Curriculum for the Master’s programme in Digital Communication Leadership (DCLead)

Aalborg University

September 2018
Preface

Pursuant to Act 261 of March 18, 2015 on Universities (the University Act) with subsequent changes, the following curriculum for the Master's program in Digital Communication Leadership (DCLead) is stipulated. The program also follows the Joint Programme Regulations and the Examination Policies and Procedures.
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Chapter 1: Legal Basis of the Curriculum, etc.

1.1 Basis in ministerial orders
The Master’s program in Digital Communications Leadership is organised in accordance with the Ministry of Science, Innovation and Higher Education’s Order no. 1328 of November 15, 2016 on Bachelor’s and Master’s Programs at Universities (the Ministerial Order of the Study Programs) and Ministerial Order no. 1062 of June 30, 2016 on University Examinations (the Examination Order). Further reference is made to Ministerial Order no. 111 of January 30, 2017 (the Admission Order) and Ministerial Order no. 114 of February 13, 2015 (the Grading Scale Order) with subsequent changes.

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

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

1.4 External Examiners Corps
The Master’s programme is associated with the body of external examiners for engineering educations: electro (In Danish: censorkorps for Ingeniøruddannelsernes landssækkende censorkorps; elektro).

1.5 Erasmus+ programme
DCLead is an Erasmus+ Master’s programme. The programme has two study tracks: Digital Technology and Management delivered by Aalborg University Copenhagen and Paris Lodron University of Salzburg (PLUS) and Digital Communications, Policy and Innovation in Europe delivered by Vrije Universiteit Brussel (VUB) and PLUS. The programme described in the following is the Digital Technology and Management track of the education.

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

2.1 Admission

Applicants with a legal right of admission (retnskrav):
Aalborg University offers no bachelor’s programmes with a legal right of admission to this Master’s program

Applicants without legal right of admission
Bachelor’s programmes qualifying students for admission:
  • Bachelor of Science (BSc) in Information Technology, Aalborg University
  • Bachelor of Science in Informatics, Aalborg University

All students must document English language qualifications comparable to an 'English B level' in the Danish upper secondary school (minimum average grade 02).

DCLead is an Erasmus+ Master’s programme focusing primarily on students from non-EU countries.
Selection among the students who apply for admission will be made by a committee consisting of representatives from the three involved universities. Selection criteria include educational background, grades and other relevant activities, including work experience.
2.2 Degree designation in Danish and English
The Master’s programme entitles the graduate to the designation:

In Danish:
- Cand.it. i ledelse af digital kommunikation

In English:
- Master of Science (MSc) in Information Technology (Digital Communication Leadership)

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

2.4 Competence profile on the diploma
The following competence profile will appear on the diploma:

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

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

The graduate of the Master’s programme:

<table>
<thead>
<tr>
<th>Knowledge</th>
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<tbody>
<tr>
<td>has knowledge on information and communication technologies (ICT) that, in selected areas, is based on the highest international research</td>
<td></td>
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<tr>
<td>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</td>
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<tr>
<td>understands the importance of innovation, creativity and entrepreneurship for ICT solutions and services</td>
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<tr>
<td>understands and can reflect, on a scientific basis, on the technical, organizational and market-related drivers in the convergence of ICT, as well as the interplay between technology, market and user issues</td>
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<tr>
<td>has a holistic understanding of the environment of ICT services and solutions: Scenarios of use, target users, stakeholders, business aspects, and societal implications at large</td>
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<tr>
<td>has knowledge about different cost concepts and different methods for investment analysis</td>
<td></td>
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<tr>
<td>has in-depth knowledge and understanding of ICT-related business plan and business models</td>
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<tr>
<td>has in-depth knowledge on economic concepts and tools relevant for preparing a market analysis</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Skills</th>
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<tbody>
<tr>
<td>can identify scientific problems within the field of ICT</td>
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<td>can evaluate and select among scientific theories, methods, tools and general skills and – on a scientific basis – advance new analyses and solutions within applied ICT</td>
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<td>can efficiently communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists</td>
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<td>can produce scientific writing: Articles, reports, documentation, etc.</td>
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<td>can apply scientific methods, tools and general skills related to employment within the field of ICT</td>
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<tr>
<td>can identify and select among relevant standards, technologies and methods for development of ICT solutions and services</td>
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<tr>
<td>can assess the market, ethical and regulatory framework for application of the technologies</td>
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<td>can develop innovative services, applications and solutions at a conceptual level, which are relevant in a user perspective</td>
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<td>can assess the implications and business potential of new ICT solutions and services and develop viable business models and strategies</td>
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<td>can prepare a business plan with a detailed financial analysis for introducing an ICT solution or service</td>
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<tr>
<td>can assess the role of existing and emerging ICT solutions and services in relation to sustainable development and evaluate the feasibility of sustainable technologies and solutions</td>
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<tr>
<td>Competencies</td>
<td>can manage work and development situations that are complex, unpredictable and require new solutions</td>
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<td>---------------------------------------------------------------------------------------------------------</td>
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<td></td>
<td>can independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility</td>
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<td></td>
<td>can independently take responsibility for own professional development and specialisation</td>
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<td></td>
<td>has competencies in project work and problem based learning in a global/multicultural environment</td>
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<td>can mediate collaboration and exchange between development- and business-related functions in organizations.</td>
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<td></td>
<td>has competencies in business development with a holistic perspective, based on a thorough understanding of the interplay between technology, market and users in ICT and media</td>
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<td></td>
<td>can contribute creatively and innovatively to propose and develop new services/solutions respecting and challenging established legal rules and design principles.</td>
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<td></td>
<td>has an in-depth understanding of ICT technologies enabling creative and innovative solutions and development of these</td>
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<td></td>
<td>has competencies in innovation and entrepreneurship that can be used to transform the potentials of new ICT and media technologies into new solutions and services with an engineering approach</td>
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</tbody>
</table>
Chapter 3: Content and Organisation of the Programme

