barriers, commercialization and communication systems.

**Students who complete the module:**

**Knowledge**
- Must have knowledge about eHealth technology and related applications
- Must be able to understand design methods for eHealth systems
- Must have knowledge about standardization and legislation for eHealth systems and how these apply for different global market segments
- Demonstrate understanding of the multiple users, suppliers, and delivery modalities of eHealth services and systems

**Skills**
- Must be able to apply evaluation frameworks to eHealth systems
- Must be able to evaluate telecommunications systems used in eHealth and interoperability aspects and present original solutions to challenges in interoperability
- Must be able to understand commercialization and reimbursement (long-term sustainability) possibilities and barriers
- Must be able to integrate the interdisciplinary aspects involved in designing eHealth systems

**Competencies**
- Must show innovative and entrepreneurial development skills in regards to eHealth technologies and services
- Must have a clear understanding of the multifaceted aspects of eHealth development and use

**Type of instruction:**  
Types of instruction are listed at the start of Chapter 3.

**Exam format:**  
Individual oral or written examination.

**Evaluation criteria:**  
Are stated in the Framework Provisions.
| Course module: | Machine Learning  
(Maskinlæring) |
<table>
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<tr>
<td>Prerequisites:</td>
<td>Basic knowledge in probability theory, statistics, and linear algebra.</td>
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<tr>
<td>Students who complete the module:</td>
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</table>
| Knowledge | • Must have knowledge about supervised learning methods including K-nearest neighbours, decision trees, linear discriminant analysis, and neural networks  
• Must have knowledge about unsupervised learning methods including: K-means, Gaussian mixture model, hidden Markov model, EM algorithm, and principal component analysis  
• Must have knowledge about algorithm-independent machine learning: Bayesian decision theory, bias and variance trade-off, and cross-validation  
• Must be able to understand reinforcement learning |
| Skills | • Must be able to implement the fundamental methods either from scratch or by using existing tools  
• Must be able to evaluate and compare the methods for a specific application problem in a scientific way |
| Competencies | • Must have competencies in analysing a given problem and identifying appropriate machine learning methods to the problem  
• Must have competencies in understanding the strengths and weaknesses of the methods |
| Type of instruction: | Lectures followed by laboratory exercises, in addition to a mini-project where students will apply appropriate methods to application problems selected from a list of suggestions or proposed by the students themselves. |
| Exam format: | Individual oral exam on the basis of the mini project and the lectures. |
### Semester project:
**Master’s Thesis**  
(Kandidatspeciale)

### Prerequisites:
3rd semester project, Converging Media Technologies / Telecom infrastructure

### Objectives:
Students who complete the module:

**Knowledge**
- Must be able to understand the relevance of the chosen problem in relation with telecommunications, infrastructure, entrepreneurship and innovation that includes specific knowledge for the kernel of the problem and the technical context
- Must be able to understand at synthesis level relevant theories and methods in a way that underlines important properties, and thus document the knowledge about the applied theories, methods and delimitations within the problem field

**Skills**
- Must be able to design, develop or analyse a comprehensive service or solution that is solidly technical founded, meets end-user requirements and is validated from a market and business perspective
- Must be able to undertake a thorough analysis of specific applications for technology choices, strategic decisions and innovation
- Must be able to analyse the possible methods to solve the problem, describe and assess the application of the chosen methods and how these influence the project results

**Competencies**
- Must be able to synthesize and describe the chosen problem and apply relevant theories, methods and experimental data
- Must have competencies in innovation and entrepreneurship within the field of ICT
- Must be able to contribute to the creative use of technologies to resolve user needs and improve organizational processes

If the project is carried out as a long master project the learning objectives include those defined for the 3rd semester of the specialisation.

### Type of instruction:
The project is run individually or in small groups of maximum three members. At least one internal supervisor is assigned, who works with the primary subject within his/her research. Moreover, additional supervisors e.g. from industry can be involved in the project.

### Exam format:
Oral examination based on a written thesis.

### Evaluation criteria:
Are stated in the Framework Provisions.
Chapter 4: Entry into Force, Interim Provisions and Revision

The curriculum is approved by the Dean of the Faculty of Engineering and Science and enters into force as of Sept. 1, 2014.

Students who wish to complete their studies under the previous curriculum from ICTE (version 12, 6 June 2012) must conclude their education by the summer examination period 2015 at the latest, since examinations under the previous curriculum are not offered after this time.

In accordance with the Framework Provisions for the Faculty of Engineering and Science and The Faculty of Medicine at Aalborg University, the curriculum must be revised no later than 5 years after its entry into force.

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 also given to the student's spelling and formulation 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. If the project is written in English, the summary must be in Danish. The summary must be at least 1 page and not more than 2 pages. 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
In the individual case, the Board of Studies can approve successfully completed (passed) program elements from other Master's programs in lieu of program elements in this program (credit transfer). The Board of Studies can also approve successfully completed (passed) program elements from another Danish program or a program outside of Denmark at the same level in lieu of program elements within this curriculum. Decisions on credit transfer are made by the Board of Studies based on an academic assessment. See the Framework Provisions 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 the Faculties of Engineering, Science and Medicine on their website.

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

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6 Or another foreign language (upon approval from the Board of Studies.
7 The Board of Studies can grant exemption from this.
5.6 Completion of the Master’s programme
The Master’s program must be completed no later than four years after it was begun.

Rules and requirements concerning the reading of texts in foreign languages and a statement of the foreign language knowledge this assumes
It is assumed that the student can read academic texts in modern English and use reference works, etc., in other European languages.