Curriculum for the Master’s Programme in Innovative Communication Technologies and Entrepreneurship (ICTE)

Aalborg University, September 2011

Version 12 (2 July 2012)
Preface

Pursuant to Act 985 of October 21, 2009 on Universities (the University Act) with subsequent changes, the following curriculum for the Master's programme in Innovative Communication Technologies and Entrepreneurship is stipulated. The programme also follows the Framework Provisions and the Examination Policies and Procedures for the Faculty of Engineering and Science.
# Table of Contents

Chapter 1: Legal Basis of the Curriculum, etc. .................................................................3  
  1.1 Basis in ministerial orders ..........................................................................................3  
  1.2 Faculty affiliation ......................................................................................................3  
  1.3 Board of Studies affiliation ......................................................................................3  

Chapter 2: Admission, Degree Designation, Programme Duration and Competence Profile .........................................................................................................................3  
  2.1 Admission ..................................................................................................................3  
  2.2 Degree designation in Danish and English ..................................................................3  
  2.3 The programme’s specification in ECTS credits .........................................................4  
  2.4 Competence profile on the diploma ...........................................................................4  
  2.5 Competence profile of the programme ......................................................................4  

Chapter 3: Content and Organization of the Programme ..................................................6  
  Overview of the programme: ........................................................................................6  

Chapter 4: Entry into Force, Interim Provisions and Revision ..........................................47  

Chapter 5: Other Provisions .............................................................................................47  
  5.1 Rules concerning written work, including the Master’s thesis ..................................47  
  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 .................................47  
  5.3 Rules for examinations .............................................................................................47  
  5.4 Exemption ................................................................................................................47  
  5.5 Additional information .............................................................................................48  
  5.6 Completion of the Master’s programme ....................................................................48
1.1 Basis in ministerial orders
The Master’s programme in Innovative Communication Technologies and Entrepreneurship is organized in accordance with the Ministry of Science, Technology and Innovation’s Ministerial Order no. 814 of June 29, 2010 on Bachelor’s and Master’s Programmes at Universities (the Ministerial Order of the Study Programmes) and Ministerial Order no. 857 of July 1, 2010 on University Examinations (the Examination Order) with subsequent changes. Further reference is made to Ministerial Order no. 233 of March 24, 2011 (the Admission Order) and Ministerial Order no. 250 of March 15, 2007 (the Grading Scale Order) with subsequent changes.

1.2 Faculty affiliation
Kandidatuddannelsen hører under Det Teknisk-Naturvidenskabelige Fakultet, Aalborg Universitet.
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 Innovative Communication Technologies and Entrepreneurship requires a Bachelor’s degree in
- IT, Communication and New Media (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 (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 entrepreneur skab med specialisering i:
- “Konvergerende medieteknologier” (graduates from AAU Copenhagen)
- “Telekommunikationsinfrastruktur” (graduates from AAU Aalborg)

The English designation is: Master of Science (MSc) in Engineering (Innovative Communication Technologies and Entrepreneurship with specialisation in:
- “Converging Media Technologies” (graduates from AAU Copenhagen)
- “Telecom Infrastructure” (graduates from AAU Aalborg).
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 graduate of the Master’s programme has competencies acquired through an educational programme that has taken place in a research environment.

The graduate of the Master’s programme can perform highly qualified functions on the labour market on the basis of the educational programme. Moreover, the graduate has prerequisites for research (a Ph.D. programme). Compared to the Bachelor’s degree, the graduate of the Master’s programme has developed her/his academic knowledge and independence, so that the graduate can independently apply scientific theory and method in both an academic and occupational/professional context.

2.5 Competence profile of the programme

The graduate of the Master’s programme:

Knowledge

- has in-depth knowledge and understanding of issues within one of the areas: service development; business development; secure services and technologies; cognitive radio; or eHealth
- can understand and, on a scientific basis, reflect on the technical, organizational and market drivers in the convergence of ICT as well as the interplay between technology, market and user issues
- can reflect on the subject area’s knowledge, theory, methodologies and practice, and identify scientific issues
- understands the importance of innovation, creativity and entrepreneurship for ICT solutions and services
- depending on the chosen specialisation:
  - has knowledge on information and communication technologies (ICT) that is based on the highest level of international research, in the areas of either ‘converging media technologies’ or ‘telecom infrastructure’
  - understands the methods of organisation and distribution of digital media content and the analysis of related issues
  - understands 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
  - has a holistic understanding of the environment of ICT services and solutions: Scenarios of use, target users, stakeholders, business aspects, etc.
  - has knowledge on the significance of standardization and IPR including patents from a commercialization and market perspective

Skills

- excels in scientific methods, tools and general skills within the field of innovative communication technologies and entrepreneurship, specifically in the areas of ‘converging media technologies’ and ‘telecom infrastructure’
- can evaluate and select among relevant scientific theories, methods, tools and general skills and, on a scientific basis, advance new analyses and solutions within the subject areas
- can communicate research-based knowledge and discuss professional
and scientific problems with both peers and non-specialists

- excels in scientific writing: Articles, reports, documentation, etc.

- can identify and select among relevant standards, technologies and methods for development of ICT solutions and services

- can assess and compare different technologies for optimal technology selection, strategic decisions and business development

- can assess the market, ethical and regulatory framework for application of the technologies.

- can – depending on the chosen specialisation:
  - 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
  - develop innovative services, applications and solutions at a conceptual level, which are relevant in a user perspective.

- can – depending on the chosen sub-specialisation:
  - develop prototypes or demonstrators of viable ICT solutions and services, based on in-depth analysis of user requirements, technology and market issues and using state-of-the-art methods, technologies and tools
  - develop ICT solutions and services with a special focus on security issues: attack scenarios, risk analysis, protection against hackers, privacy protection and identity management
  - assess the implications and business potential of new ICT solutions and services and develop viable business models
  - 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
  - develop solutions for eHealth addressing social and technical aspects with special focus on security and privacy in the context of system design

**Competencies**

- has competencies in innovation and entrepreneurship that can be used to explore and exploit the great potential of new ICT and media technologies with an engineering approach

- has competencies in business development in a holistic perspective, based on a thorough understanding of the interplay between technology, market and users in ICT and media

- 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

- has competencies in project work and problem based learning in a global/multicultural environment

- can manage work and development situations that are complex, unpredictable and require new solutions

- can independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility

- can independently take responsibility for own professional development and specialisation

- can mediate collaboration and exchange between development- and business-related functions in organizations.
Chapter 3: Content and Organization of the Programme

The programme consists of two specialisations, and each of these is further divided into sub-specialisations:

1) **Converging Media Technologies (ICTE-C)**
   a. Service development
   b. Business development
   c. Secure services and technologies

2) **Telecom Infrastructure (ICTE-A)**
   a. Cognitive radio
   b. eHealth

In the following we shall refer to these specialisations as **ICTE-C** and **ICTE-A**, respectively. The former is offered in Copenhagen, whereas the latter is offered in Aalborg. The two specialisations 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 or more courses will be offered jointly for students at the two locations. For students on the September intake it is possible to change specialisation after the first semester.

