AALBORG UNIVERSITET

STUDIEORDNING FOR KANDIDATUDDANNELSEN I INNOVATIV KOMMUNIKATIONSTEKNIK OG ENTREPRENEURSKAB, 2019

CIVILINGENIØR
KØBENHAVN

MODULER SOM INDGÅR I STUDIEORDNINGEN

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SERVICES AND PLATFORMS

2020/2021

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

This project module consists of 3 parts with separate learning objectives:

1. Problem Based Learning (PBL)
2. Scientific Methods
3. The main project: “Services and Platforms"

LEARNING OBJECTIVES

KNOWLEDGE

Part 1: Problem Based Learning (PBL)

- Must know methods for planning of project work
- Must have knowledge about process analysis
- Must have knowledge about different learning styles
- Must have knowledge of different approaches to project- and problem-based learning, including the Aalborg PBL model

Part 2: Scientific Methods

- Must have knowledge about scientific methods and their applicability in ICT engineering
- Must have knowledge about main scientific paradigms and their applicability for different problems
- Must know methods for the iterative development and refining of project ideas and problem formulations.
- Must know methods for quantitative and qualitative data gathering, data analysis and data presentation, e.g. interview techniques for expert interviews.
- Must know the consequences of plagiarism

Part 3: Services and Platforms

- Must have a holistic understanding of the ICT environment, i.e. the heterogeneous networks, Internet technologies and business models, on which ICT solutions and services rely
- Must have knowledge about the key Internet technologies and standards for content networking: representation, identification and transport
- Must have knowledge about the characteristics of different networks and the technologies that are important to provide a good user experience for a service
- Must be able to understand the service architectures, platforms and business models that are needed to provide future services and applications

SKILLS

Part 1: Problem Based Learning (PBL)

- Must be able to apply basic principles related to planning and management of a problem based project: basic study techniques, phases in a problem-oriented project, from initial problem to problem analysis and problem formulation, design and implementation
- Must be able to analyse and evaluate the organisation of the project group work and collaboration, especially regarding identification of strong and weak factors, and, based on this, suggest how group organisation and collaboration can be improved in future situations: team roles, group dynamics, communication within the group and externally, creativity, methods for analysis and documentation of learning processes
- Must be able to analyse group conflicts, causes and possible solutions
- Must know methods for resolving project-related conflicts

- Must be able to analyse and evaluate own contributions to the group work
- Must be able to communicate problems and findings to the group
- Must be able to analyse learning processes within the group

- Must be able to create optimal collaborative learning processes

Part 2: Scientific Methods

- Must be able to extract scientific knowledge from academic publications, e.g. journal papers, conference proceedings and anthologies.
- Must be able to master good academic praxis for the use and presentation of sources
- Must be able to discern between inductivism vs. deductivism, models vs. reality, hypothesis, empirical data, assumptions and proofs for a given research problem within the scope of the study programme.
- Must be able to explain the applicability for qualitative and quantitative methods for a given ICT engineering problem
- Must be able to conduct a structured search for sources, e.g. peer-reviewed literature
- Must be able to assess the quality and applicability of a given source (e.g. peer-reviewed / non peer-reviewed sources, industry whitepapers, interviews, marketing texts)

Part 3: Services and Platforms

- Must be able to specify requirements for innovative applications, services, solutions or service architectures based on a thorough analysis of the ICT environment and the needs of the target users
- Must be able to assess the network characteristics and limitations, which affect the delivery of content and services to the end users
- Must be able to discuss the technical and business-related aspects of services and service architectures
- Must be able to conceptually construct relevant business models

COMPETENCES

Part 1: Problem Based Learning (PBL)

- Must have competencies in group work and project-organized learning
- Must have competencies in communication in a group
- Must know methods for the management of group-based project work for ill-defined problems

Part 2: Scientific Methods

- Must have the competency to identify and apply relevant scientific methods in relation to ICT engineering problems and projects
- Must have the competency to structure an academic presentation of project (e.g. semester project) in a report
- Must master the principles for correct academic citing

Part 3: Services and Platforms

- Must have the competency to assess the viability and potential of new ICT-related technologies, frameworks and concepts
- Must have the competency to identify the value proposition in ICT services and solutions and develop a technical realization as well as a relevant business model for the value proposition
- Must have the competency to identify new business opportunities in relation to ICT services and service architectures

TYPE OF INSTRUCTION

Project work. There will be lectures and assignments for Part 1 and Part 2 at the start of the semester project.