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

The programme is based on a combination of academic, problem-oriented and interdisciplinary approaches and organized based on the following work and evaluation methods that combine skills and reflection: a) lectures, b) classroom instruction, c) project work, d) workshops, e) exercises (individually and in groups), f) teacher feedback, g) reflection, h) portfolio work

3.1 Overview of the programme
All students admitted to the program, start at Salzburg (PLUS) and take the first semester in Salzburg. With respect to the second and third semester, the students, who follow the specialisation in 'Digital Technology and Management', go to AAU:

As for the last semester where the students are doing their master’s thesis and complete their education, students of the specialization in Digital Communication and Management can choose to go to Salzburg or stay at AAU. Alternatively, students can undertake their last semester at one of the associate partner universities. However, it is a requirement, that the master’s thesis is supervised and examined by supervisors from PLUS and AAU in collaboration with a supervisor from the associated partner university.

The structure of the whole education is depicted in the following figure 1:
The following table gives an overview over the courses and projects that constitutes the education’s scientific content.

Table 1: Complete semester structure.

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>PLUS</th>
<th>AAU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer symposium I - 3 ECTS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Introduction to core competency I - 5 ECTS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Introduction to core competency II - 5 ECTS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elective course - 2 ECTS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Semester Project - 15 ECT</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 2</th>
<th>Managerial Economics - 5 ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Green ICT – Sustainable Business Development - 5 ECTS</td>
</tr>
<tr>
<td></td>
<td>Elective course - 5 ECTS*</td>
</tr>
<tr>
<td></td>
<td>Semester project: Design and Markets - 15 ECTS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 3</th>
<th>PLUS</th>
<th>AAU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer symposium II - 5 ECTS **</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 4</th>
<th>All Universities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Master Project – 30 ECTS</td>
</tr>
</tbody>
</table>

* The elective courses must be chosen amongst the elective courses listed below.

** The course is offered in collaboration between PLUS and AAU in accordance with AAU regulations.

The curriculum contains the following number of elective courses:
1. 1st semester: 1 course, 2ECTS
2. 2nd semester: 1 course, 5 ECTS
3. 3rd semester: 1 course, 5 ECTS

Elective courses may be chosen amongst the following courses from the Master's program in Innovative Communication Technologies and Entrepreneurship (ICTE):

2nd semester:
- Development of ICT and Media Services
- Identity and Access Management
- Interaction design

3rd semester
- Communication and Broadcast networks
- Internet Technologies and Service Architectures
- Content and Media Management
- Entrepreneurship, Innovation and Business Models
- Standardization
- Cyber Security and Trust
- Smart Sensor Data Processing

As the DClead education is based on POPBL, the teaching on POPBL takes place within the introductory course in the first semester. The teachers from AAU participating in the introductory course will give an introduction to the POPBL learning/teaching method. Furthermore, when the students come to Aalborg in the beginning of the second semester there will be common project meetings/seminars with all DCLead students where different aspects of POPBL will be discussed in more details.

In the following we only provide details about courses and projects offered at AAU. For courses and projects offered at PLUS please refer to the PLUS's study plan.