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. Each semester has an overall theme, which is reflected in the scope of the (mandatory) course modules and semester projects.

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

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:

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).

An overview of the ECTS credit breakdown for the various semesters by modules is shown in the tables below. **Part A** describes the curriculum for students admitted on the September in-

take (either in Copenhagen or Aalborg), whereas Part B describes the modified curriculum for students admitted on the February intake (only in Copenhagen).

In general, students may choose different options for the 3rd and 4th semester. The thesis project must have a size of at least 30 ECTS, but it is possible to make larger thesis projects of 35, 40, 45, 50, 55 or 60 ECTS, if the thesis project is initiated in the 3rd semester. Depending on the choice, there will be room for 2-3 elective courses on the 3rd semester. The following options may be chosen:

**Option 1:**
- 3rd semester: 15, 20 or 25 ECTS semester project, supplemented by courses as specified in the tables below
- 4th semester: 30 ECTS thesis project

**Option 2:**
- 3rd semester: Internship in Denmark or abroad, or exchange abroad (in this case the mandatory courses on the 3rd semester may be waived)
- 4th semester: 30 ECTS thesis project

**Option 3 (long thesis project):**
- A thesis project of 35, 40, 45, 50, 55 or 60 ECTS, extending over 2 semesters, if necessary supplemented by courses on the 3rd semester in order to achieve the required number of ECTS.
- For students on the ICTE-C February intake, it is possible to make a 30 ECTS thesis project over 2 semesters and supplement by elective courses on both 3rd and 4th semester. At least 20 ECTS of the thesis project must be placed in the 4th semester.

**A: September intake (Copenhagen and Aalborg)**
The first semester consists of mandatory courses only (see Table 1). For semesters 2-4 students must choose a sub-specialisation, containing a mix of mandatory and elective courses. This is shown in Tables 2A and 2B.

Elective courses may generally be chosen from mandatory courses on other sub-specialisations 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 sub-specialisations or elective courses may be offered in a given semester.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Module</th>
<th>ICTE-C</th>
<th>ICTE-A</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</td>
<td></td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></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>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>Communication Networks and Ambient Intelligence</td>
<td>Mandatory</td>
<td></td>
<td>5</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>PHY and MAC Fundamentals</td>
<td>Mandatory</td>
<td></td>
<td>5</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Services and Platforms</td>
<td>Mandatory</td>
<td>Mandatory</td>
<td>15</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
</tbody>
</table>

Table 1. Structure of the 1st semester of ICTE (September intake).
### ICTE-C specialisation: Converging Media Technologies

<table>
<thead>
<tr>
<th>Semester</th>
<th>Module</th>
<th>Service development</th>
<th>Business development</th>
<th>Secure services and technologies</th>
<th>ECTS</th>
<th>Assessment</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd</td>
<td>Application Security and Identity Management</td>
<td>Elective</td>
<td>Elective</td>
<td>Mandatory</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>Mandatory</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>Mandatory</td>
<td>Elective</td>
<td>Elective</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>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Standardization</td>
<td>Elective</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>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>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>Mandatory</td>
<td>Mandatory</td>
<td></td>
<td>15</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td>Secure Services</td>
<td></td>
<td>Mandatory</td>
<td></td>
<td>15</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td>3rd</td>
<td>Content and Media Management</td>
<td>Mandatory</td>
<td>Elective</td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Governance of ICT Infrastructures</td>
<td>Elective</td>
<td>Mandatory</td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Advanced Security Topics</td>
<td>Elective</td>
<td>Elective</td>
<td>Mandatory</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Cognitive Systems and Semantic Modelling</td>
<td>Elective</td>
<td>Elective</td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Creativity and ICT Design</td>
<td>Elective</td>
<td>Elective</td>
<td>Elective</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Governance of ICT Content, Services and Applications</td>
<td>Elective</td>
<td>Elective</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>Elective</td>
<td>Elective</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></td>
<td>15</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Governance and Strategies</td>
<td></td>
<td>Mandatory</td>
<td></td>
<td>15</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Secure Technologies</td>
<td></td>
<td></td>
<td>Mandatory</td>
<td>15</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td>4th</td>
<td>Master’s Thesis</td>
<td>Mandatory</td>
<td>Mandatory</td>
<td>Mandatory</td>
<td>30, possibly 60</td>
<td>7-point scale</td>
<td>External</td>
</tr>
</tbody>
</table>

**Total** 90

Table 2A. Structure of semesters 2 to 4 of the ICTE-C specialisation (September intake). The sub-specialisations on "Service development", "Business development" and “Secure services and technologies” differ with respect to mandatory and elective courses as well as the semester and thesis projects.