EXAM

EXAMS

Name of exam	Services and Platforms
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Services og platforme
Module code	ESNICTEK1P1N
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

COMMUNICATION SYSTEMS

2020/2021

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about advanced PHY layer technologies and principles such as spectrum usage and limitations, advanced modulation and multiplexing techniques, and channel coding in selected systems
- Must have knowledge about mobile systems and technologies in the light of 3G, 4G and beyond 4G
- Must have knowledge about access technologies like mobile cellular access
- Must have knowledge about Machine Type Communication (MTC) and similar 5G technologies
- Must have knowledge about network architectures (densification, Cloud Radio Access Network, Software Defined Networking, Network Function Virtualization)
- Must have knowledge about Digital broadcast networks (radio and TV) such as cable, satellite and terrestrial networks
- Must have knowledge about wired (broadband) networks such as DSL-, cable TV- and fibre-based infrastructures

SKILLS

- Must be able to explain the principles and technologies used in advanced PHY layers
- Must be able to discuss the mobile systems / technologies, network architectures, access technologies, and MTC technologies
- 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.

COMPETENCES

- Must have the competency to analyse and assess the potentials and limitations of existing and future PHY layer technologies in selected systems
- 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 potentials and limitations of existing and future mobile cellular technologies including MTC technologies.

TYPE OF INSTRUCTION

Types of instruction are listed at the start of §17; Structure and contents of the programme.

EXAM

EXAMS

Name of exam	Communication Systems
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kommunikationssystemer
Module code	ESNICTEK1K4N
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

INNOVATION AND BUSINESS MODELS

2020/2021

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

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 have an understanding of theories on innovation

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

COMPETENCES

- Must have the competencies to discuss the links between different design elements of business models: customer value, organisation, 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 §17; Structure and contents of the programme.

EXAM

EXAMS

Name of exam	Innovation and Business Models
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Innovation og forretningsmodeller
Module code	ESNICTEK1K5N

Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

INTERNET TECHNOLOGIES AND SERVICE ARCHITECTURES

2020/2021

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about the structure of the Internet and its design principles
- Must have knowledge about the principles and technologies of different web generations (Web 1.0, 2.0, 3.0, …) and their implications for services
- Must have knowledge of content networking principles, including representation, identification and transport of web objects
- Must have knowledge of the main standardisation bodies and the process of developing specifications and standards for Internet technologies
- Must have knowledge of user agents and their functionality, in particular the use of JavaScript and HTML5
- Must have knowledge about programming models and interfaces for Internet services, in particular REST, SOAP and Web Services
- Must have knowledge about session-based services such as instant messaging and streaming media, including session initiation and management and the main protocols
- Must be able to explain the concepts of "service", "service enablers" and "service architectures"
- Must have knowledge of different methods for "enrichment" of services: User involvement, personalisation, use of context information, extracting value from large amounts of data, etc.
- 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

COMPETENCES

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

TYPE OF INSTRUCTION

Types of instruction are listed at the start of §17; Structure and contents of the programme.

EXAM

EXAMS

Name of exam	Internet Technologies and Service Architectures
Type of exam	Written or oral exam
ECTS	5

Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Internetteknologier og tjenestearkitekturer
Module code	ESNICTEK1K6N
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ICT SERVICES: DESIGN AND ARCHITECTURES

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds upon knowledge obtained in the first semester project.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about how to include the users in the design process of ICT services from initial requirement analysis phases to the final test, validation and deployment part
- Must have knowledge about privacy and computer ethics in ICT service design
- Must have knowledge about ICT services design focusing on Machine learning, access control and / or governance issues

SKILLS

- Must be able to design and develop a concrete ICT service taking into account computer ethics and “privacy by design” / “privacy by default” principles
- Must be able to design and develop service architectures including distributed resources and personal data
- Must be able develop a concrete ICT service or solution, either as a conceptual design or as a working prototype, including one or more of the following elements:
    - Addressing the needs of citizens on a national or cross-border level and ICT governance aspects
    - Machine learning theories and algorithms
    - Controlled exposure of protected resources and interfaces with access control

COMPETENCES

- Must have competencies in using a critical approach when assessing the potential of technologies and businesses in ICT design
- Must have the competency to critically assess the use of ICT in services and service architectures, considering ethical, legal and privacy implications
- Must have competencies in discussing the governance aspects of service design, either as core element of services design when the focus is on conceptual design or as a related issue if the focus is on prototyping

TYPE OF INSTRUCTION

Project work

EXAM

PREREQUISITE FOR ENROLLMENT FOR THE EXAM

- An approved PBL competency profile is a prerequisite for participation in the project exam

EXAMS

Name of exam	ICT Services: Design and Architectures
Type of exam	Oral exam based on a project

ECTS	10
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	IKT services: Design og arkitekturer
Module code	ESNICTEK2P3N
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	10
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

INTERNET SERVICES AND GOVERNANCE

2020/2021

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Objectives:

The student shall have knowledge about the economics of provision of electronic communication services and infrastructures.