The following table provides an overview of the courses and projects offered at AAU.

<table>
<thead>
<tr>
<th>Sem.</th>
<th>Module</th>
<th>Project/course</th>
<th>ECTS</th>
<th>Assessment</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd</td>
<td>Managerial Economics (mandatory)</td>
<td>C</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Green ICT – Sustainable Business Development (mandatory)</td>
<td>C</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Development of ICT and Media Services (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Identity and Access Management (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Interaction Design (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Design and Markets</td>
<td>P</td>
<td>15</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td>3rd</td>
<td>Summer symposium II - 5 ECTS * (mandatory)</td>
<td>C</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Internet Economics and Govern-</td>
<td>C</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td>Course Description</td>
<td>Code</td>
<td>Credits</td>
<td>Scale</td>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>Communication and Broadcast Networks (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>Internet Technologies and Service Architectures (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>Content and Media Management (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>Entrepreneurship, Innovation and Business Models (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>Standardization (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>Cyber Security and Trust (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>Smart Sensor Data Processing (elective)</td>
<td>C</td>
<td>5</td>
<td>7-point</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>Governance and strategies (P)</td>
<td>P</td>
<td>15</td>
<td>7-point</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>Master's Thesis (P)</td>
<td>P</td>
<td>30</td>
<td>7-point</td>
<td>External</td>
<td></td>
</tr>
</tbody>
</table>

* This course is offered in collaboration between AAU and PLUS in accordance with AAU regulations.
## Descriptions of modules

### Semester project:  
**Design and Markets**  
*(Design og markeder)*

### Recommended academic prerequisites:  
The project module builds upon knowledge obtained during the 1st first semester project or similar knowledge, skills and competences obtained otherwise.

### Objectives:  
Students who complete the module:

**Knowledge**
- Must be able to understand technology as socio-technical systems where the context of use is pivotal for the value of communication, media and information (CMI) technologies.
- Must have knowledge on new organizational forms, new business concepts and changes in the market conditions together with new methods for involving users in the design of communication, media and information technology solutions.

**Skills**
- Must be able to identify and apply relevant theories for the synthesis and evaluation of the studied situation.
- Must be able to apply knowledge of green ICT and managerial economics as presented in the mandatory semester courses.
- Must be able to identify situations of CMI technology related implications for the market.
- Must be able to analyse the conditions and implications of use of communication, media and information technologies for individual users, groups, organizations and society by drawing on technical, organizational and techno-economic perspectives.

**Competencies**
- Must have the competencies to distinguish between design and market implications at individual, group, organizational or societal level.
- Must have the competencies to perform and analysis of the conditions and implications of communication, media and information technologies in a specific market context.
- Must have the competencies to combine theories from different technology, organizational and socio-technical areas to create a multi-faceted understanding of the "problem".
- Must have the competencies to focus on a particular situation of use or a new phenomenon related to new CMI technologies; it could be the conditions and implications related to an organization engaging in outsourcing, or it could be the conditions and needs for new standards.

### Type of instruction:  
Project work.

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

### Evaluation criteria:  
Are stated in the Joint Programme Regulations.
## Course module:
**Managerial Economics (Erhvervsøkonomi)**

### 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

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

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

### Evaluation criteria:
Are stated in the Joint Programme Regulations.
**Course module:**
**Green ICT – Sustainable Business Development**  
(Gron IKT – Bæredygtig forretningsudvikling)

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

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

**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 and induction 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 competency to apply and integrate sustainability in an interdisciplinary way, considering user, technology and market aspects.
- Must have the competency to independently define and analyse scientific problems within the area of Green ICT

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

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

**Evaluation criteria:**  
Are stated in the Joint Programme Regulations.
**Semester project:**  
**Governance and Strategies**  
*(Regulering og strategier)*

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

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

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

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

<table>
<thead>
<tr>
<th><strong>Type of instruction:</strong></th>
<th>Project work.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exam format:</strong></td>
<td>Oral examination based on a written report.</td>
</tr>
<tr>
<td><strong>Evaluation criteria:</strong></td>
<td>Are stated in the Joint Programme Regulations.</td>
</tr>
</tbody>
</table>
Course module:  
**Internet Economics and Governance**  
(Internet-økonomi og regulering)

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

Students who complete the module:

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

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

**Competencies**
- Must be able to demonstrate development of his/her knowledge, understanding, and ability to make use of socio-economic methods within the fields of Internet economics and governance

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

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

**Evaluation criteria:** Are stated in the Joint Programme Regulations.
# Course module:
**Summer Symposium II**
*(Sommer Symposium II)*

## Objectives:
The objective of the course is to enable the students to develop an advanced scientific research project as a preparation for the master project.