---

2 The course is offered in either spring or autumn semesters, depending on student interest.
3 The course is offered in either spring or autumn semesters, depending on student interest.
<table>
<thead>
<tr>
<th>Semes-ter</th>
<th>Module</th>
<th>Cognitive radio</th>
<th>eHealth</th>
<th>ECTS</th>
<th>Assessment</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd</td>
<td>Advanced Telecommunication and its Applications</td>
<td>Mandatory</td>
<td></td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Standardization, IPR, Patenting and Technology Transfer</td>
<td>Mandatory</td>
<td></td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Distributed Network Management and Security</td>
<td>Mandatory</td>
<td></td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Development of ICT-based Applications</td>
<td>Mandatory</td>
<td></td>
<td>15</td>
<td>7-point</td>
<td>External</td>
</tr>
<tr>
<td>3rd</td>
<td>Techniques and Aspects for Cooperative and Cognitive Radio</td>
<td>Mandatory</td>
<td>Elective</td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Techniques and Aspects for eHealth</td>
<td>Elective</td>
<td>Mandatory</td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Machine Learning</td>
<td>Elective</td>
<td>Elective</td>
<td>5</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Cognitive Radio Systems Design</td>
<td>Mandatory</td>
<td></td>
<td>15-20</td>
<td>7-point</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>eHealth Systems Design</td>
<td>Mandatory</td>
<td></td>
<td>15-20</td>
<td>7-point</td>
<td>Internal</td>
</tr>
<tr>
<td>4th</td>
<td>Master’s Thesis</td>
<td>Mandatory</td>
<td>Mandatory</td>
<td>30, possibly 60</td>
<td>7-point</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2B. Structure of semesters 2 to 4 of the ICTE-A specialisation. The sub-specialisations on “Cognitive radio” and “eHealth” differ with respect to mandatory and elective courses as well as the semester and thesis projects.

The curriculum contains the following number of elective courses:

- **ICTE-C:**
  - 1st semester: No elective courses
  - 2nd semester: 1 course, 5 ECTS
  - 3rd semester: 2 courses, 10 ECTS

- **ICTE-A:**
  - 1st and 2nd semester: No elective courses
  - 3rd semester: 2 courses, 10 ECTS
B: February intake (Copenhagen only)

Students, who start in February, must choose a sub-specialisation already from the 1st semester. 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. The complete semester plan is shown in Table 3.

Elective courses may generally be chosen from mandatory courses on other sub-specialisations or from other related MSc programmes within the School of ICT, after consultation with the programme coordinator and approval from the Board of Studies. One elective course must be chosen for semester 1. Depending on student demand and staff availability, not all elective courses may be offered in a given semester.

<table>
<thead>
<tr>
<th>ICTE-C specialisation: Converging Media Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>1st</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2nd</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3rd</td>
</tr>
<tr>
<td>Development of ICT and Media Services</td>
</tr>
<tr>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Interaction Design</td>
</tr>
<tr>
<td>Managerial Economics</td>
</tr>
<tr>
<td>Standardization</td>
</tr>
<tr>
<td>Green ICT – Sustainable Business Devel-</td>
</tr>
<tr>
<td>opment 4</td>
</tr>
<tr>
<td>Advanced ICT Solutions</td>
</tr>
<tr>
<td>Governance and Strategies</td>
</tr>
<tr>
<td>Secure Technologies</td>
</tr>
<tr>
<td>4th</td>
</tr>
<tr>
<td>Cognitive Systems and Semantic Modelling</td>
</tr>
<tr>
<td>Creativity and ICT Design</td>
</tr>
<tr>
<td>Green ICT – Sustainable Business Devel-</td>
</tr>
<tr>
<td>opment 5</td>
</tr>
<tr>
<td>Governance of ICT Content, Services and Applications</td>
</tr>
<tr>
<td>Master’s Thesis (see NOTE below)</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 3. Complete structure of the ICTE-C specialisation (February intake). The sub-specialisations on “Service development”, “Business development” and “Secure services and technologies” differ with respect to mandatory and elective courses as well as the semester and thesis projects.

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.

The curriculum contains the following number of elective courses:

- 1st semester: 1 course, 5 ECTS
- 2nd semester: No elective courses
- 3rd semester: 0-3 courses, 0-15 ECTS
- 4th semester: Maximum 2 courses, 10 ECTS

---

4 Course offered in either spring or autumn semesters, depending on student interest.
5 Course offered in either spring or autumn semesters, depending on student interest.
**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:**
Lectures, exercises (individually and in groups), reflection, feedback, self-study.  
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.

**Evaluation criteria:** Are stated in the Framework Provisions.
### Semester project: Services and Platforms (Services og platforme)

Common description for Copenhagen and Aalborg, but offered separately at the two locations.

### 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 technologies and standards for networks and systems
  - 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 discuss the technical and business-related aspects of service architectures
  - 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 conceptually construct relevant business models
  - Must be able to assess networks characteristics and limitations
  - Must be able to identify service enablers and the specific requirements imposed by the service(s)

- **Competencies**
  - Must have competencies within at least one of the following areas:
    - be able to transform an identified user need into a conceptual design of a realistic ICT service
    - be able to analyse 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:
Individual 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 (Entrepreunerskab, innovation og forretningsmodeller)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory course for all students, offered jointly from Copenhagen.</td>
<td></td>
</tr>
</tbody>
</table>

<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 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 offering communication, media and information (CMI) services and products and using CMI solutions in their business operations

<table>
<thead>
<tr>
<th>Type of instruction:</th>
<th>Lectures, exercises and group work.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam format:</td>
<td>Individual oral or written examination.</td>
</tr>
</tbody>
</table>
### Course module:
**Communication and Broadcast Networks**  
*(Kommunikations- og broadcast-net)*  
Specialisation in Converging Media Technologies, Copenhagen

**Prerequisites:** None

**Objectives:**

Students who complete the module:

**Knowledge**
- Must have knowledge about wired (broadband) networks:
  - xDSL- and fibre-based infrastructures
- Must have knowledge about mobile and wireless networks:
  - 3G and beyond 3G, LTE, IEEE 802.11 and IEEE 802.16 standards
- Must have knowledge about short-range technologies:
  - Bluetooth, RFID, Near Field Communication
- Must be able to understand spectrum limitations and spectral efficiency:
  - Regulatory issues, characteristics of different frequency bands, interference, spread spectrum vs. OFDM
- Must have knowledge about digital broadcast networks (radio and TV):
  - Cable, satellite and terrestrial
- Must have knowledge about mobile broadcast/multicast platforms and standards:
  - MBMS, DVB-H, DMB, etc.
- 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 mobile and wireless 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 mobile networks, technologies and services and help develop new solutions and initiatives

**Type of instruction:** Traditional lectures.

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

**Evaluation criteria:** Are stated in the Framework Provisions.
**Course module:**
*Internet Technologies and Service Architectures (Internet-teknologier og tjenestearkitekturer)*
Specialisation in Converging Media Technologies, Copenhagen

**Prerequisites:** None

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

**Knowledge**
- Must have knowledge about the structure of the Internet and Internet design principles
- Must have knowledge about the key Internet technologies for representation, identification and transport of digital content
- Must have knowledge about the protocols, data structures and programming models for Internet services, including REST and SOAP
- Must have knowledge of session initiation and management, and real-time content delivery
- Must have knowledge of the main methods and technologies for adaptive content delivery to mobile terminals and other end-user devices
- Must have knowledge of mark-up languages, e.g. XML, HTML5
- Must be able to explain the concepts of “service”, “service enablers” and “service architectures” and be able to classify services
- Must have knowledge of the main standardization bodies and the process of developing specifications and standards for Internet technologies
- Must be able to understand the principles of Web 2.0 and their implications for services
- Must have knowledge of and be able to reflect on methods for "enrichment" of services: involvement of users, personalization, use of context, etc.