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge about e-government services and citizen access
- 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 network neutrality, unbundling and vertical separation of Internet infrastructures
- Must have knowledge about consumer rights issues in relation to provision of Internet services

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 the role of data protection and privacy in provision of public and private internet services
- Must be able to analyse the digital transformation of the public sector and policy issues involved in this process.

COMPETENCES

- Must be able to discuss and evaluate Internet policies at the national and international level
- 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 services and governance

TYPE OF INSTRUCTION

Types of instruction are listed at the start of §17; Structure and contents of the programme.

EXAM

EXAMS

Name of exam	Internet Services and Governance
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Internet-services og regulering
Module code	ESNICTEK2K6N
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

IDENTITY AND ACCESS MANAGEMENT

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge obtained in the module “Internet Technologies and Service Architectures”.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to explain the concepts of security, privacy and trust
- Must be able to explain the differences between physical identities and online digital identities
- Must be able to explain the key concepts and principles of digital identities and identity management, e.g. attributes, claims, assertion and claims-based identities
- Must have knowledge about state-of-the-art principles, guidelines, technologies and frameworks for protecting users’ privacy, including fine-grained management of personal attributes
- Must have knowledge of key management, certificates, tokens and credentials
- Must have knowledge about the principles and methods for identification, authentication, authorisation and access control
- Must have knowledge about role-based, attribute-based and other access control schemes
- Must have knowledge about security architectures, including policies and policy management
- Must be able to understand the concepts of linkability and unlinkability and state-of-the-art principles for establishing trust
- Must have knowledge of national identity management frameworks such as NemID / MitID

SKILLS

- Must be able to identify the personal attributes that are needed to perform a given task
- Must be able to apply methods and technologies for privacy protection as a part of service development, including “privacy by design” principles
- Must be able identify resource sets and protect them with secure interfaces
- Must be able to apply state-of-the-art technologies for realising advanced services with authentication, authorisation and access control, 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, authorisation, privacy protection)

COMPETENCES

- Must have the competency to design secure services and policy architectures with controlled exchange of attributes between stakeholders and minimal disclosure of personal information
- Must have the competency to discuss and reflect on management of personal information for access to resources and for personalisation of services

TYPE OF INSTRUCTION

Types of instruction are listed at the start of §17; Structure and contents of the programme.

EXAM

EXAMS

Name of exam	Identity and Access Management
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Identitets- og adgangshåndtering
Module code	ESNICTEK2K2N
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
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Faculty	Technical Faculty of IT and Design

MACHINE LEARNING

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The course builds on knowledge obtained during the bachelor courses in “Linear Algebra” and “Introduction to Probability and Applied Statistics“.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge of data modelling in form of preparing data, modelling data, and evaluating and disseminating the results.
- Must have knowledge about key machine learning concepts such as feature extraction, cross-validation, generalization and over-fitting, prediction and curse of dimensionality.
- Must have knowledge about different machine learning principles, algorithms, techniques and be able to define and describe fundamental problems and consequences within machine learning.
- Must have knowledge about basic recommender system principles, techniques, algorithms and be able to define and describe fundamental problems and consequences within these.

SKILLS

- Must be able to discuss how the data modelling methods work and describe their assumptions and limitations.
- Must be able to map practical problems to standard data models such as regression, classification, density estimation, clustering and association mining.
- Must be able to select and apply a range of different machine learning algorithms and techniques on specific problems.
- Must be able to select and apply the basic recommender system algorithms and techniques on specific problems.

COMPETENCES

- Must have the competency to solve machine learning related problems in a practical context.
- Must have the competency to apply machine learning algorithms and analyse the results

TYPE OF INSTRUCTION

Types of instruction are listed at the start of §17; Structure and contents of the programme.

EXAM

EXAMS

Name of exam	Machine Learning
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Maskinlæring
Module code	ESNICTEK2K7N
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

USER EXPERIENCE AND COMPUTER ETHICS

2020/2021

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

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
- Must understand the concept and applicability of computer ethics

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 possible computer ethical issues related to a ICT system and / or its use context
- Must be able to discuss user cognitive models and other descriptions of 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

COMPETENCES

- 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 personalisation in relation to design dilemmas in the design of interactive systems

TYPE OF INSTRUCTION

Types of instruction are listed at the start of §17; Structure and contents of the programme.