Students who complete the module:

### Knowledge
- Must have knowledge about broad range of advanced scientific theories and their applicability for designing a research project
- Must have knowledge about scientific methodology including the relationship between inductive and deductive methodologies.
- Must have knowledge about scientific methods including the use of qualitative and quantitative methods in their projects
- Must have knowledge about interdisciplinary approaches, including combining approaches from media science and engineering science

### Skills
- Must be able to discuss the concept of scientific methods
- Must be able to apply different scientific methods for a particular problem
- Must be able on basis of a specific relevant topic work on definition of an advanced research project
- Must be able in the definition of the project: define problem definition and argue for the choice of methodology and theoretical framework, methods, and source of data to be used

### Competencies
- Must have competencies in use of scientific methods
- Must have competencies in setting up a report as a scientific document
- Must have competencies in presenting their work in the summer symposium and reflect on the comments from fellow students, senior teachers and industry representatives and update the initial outline after the summer symposium

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

## Exam format:
Individual oral or written examination.

## Evaluation criteria:
Are stated in the Joint Programme Regulations.
**Semester project: Master’s Thesis (Kandidatspeciale)**

**Recommended academic prerequisites:** The module builds upon knowledge obtained during the 3rd semester project.

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

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

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

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

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

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

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

**Evaluation criteria:** Are stated in the Joint Programme Regulations.
Elective courses:

**Course module:**
**Communication and Broadcast Networks**
*(Kommunikations- og broadcast-net)*

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

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

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

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

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

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

**Evaluation criteria:** Are stated in the Joint Programme Regulations.
Course module: Entrepreneurship, Innovation and Business Models (Entrepreneurskab, innovation og forretningsmodeller)

Objectives: Students who complete the module:

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

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

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

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

Exam format: Individual oral or written examination.

Evaluation criteria: Are stated in the Joint Programme Regulations.
Course module:
Internet Technologies and Service Architectures
(Internet-teknologier og tjenestearkitekturer)

Objectives:
Students who complete the module:

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

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

Competencies
- Must have the competency to assess the potential and applicability of state-of-the-art Internet technologies, programming models and architectures in order to realize a given functionality

Type of instruction: Types of instruction are listed at the start of Chapter 3.
Exam format: Individual oral or written examination.
Evaluation criteria: Are stated in the Joint Programme Regulations.
Course module: Development of ICT and Media Services (Udvikling af IKT- og medietjenester)

Recommended academic prerequisites: The module builds upon knowledge of object-oriented programming.

Objectives: Students who complete the module:

Knowledge
- Must be able to understand architectural issues such as the division of functions between terminal, server and networks.
- Must have knowledge about low-level service enablers in relation to Internet of Things, sensors, and smart actuators.
- Must have knowledge about development platforms and environments, such as Software Development Kits (SDK), simulators, emulators, and Integrated Development Environment (IDE).
- Must have knowledge of web development tools, e.g. MEAN (MongoDB, Express.js, Angular.js and Node.js), RESTful programming models and JSP (Java Server Pages)/servlets.
- Must have knowledge about basic artificial intelligence and pattern recognition algorithms and principles.
- Must have knowledge about platform programming and scripting, e.g. tablets, Raspberry Pi, Arduino, or Smart TV.
- Must understand interface and communication concepts in relation to external servers, databases, and cloud-based services.

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

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

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

Exam format: Individual oral or written examination.

Evaluation criteria: Are stated in the Joint Programme Regulations.
# Course module: Identity and Access Management (Identitets- og adgangshåndtering)

## Recommended academic prerequisites:
The modules builds upon knowledge obtained in the course “Internet technologies and service architectures” or similar. Moreover, knowledge of basic security principles is desirable.