**Skills**
- Must be able to analyse the requirements that a given service imposes on servers, networks and terminals
- Must be able to evaluate QoS requirements for Internet applications and services
- Must be able to make a qualified choice of technologies, methods, platforms and service architecture in order to realize a given service
- Must be able to design services for real-time messaging and content distribution, including streaming media, over IP networks

**Competencies**
- Must be able to analyse and design a realistic ICT service (on a conceptual level) to address an identified user need
- Must be able to apply user-centric service development and stakeholder analysis in setting up the requirements specification for a service

**Type of instruction:** Lectures, exercises, self-study, reflection.

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

**Evaluation criteria:** Are stated in the Framework Provisions.
Course module: Communication Networks and Ambient Intelligence (Kommunikationsnetværk og omgivende intelligens)  
Specialisation in Telecom Infrastructure, Aalborg

Prerequisites: None

Objectives:  
Students who complete the module:

Knowledge
- Must have knowledge about general network models and architectures including the OSI model (MAC, transport, network and application layers) as well as the TCP/IP protocol stack (IP, TCP and UDP protocols)
- Must have knowledge about selected technologies within Internet of Things (IoT), including wireless sensors, wireless sensor networks and RFID, and their application within IoT.
- Must have knowledge of simulation tools
- Must have knowledge of protocols for unicast, multicast and broadcast

Skills
- Must be able to understand the OSI model and the TCP/IP protocol stack at a level where selected data link, network, transport, and application layer protocols can be modelled
- Must be able to monitor and observe traffic from different networks, and to use the observations for creating simple traffic models that can be used for simulations
- Must be able to describe and evaluate basic security mechanisms
- Must be able to select and compare methods for traffic engineering at data link, network and transport layers: in particular the students must be able to understand how Quality of Service mechanisms are actually implemented through e.g. marking and queueing policies
- Must be able to understand the RFID and sensor networking and protocols at such a level that they are able to model selected parts of such protocols
- Must be able to apply relevant methods for designing services and applications based on RFID and wireless sensor networks

Competencies
- Must be able to compare different network technologies and configurations by selecting and using appropriate methods, including analysis, simulation and experiments
- Must have understanding of the scenarios where IoT can be applied, both from technical and business viewpoints, identifying possible new services and applications
- Must have understanding of a network’s topology and its topological properties and qualities

Type of instruction:  
Instruction will be given through lectures and class discourse regarding lecture topics, workshops, mini projects/larger assignments and self-study.

Exam format: Individual oral or written examination.

Course module:
PHY and MAC Fundamentals
(PHY og MAC grundbegreber)
Specialisation in Telecom Infrastructure, Aalborg

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

Skills
- Must be able to:
  - Establish a link budget
  - Illustrate the information flow on a block level
  - 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:
Instruction will be given through lectures and class discourse regarding lecture topics.

Exam format: Individual oral or written examination.

### Semester project: Application Development (Applikationsudvikling)
Specialisation in Converging Media Technologies, Copenhagen
Sub-specialisation 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 design, test and analysis of applications or services based on current or future ICT platforms
- Must have knowledge about the necessary tools to develop ICT or media applications / services
- Must have knowledge of the implications that mobile platforms, devices, applications and services provide to Interaction Design and to the user interface of the application/services

**Skills**
- Must be able to analyse and assess user needs and ICT impact in relation to the design of new applications, software, mobile devices, etc.
- Must be able to reflect on the application development process and to characterize the process in relation
- Must be able to analyse, design, develop and test applications and services that can be deployed on ICT and media platforms and infrastructures
- Must be able to carry out the technical development process with a constant focus on target users, usage scenarios, stakeholders and business aspects to ensure the validity of approaches
- Must be able to identify and apply relevant theories and methods for synthesis and evaluation of the user interaction
- Must be capable of exploring and applying the potential of ICT to address a wide variety of private and professional user needs

**Competencies**
- Must have the competency to analyse a technical service design and develop one or more of the applications necessary to provide the service based on a specific user need. The scope can be private as well as professional users. In both cases, part of the work consists of designing the scenario, requirement specification, use cases and the final prototype design. Projects must include development of a Graphical User Interface (GUI), a concrete application or a service prototype. Examples could be the design, analysis or implementation of mobile media services, context-aware services, and interactive media services.

### Type of instruction: Project work.

### Exam format: Individual oral examination based on a written report.

**Semester project:**  
**Design and Markets**  
*(Design og markeder)*  
Specialisation in Converging Media Technologies, Copenhagen  
Sub-specialisation in Business 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 on issues relating to standardization and managerial economics as presented in the mandatory semester courses
- 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 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. Supervision and coaching. Furthermore, shorter seminars can be part of the semester project instruction.

**Exam format:**  
Individual oral examination based on a written report.

**Evaluation criteria:**  
Are stated in the Framework Provisions.
Semester project:
Secure Services
(Sikre tjenester)
Specialisation in Converging Media Technologies, Copenhagen
Sub-specialisation in Secure Services and Technologies

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 the necessary tools to develop ICT or media applications / services
- Must have knowledge about the necessary tools and elements for realizing security and trust at different levels
- Must have knowledge about methods for design, analysis, implementation and testing of secure applications or services on ICT platforms
- Must have knowledge about digital, partial and virtual identities
- Must have knowledge about technologies and frameworks for identity management
- Must have knowledge about methods for privacy, authentication and authorization, in particular privacy by design principles

Skills
- Must be able to identify and analyse possible security risks and attack scenarios for an application
- Must be able to apply appropriate methods for analysis, design, implementation and testing of applications or services based on common or future ICT platforms
- Must be able to develop ICT applications and services with different levels of security and trust
- Must be able to apply privacy by design principles and related methods for privacy, authentication and authorization

Competencies
- Must be able to analyse and assess user needs, security needs and ICT impact in relation to the design of new applications, software, mobile devices, embedded devices, etc.
- Must be able to identify relevant scenarios for violation of security and privacy
- Must be able to develop concepts and solutions for privacy protection and identity management with special emphasis on user empowerment and minimization of personal information disclosure
- Must be able to compare and select between different architectures and approaches for security, privacy protection and identity management

Type of instruction: Project work.