## Objectives:
Students who complete the module:

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

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

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

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

## Exam format:
Individual oral or written examination.

## Evaluation criteria:
Are stated in the Joint Programme Regulations.
## Course module:
**Interaction Design**  
*Interaktionsdesign*

### Recommended academic prerequisites:
The module builds upon an basic understanding of human-computer interaction.

### Objectives:
Students who complete the module:

#### Knowledge
- Must understand the concepts of human computer interaction, interaction design and user experience and the relation between them
- Must have knowledge of different input and output modes for interactive systems, also in a historical perspective
- Must have knowledge of different methods for designing interaction of ICT systems
- Must have knowledge of different strategies for planning the interaction design of ICT systems

#### Skills
- Must be able to apply the concepts of usability and user experience both to screen-based and non-screen-based interactive systems
- Must master different design methods and techniques for creating and testing interactive systems, including non-screen-based systems
- Must be able to identify tensions between different visions for – and interests in – the design of an interactive system
- Must be able to discuss user cognitive models and other descriptions of users
- Must be able to analyse different types of data from and about users
- Must be able to design the interaction of a given system based on data from and about users
- Must be able to reflect critically on methodological challenges in data from and about users as a source for design
- Must be able to evaluate interactive systems using techniques from interaction design and Human Computer Interaction

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

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

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

### Evaluation criteria:
Are stated in the Joint Programme Regulations.
**Course module:**
**Content and Media Management**  
(Indholds- og medieorganisation)

**Recommended academic prerequisites:**
The module builds upon knowledge obtained in the courses “Internet technologies and service architectures” and “Development of ICT and media services” or similar.

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

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

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

**Competencies**
- Must have the competency to analyse and evaluate systems and solutions for content and media management
- Must have the competency to advice content providers and non-technical persons on content and media management systems
- Must have the competency to analyse technical aspects of content and media management in a larger political-social-economical context

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

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

**Evaluation criteria:**
Are stated in the Joint Programme Regulations.
**Course module:**

**Standardization**  
*(Standardisering)*

**Recommended academic prerequisites:**

The module builds upon knowledge obtained in the course “Entrepreneurship, Innovation and Business Models” or similar.

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

**Type of instruction:**

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

**Exam format:**

Individual oral or written examination.

**Evaluation criteria:**

Are stated in the Framework Provisions.
Course module:  
Cyber Security and Trust  
(Cyber-sikkerhed og tillid)

**Recommended academic prerequisites:** The modules builds upon a basic understanding of network security.

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

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

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

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

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

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

**Evaluation criteria:** Are stated in the Joint Programme Regulations.
### Course module:
**Smart Sensor Data Processing**  
(Databehandling for smart sensors)

### Recommended academic prerequisites:
The module builds upon basic knowledge of linear algebra and statistics. Moreover, the module builds upon knowledge obtained in the course “Development of ICT and media services” or similar.

### Objectives:
Students who complete the module:

**Knowledge**
- Must have knowledge about high level smart sensors (e.g. cameras, 3D sensors, EEG sensors)
- Must have knowledge about advanced artificial intelligence and pattern recognition algorithms (e.g. kernel methods, neural networks)
- Must have knowledge about artificial intelligence in the context of data mining
- Must have knowledge about hardware processing platforms (e.g. Arduino, Raspberry Pi) for sensor integration
- Must have a clear understanding of the smart sensor processing technology

**Skills**
- Must be able to use and integrate various high level smart sensors to acquire data
- Must be able to apply machine learning and pattern recognition techniques on acquired sensor data
- Must be able to design and develop smart sensor systems using hardware (e.g. Arduino, Raspberry Pi) for real-time data processing

**Competencies**
- Must have the competency to compare and choose the most relevant high-level smart sensors for a given application
- Must have the competency to assess the use of various artificial intelligence and pattern recognition techniques for a given application
- Must have the competency to compare and assess the use of various hardware platforms for data processing and sensor integration

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

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

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

The curriculum is approved by the Dean of the Technical Faculty of IT and Design and enters into force as of September 2018.

Students who wish to complete their studies under the previous curriculum from 2017 must conclude their education by the summer examination period 2019 at the latest, since examinations under the previous curriculum are not offered after this time.

Chapter 5: Other Provisions

5.1 Rules concerning written work, including the Master's thesis
In the assessment of all written work, regardless of the language it is written in, weight is 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.\(^1\) 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
The Board of Studies can approve successfully completed (passed) program elements from other Master's programs in lieu of program elements in this program (credit transfer). The Board of Studies can also approve successfully completed (passed) program elements from another Danish program or a program outside of Denmark at the same level in lieu of program elements within this curriculum. Decisions on credit transfer are made by the Board of Studies based on an academic assessment. See the Framework Provisions for the rules on credit transfer.

5.3 Rules for examinations
The rules for examinations are stated in the Examination Policies and Procedures published by the Faculties of Engineering, Science and Medicine on their website.

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

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

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\(^1\) Or another foreign language (upon approval from the Board of Studies).
5.6 Additional information
The current version of the curriculum is published on the Board of Studies’ website, including more detailed information about the program, including exams.