Exam format: Individual oral examination based on a written report.

**Semester project:**  
**Development of ICT-based Applications**  
*(Udvikling af IKT-baserede applikationer)*  
Specialisation in Telecom Infrastructure, Aalborg

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

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

**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:  
  - The underlying methodology and techniques  
  - 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:** Supervised project work.

**Exam format:** Individual oral examination based on a written report.

**Evaluation criteria:** Are stated in the Framework Provisions.
### Course module:
**Application security and Identity Management**  
*(Applikationssikkerhed og identity management)*

Specialisation in Converging Media Technologies, Copenhagen

### Prerequisites:
None

### Objectives:

Students who complete the module:

#### Knowledge
- Must have knowledge of the basic requirements for secure applications
- Must have knowledge of key management, certificates, tokens and secure elements
- Must have knowledge of security standards for end-to-end application/service security
- Must have knowledge of network, application and data security principles and methods
- Must have knowledge about security architectures, including policies and policy management
- Must be able to understand the principles and methods for authentication, authorization and identification
- Must be able to understand the concepts of digital, virtual and partial identities
- Must have knowledge of the key concepts of identity management and major identity management frameworks
- Must be able to explain the concepts of security, trust, assertion and privacy
- Must be able to understand the concepts of linkability and unlinkability and state-of-the-art principles for establishing trust and privacy protection

#### Skills
- Must be able to analyse risks and security requirements for an application at different levels
- Must be able to apply privacy by design principles and related methods for privacy, authentication and authorization
- Must be able to analyse and select the most relevant security technologies in a practical application
- Must be able to design and implement secure services with different levels of security

#### Competencies
- Must be able to design secure services and security architectures with controlled exchange of attributes between stakeholders and minimal disclosure of personal information
- Must be able to design applications and services incorporating security elements (e.g. payment, authentication) and management of user identities (authentication, authorization, privacy protection)
- Must be able to discuss management of personal information for access to resources and for personalization of services

### Type of instruction:
Lectures, exercises, self-study, reflection.

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

### Evaluation criteria:
Are stated in the Framework Provisions.
Course module:
Development of ICT and Media Services
(Udvikling af IKT- og medietjenester)
Specialisation in Converging Media Technologies, Copenhagen

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 be able to understand advanced service features such as personalization and context awareness
- Must have knowledge about service enablers like SyncML and OMA BCAST
- Must have knowledge about ‘context triggers’, sensors, NFC, etc.
- Must have knowledge about a range of software technologies (e.g. Qt, Python, AJAX, SOAP, HTML5, CSS3, JavaScript, XML, SQL)
- Must have knowledge about different Software Development Toolkits (SDK), simulators, emulators and Integrated Development Environment (IDE)
- Must have knowledge about automatic verification of properties in a formal model

Skills
- Must be able to design and implement mobile services/applications using high-level programming languages
- Must be able to formulate a requirement specification and discuss relevant methods, models and architectures
- Must be able to apply understanding of services and service platforms to develop a concrete and viable ICT solution or service
- Must be able to design, develop and evaluate the software components
- Must be able to produce a technical documentation

Competencies
- Must have the competency to design and develop ICT and media services and applications

Type of instruction: Traditional lectures and exercises.

Exam format: Individual oral or written examination.

<table>
<thead>
<tr>
<th>Course module: Interaction Design (Interaktionsdesign)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialisation in Converging Media Technologies, Copenhagen</td>
</tr>
</tbody>
</table>

| Prerequisites: | None |

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

**Knowledge**
- Must be able to understand the concepts of and relation between: human computer interaction, interaction design and user experience
- Must know different techniques and methods for elucidating user requirements
- Must be able to transform user requirements into interaction design
- Must know different techniques and methods for evaluation of various ICT products
- Must be able to use theories and methods applied in professional interaction design
- Must have knowledge of the implications that mobile platforms and devices provide to interaction design

**Skills**
- Must be able to apply the concept of user experience to mobile platforms and devices
- Must be able to evaluate a particular software, application or ICT product using techniques from interaction design and Human Computer Interaction
- Must be able to elucidate user requirements by involvement of user and application of a techniques (such as “think-aloud” test, and interviews)
- Must be able to reflect on user involvement

**Competencies**
- Must have competencies in evaluation of ICT products (software, applications or a device)
- Must be able to analyse the social context in which the use of ICT takes place
- Must have competencies in involvement of users in an ICT development process
- Must have competencies in interaction design theories as basis for general analyses of ICT related products
- Must have competencies in techniques for elucidation of user requirements

| Type of instruction: |
|Lectures, exercises (individually and in groups), workshops, self-study, reflection.|

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

| Evaluation criteria: |
|Are stated in the Framework Provisions.|
**Course module:**  
**Managerial Economics**  
(*Erhvervsøkonomi*)  
Specialisation in Converging Media Technologies, Copenhagen

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

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

**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

<table>
<thead>
<tr>
<th><strong>Type of instruction:</strong></th>
<th>Lectures and group work.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exam format:</strong></td>
<td>Individual oral or written examination.</td>
</tr>
<tr>
<td><strong>Evaluation criteria:</strong></td>
<td>Are stated in the Framework Provisions.</td>
</tr>
<tr>
<td><strong>Course module:</strong></td>
<td>Standardization (Standardisering)</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td><strong>Specialisation in Converging Media Technologies, Copenhagen</strong></td>
<td></td>
</tr>
</tbody>
</table>

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

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

**Knowledge**
- Must have knowledge on different types of standards, including open and closed standards and de facto and de jure standards
- Must be able to understand the importance and role of standards, standardization strategies, and standardization processes
- Must have knowledge on standardization organizations in the area of communication, media and information technologies
- Must have knowledge on the relationships between innovation and standardization

**Skills**
- Must be able to apply theories on network economics, information economics, and transaction costs analysis on standardization issues
- Must be able to analyse and evaluate the importance and role of standards, particularly within the area of communication, media and information technologies
- Must be able to appraise the role of standards in relation to processes of transaction between market players

**Competencies**
- Must have competencies to interpret the interests which underlie the development of standards
- 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
- Must have competencies to compare standardization strategies

<table>
<thead>
<tr>
<th><strong>Type of instruction:</strong></th>
<th>Lectures, exercises and group work.</th>
</tr>
</thead>
</table>

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

<table>
<thead>
<tr>
<th><strong>Evaluation criteria:</strong></th>
<th>Are stated in the Framework Provisions.</th>
</tr>
</thead>
</table>
**Course module:**
**Green ICT – Sustainable Business Development**  
*(Grøn IKT – Bæredygtig forretningsudvikling)*
Specialisation in Converging Media Technologies, Copenhagen

**Prerequisites:** None

<table>
<thead>
<tr>
<th>Objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students who complete the module:</td>
</tr>
</tbody>
</table>

**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 the topics in an interdisciplinary correspondence with other related disciplines
- Must be able to independently define and analyse scientific problems within the area of Green ICT

**Type of instruction:**
The course will be taught by a mixture of lectures, workshops, exercises, mini-projects and self-study.

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

**Evaluation criteria:** Are stated in the Framework Provisions.
Course module:
*Advanced Telecommunication and its Applications*
(*Avanceret telekommunikation og dets applikationer*)
Specialisation in Telecom Infrastructure, Aalborg

<table>
<thead>
<tr>
<th>Prerequisites:</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students who complete the module:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Must have knowledge about:</td>
</tr>
<tr>
<td>o Software defined radio (SDR)</td>
</tr>
<tr>
<td>▪ The motivation and purpose</td>
</tr>
<tr>
<td>▪ Implementation scenarios and issues</td>
</tr>
<tr>
<td>▪ Use cases</td>
</tr>
<tr>
<td>o Cognitive radio</td>
</tr>
<tr>
<td>▪ The motivation and purpose</td>
</tr>
<tr>
<td>▪ Implementation scenarios and issues</td>
</tr>
<tr>
<td>▪ Use cases</td>
</tr>
<tr>
<td>o Cooperative communications</td>
</tr>
<tr>
<td>▪ Basic techniques</td>
</tr>
<tr>
<td>▪ Purpose, benefit and drawbacks</td>
</tr>
<tr>
<td>• Must have knowledge about the applications for advanced telecommunication systems along with the special requirements related to reliability, privacy and trust</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 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</td>
</tr>
<tr>
<td>• Must be able to evaluate the taught techniques in relation to an application along with the benefits and drawbacks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Must be able to establish use cases for applications and apply SDR, cognitive radio and/or cooperative communication techniques in advanced telecommunication</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of instruction:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruction will be given through lectures and class discourse regarding lecture topics.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Evaluation criteria:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are stated in the Framework Provisions.</td>
</tr>
</tbody>
</table>
## Course module:
**Standardization, IPR, Patenting and Technology Transfer**  
(Standardisering, IPR, patentering og teknologioverførsel)  
Specialisation in Telecom Infrastructure, Aalborg

### Prerequisites:
None

### Objectives:
Students who complete the module:

**Knowledge**
- Must have knowledge about IPRs, the application process and the importance
- Must have knowledge about different standards, strategies and organizations for such
- Must be able to understand the importance of IPRs and standards from different business perspectives
- Must have knowledge about technology transfer, different processes and the advantages from an academic and industrial point-of-view

**Skills**
- Must be able to survey IPRs and assess the feasibility of applying such for a given invention
- Must be able to evaluate the organizational as well as competitive aspects of IPRs and standards

**Competencies**
- Must be able to assess strategies for applying standards and IPRs in a commercial perspective
- Must be able to assess the feasibility, impact and complications of IPRs and standards
- Must be able to assess technology transfer processes and the impact on different market players

### Type of instruction:
Instructions will be given through lectures, class discourse regarding lecture topics and self-study.

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

### Evaluation criteria:
Are stated in the Framework Provisions.
**Course module:**

**Distributed Network Management and Security**  
*(Distribueret management af netværk og sikkerhed)*  
Specialisation in Telecom Infrastructure, Aalborg

**Prerequisites:**

Students should have basic understanding of wireless and wired networks such as the one obtained through the course on “Communication networks and ambient intelligence”.

**Objectives:**

Students who complete the module:

**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

**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:**
Instructions will be given through lectures and class discourse regarding lecture topics.

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

**Evaluation criteria:**
Are stated in the Framework Provisions.
Semester project:
Advanced ICT Solutions
(Avancerede IKT-løsninger)
Specialisation in Converging Media Technologies, Copenhagen
Sub-specialisation in Service Development

Prerequisites:
Students must have completed their first two semester projects or 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 about how ICT applications and solutions can be deployed in order to address needs and improve efficiency in other sectors, including energy, emergency and environmental sectors

Skills
- Must be able to develop a converged media application or ICT service/solution targeting a specific application domain and considering scalability, state-of-the-art technologies and the use of different devices, networks and platforms. Examples for the latter could be Green ICT applications or applications related to Intelligent Transport Systems (ITS)
- Must be able to identify, select and apply suitable programming languages and software development strategies and justify their choices
- Must be able to analyse problems and solutions for the distribution of digital media content
- Must be able to formulate and plan how to manage and optimize content adaptation and delivery to meet the limitations of various types of networks and terminals as well as to meet stakeholders requirements
- Must be able to identify and analyse issues related to digital rights management (DRM), privacy protection and consumer protection regarding the introduction of ICT-related services
- Must be able to undertake a thorough analysis of the chosen application for technology choices, strategic decisions, innovation and entrepreneurship
- Must be able to analyse the possible methods to solve the problem, describe and assess the application of the chosen methods and evaluate how these influence the project results

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: Individual oral examination based on a written report.
<table>
<thead>
<tr>
<th><strong>Semester project:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Governance and Strategies</strong></td>
</tr>
<tr>
<td>(Governance og strategier)</td>
</tr>
<tr>
<td>Specialisation in Converging Media Technologies, Copenhagen</td>
</tr>
<tr>
<td>Sub-specialisation in Business Development</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Prerequisites:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Students must have completed their first two semester projects or have acquired similar knowledge, skills and competences otherwise.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Objectives:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Students who complete the module:</td>
</tr>
</tbody>
</table>

**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 (CMI) 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 CMI technologies
- Must be able to analyse the interaction between technologies, institutions, organisations and markets in a system perspective

<table>
<thead>
<tr>
<th><strong>Type of instruction:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervised project work. Furthermore, shorter seminars can be part of the semester project instruction.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Exam format:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual oral examination based on a written report.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Evaluation criteria:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Are stated in the Framework Provisions.</td>
</tr>
</tbody>
</table>
**Semester project:**
**Secure Technologies (Sikkerhedsteknologier)**
Specialisation in Converging Media Technologies, Copenhagen
Sub-specialisation in Secure Services and Technologies

**Prerequisites:**
- Course on 'Advanced security topics' (can be taken same semester)
- Project on 'Secure services'

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

**Knowledge**
- Must have knowledge about the commonly used security solutions for wireless communication standards and ICT systems in general
- Must have knowledge about the internal structure of the commonly used algorithms for encryption/decryption and authentication
- Must have knowledge about common methods for implementing safe code
- Must have knowledge of state-of-the-art firewall technologies

**Skills**
- Must be able to analyse and select the relevant security technologies for an actual system
- Must be able to design a secure communication protocol
- Must be able to use appropriate methods for implementing safe code
- Must be able to design an application, an algorithm, a protocol, a service or a network configuration where security plays a particularly important role

**Competencies**
- Must be able to discuss, advantages and disadvantages of algorithms for encryption/decryption and authentication
- Must be able to compare security designs
- Must be able to apply state-of-the-art security approaches in the context of a development project

**Type of instruction:**  Project work.

**Exam format:**  Individual oral examination based on a written report.

**Evaluation criteria:**  Are stated in the Framework Provisions.
Semester project:
**Cognitive Radio Systems Design** *(Design af kognitiv radio-systemer)*
Specialisation in Telecom Infrastructure, Aalborg
Sub-specialisation in Cognitive Radio

**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:** Individual oral examination based on a written report.

**Evaluation criteria:** Are stated in the Framework Provisions.
Semester project:
**eHealth Systems Design**  
*(Design af eHealth-systemer)*  
Specialisation in Telecom Infrastructure, Aalborg  
Sub-specialisation in eHealth

**Prerequisites:**
A thorough understanding of telecommunication systems and principles and analysis, design, implementation and test of innovative ICT applications.

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

**Knowledge**
- Must have knowledge about major eHealth systems related to:
  - Electronic health records
  - Telemedicine and mobile health (mHealth)
  - Information systems for healthcare
- Must have knowledge about telecommunications infrastructures and the special requirements of eHealth systems
- Must have knowledge about systems for management of health knowledge and consumer health informatics

**Skills**
- Must be able to use telecommunications protocols for design of eHealth systems
- Must be able to define user requirements for dimensioning of eHealth systems
- Must be able to understand evaluation protocols and methodologies for eHealth systems/services
- Must be able to define the target market for eHealth services

**Competencies**
- Must be able to design, implement and test innovative eHealth system architectures and network topologies

**Type of instruction:** Project work.

**Exam format:** Individual oral examination based on a written report.

**Evaluation criteria:** Are stated in the Framework Provisions.
### Course module:
**Content and Media Management**  
*(Indholds- og medieorganisation)*  
Specialisation in Converging Media Technologies, Copenhagen

### 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 Integrate multimedia content in a service
- 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:
Lectures, exercises, self-study and reflection.

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

### Evaluation criteria:
Are stated in the Framework Provisions.
Course module: Governance of ICT Infrastructures (Regulering af IKT-infrastrukturer)  
Specialisation in Converging Media Technologies, Copenhagen

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

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

**Knowledge**
- Must have knowledge about spectrum management
- Must have knowledge about Universal Service
- Must have knowledge about interconnection of communication networks
- Must have knowledge about regulation of numbers and domain names and VoIP
- Must have knowledge about recent regulatory regimes
- Must have knowledge about roaming
- Must have knowledge about governance of the Internet

**Skills**
- Must be able to explain and analyse principal objectives and approaches to telecom regulation
- Must be able to identify key regulatory areas and assess the need for a specific regulatory action
- Must be able to evaluate identify the need for spectrum regulation and assess different regulatory approaches
- Must be able to analyse the economic and technological conditions which influence the structure of the market for ICT infrastructure
- Must be able apply regulation theory to identify the key regulatory issues for the ICT infrastructures

**Competencies**
- Must have competencies in understanding the market for ICT infrastructures, and how these are regulated at the national and international level.

<table>
<thead>
<tr>
<th>Type of instruction:</th>
<th>Lectures and group work.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam format:</td>
<td>Individual oral or written examination.</td>
</tr>
</tbody>
</table>
## Course module:
**Advanced Security Topics**  
*(Avancerede emner i sikkerhed)*  
Specialisation in Converging Media Technologies, Copenhagen

### Prerequisites:
Courses on “Application security and identity management”, “Communication and broadcast networks” and “Internet technologies and service architectures” or similar qualifications.

### Objectives:
Students who complete the module:

**Knowledge**
- Must have knowledge about the internal structure of major cryptographic algorithms like AES and ECC
- Must have knowledge about state-of-the-art firewall technologies, including intrusion detection and intrusion prevention systems
- Must have knowledge about major malware principles
- Must have knowledge about major security flaws, attacks and countermeasures
- Must have knowledge about methods for implementing state-of-the-art safe code, which is not vulnerable to malware attacks

**Skills**
- Must be able to apply common methods for creation of a secure design
- Must be able to understand major security designs, in particular in the wireless domain
- Must be able to analyse and select the most relevant security technologies with a practical relevance
- Must be able to design an application, an algorithm, a protocol or a service, where security plays a particularly important role
- Must be able to design a network configuration, where security plays a particularly important role

**Competencies**
- Must be able to analyse and evaluate the advantages and disadvantages of a security design, including the cryptographic algorithms involved
- Must be able to compare security designs
- Must be able to explain and discuss methods for securing a protocol, for implementing safe code and for securing services and networks

### Type of instruction:
Lectures, exercises, self-study and reflection.

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

### Evaluation criteria:
Are stated in the Framework Provisions.
<table>
<thead>
<tr>
<th>Course module:</th>
<th>Cognitive Systems and Semantic Modelling (Kognitive systemer og semantisk modellering)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialisation in Converging Media Technologies, Copenhagen</td>
<td></td>
</tr>
</tbody>
</table>

**Prerequisites:**
The course on “Development of ICT and media services” or similar qualifications.

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

**Knowledge**
- Must have knowledge in the basic anatomy of the human brain. This includes the various brain centres and how brain nerve cells functions
- Must be able to describe the mathematical background of neuro-informatics
- Must have knowledge in the basic concept of artificial intelligence (AI). This covers the classic and modern techniques.
- Must be able to understand the principle of evolutionary algorithms and how to do parameter optimisation based on best fitness
- Must be able to describe principles of cognitive system engineering
- Must be able to understand principles of data mining and semantic modelling relating to natural language processing (NLP)
- Must be able to understand and design ontologies to be used in data mining and adaptive systems

**Skills**
- Must be able to discuss and argue for the choice of different techniques in AI and cognitive systems engineering
- Must be able to integrate different techniques from the classic and modern AI and cognitive system engineering
- Must be able to analyse barriers and solutions for designing an autonomous machine interpreter to be used in e.g. recommender systems

**Competencies**
- Must be able to distinguish between different types of artificial intelligence technologies and where these could be applied
- Must be able to explain what challenges NLP opposes when designing an autonomous semantic interpretation system
- Must be able to define ontologies to be used when data mining in large data sets
- Must be able to design recommender system using machine learning techniques in order to make services adaptive

**Type of instruction:** Lectures, exercises, self-study and reflection.

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

**Evaluation criteria:** Are stated in the Framework Provisions.
Course module: Creativity and ICT Design (Kreativitet og IKT-design) Specialisation in Converging Media Technologies, Copenhagen

<table>
<thead>
<tr>
<th>Prerequisites:</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives: Students who complete the module:</td>
<td></td>
</tr>
</tbody>
</table>

Knowledge
- Must have knowledge about different types of ICT design processes
- Must be able to understand the concept of creativity
- Must be able to understand the creative process
- Must have knowledge about different creativity techniques and their application areas
- Must be able to understand the phrase of user driven innovation
- Must have knowledge about the link between creativity and innovations

Skills
- Must be able to apply creativity techniques in relation to an ICT product (device, software, application, service, etc.)
- Must be able to evaluate an ICT design process
- Must be able to apply a design process to the development of an idea
- Must be able to evaluate different creativity techniques to judge their applicability in a given situation
- Must be able to work theoretically with the notion of creativity

Competencies
- Must have competencies use, understanding and analysis of different creativity techniques
- Must have competencies in understanding different design processes
- Must have competencies in linking creativity into a design process

Type of instruction: Lectures, exercises (individually and in groups), self-study, reflection, teacher feedback.

Exam format: Written examination based on deliveries of exercises during and after the classes. Since the course takes a relatively practical approach to obtaining the objectives, class participation is required (presence and participation is required for a minimum of 80% of the classes).

**Course module:**
**Governance of ICT Content, Services and Applications**  
*(Regulering af IKT indhold, tjenester og applikationer)*
Specialisation in Converging Media Technologies, Copenhagen

**Prerequisites:**  
None

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

**Knowledge**
- Must have knowledge about patents, copyright, licensing, trademark, domain names, media regulation, marketing, privacy protection, consumer rights, competition law and special e-commerce

**Skills**
- Must be able to identify and analyse copyright issues and other intellectual property rights questions related to the provision of digital content, services and applications
- Must be able to identify and analyse the basic issues related to privacy protection and consumer protection regarding the introduction of ICT-related services
- Must be able to understand and explain the basic elements of international regulation and EU law on IPR, privacy and consumer protection
- Must be able to assess the impact of legal and regulatory issues on market developments
- Must be able to analyse the problems raised by the internationalisation of content provision and the national character of legal provisions
- Must be able to appraise the implications of legal and ethical issues for the development of business models

**Competencies**
- Must have competencies in legal and ethical issues related to the provision of ICT content, services and applications

**Type of instruction:**  
Lectures and group work.

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

**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)
Specialisation in Telecom Infrastructure, Aalborg

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:
Instruction will be given through lectures and class discourse regarding lecture topics.

Exam format: Individual oral or written examination.

### Course module:
**Techniques and Aspects for eHealth**  
*(Teknikker og aspekter for eHealth)*  
Specialisation in Telecom Infrastructure, Aalborg

### 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:
Instruction will be given through lectures and class discourse regarding lecture topics.

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

### Evaluation criteria:
Are stated in the Framework Provisions.
<table>
<thead>
<tr>
<th>Course module:</th>
<th>Machine Learning (Maskinlæring)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialisation in Telecom Infrastructure, Aalborg</td>
<td></td>
</tr>
</tbody>
</table>

### Prerequisites:
Basic knowledge in probability theory, statistics, and linear algebra.

### Students who complete the module:

#### 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.

### Evaluation criteria:
Are stated in the Framework Provisions.
**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 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 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:**  
Individual 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, 2011.

Students who wish to complete their on-going studies under the previous curriculum from Innovative communication technologies and entrepreneurship must conclude their education by the summer examination period 2014 at the latest, since examinations under the previous curriculum are not offered after this time.

In accordance with the Framework Provisions and the Handbook on Quality Management for the Faculty of Engineering and Science 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) programme elements from other Master’s programmes in lieu of programme elements in this programme (credit transfer). The Board of Studies can also approve successfully completed (passed) programme elements from another Danish programme or a programme outside of Denmark at the same level in lieu of programme elements within this curriculum. Decisions on credit transfer are made by the Board of Studies based on an academic assessment. See the 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 Faculty of Engineering and Science 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.

---

6 Or another foreign language (upon approval from the Board of Studies.
7 The Board of Studies can grant exemption from this.
5.5 Additional information
The current version of the curriculum is published on the website of School of Information and Communication Technology (SICT), http://www.sict.aau.dk, including more detailed information about the programme and exams.

5.6 Completion of the Master's programme
The Master's programme must be completed no later than four years after it was begun.
APPENDIX

Revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 2012</td>
<td>Elective course “Green ICT – Sustainable business development” is offered in either spring or autumn semesters, depending on student interest.</td>
</tr>
</tbody>
</table>