EXAM

EXAMS

Name of exam	User Experience and Computer Ethics
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Brugeroplevelse og computer-etik
Module code	ESNICTEK2K8N
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ADVANCED ICT SOLUTIONS

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The project builds on knowledge obtained during the first two semester projects.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

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, to take it into account in the design process
- Must have knowledge of algorithms for data processing and semantic analysis
- Must have knowledge about how ICT applications and solutions can be deployed in order to address specific needs and improve efficiency in different application areas

SKILLS

- Must be able to design and develop an ICT service or solution, including one or more of the following elements:
    - Handling of converged media content and digital rights management (DRM)
    - Acquisition and processing of sensor information, e.g. bio-signals
    - Handling of large amounts of data to extract relevant information, e.g. latent semantic analysis, machine learning techniques, or cluster analysis
    - Recommender systems
    - Advanced programming tools, e.g. graph databases, Ruby on Rails, or Hadoop
    - Complex usage scenarios including access control, resource management and privacy protection
- Must be able to develop advanced ICT services and solutions targeting a specific application domain and considering scalability, state-of-the-art technologies and the use of different devices, networks and platforms.
- Must be able to identify, select and apply suitable programming languages and software development strategies and justify their choices
- Must be able to undertake a thorough analysis of the chosen solution with respect to technology choices, strategic decisions, innovation and entrepreneurship

COMPETENCES

- 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 the 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

EXAMS

Name of exam	Advanced ICT Solutions
Type of exam	Oral exam based on a project

ECTS	15
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Avancerede IKT-løsninger
Module code	ESNICTEK3P1
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

MANAGERIAL ECONOMICS AND ENTREPRENEURSHIP

2020/2021

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge on theories of entrepreneurship
- Must have knowledge on technology management
- Must have knowledge on product, process and market innovation
- Must have knowledge on servitization of manufacturing industries and industrialization of service industries
- Must have knowledge on internationalization strategies
- Must have knowledge on business eco-systems
- Must have knowledge on financial analysis including accounting

SKILLS

- Must be able to apply a costing and pricing strategy for products and services
- Must be able to apply a basic financial analysis and investment and risk analysis
- Must be able to evaluate the benefits and disadvantages of a change management process
- Must be able to evaluate the pros and cons of insourcing and outsourcing

COMPETENCES

- Must have competences in how to apply economic terms to practical managerial circumstances
- Must have competences in preparing a business plan
- Must have competences in assessing a competitive business strategy

TYPE OF INSTRUCTION

Types of instruction are listed at the start of §17; Structure and contents of the programme.

EXAM

EXAMS

Name of exam	Managerial Economics and Entrepreneurship
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Erhvervsøkonomi og entrepreneurskab
Module code	ESNICTEK3K8N
Module type	Course

Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

SUSTAINABLE DIGITAL TRANSFORMATION

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The project builds on knowledge obtained during the first two semester projects.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to understand technologies as a socio-technical system
- Must be able to discuss economic and social potentials and challenges in the implementation of advanced ICT solutions
- Must have knowledge on the importance of including technology solutions as well as regulatory solutions and the implications of norms and behavioural patterns in digital problems solving
- Must have knowledge on environmentally, socially and economically sustainable business development including one or more of these aspects
- Must understand implications of the collaborative nature of business development including business ecosystems and product-service systems
- Must understand the interrelationships between product, process and market innovation

SKILLS

- Must be able to discuss the socio-technical choices made in connection with issues regarding sustainability, algorithmic content exposure or security and trust concerning ICT systems
- Must be able to apply approaches from managerial economics to the development of digital service provision, e.g. business planning and marketing aspects
- Must be able to apply methods and approaches from the courses on sustainability, cyber security and trust or algorithmic content exposure
- Must be able to analyse the role of business eco-systems in sustainable value creation and improvement of service quality

COMPETENCES

- Must have the competences to apply a combination of socio-technical considerations regarding sustainability, algorithmic content exposure or cybersecurity and trust with skills in managerial economics
- Must have the competences to explore the opportunities and barriers in organizations when innovating for viable and sustainable development
- Must have the competency to consider the potentials and challenges of an entrepreneurial approach to digital business development

TYPE OF INSTRUCTION

Project work

EXAM

EXAMS

Name of exam	Sustainable Digital Transformation
Type of exam	Oral exam based on a project

ECTS	15
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Bæredygtig digital transformation
Module code	ESNICTEK3P4N
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

PROJECT-ORIENTED STUDY IN AN EXTERNAL ORGANISATION

2020/2021

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The student stays in a company with the purpose of learning and applying theories and methods to address engineering problems in an industrial context. In addition, the student will be introduced to business procedures and policies.

A Project-Oriented Study in an External Organisation agreement must be approved by the company, an AAU supervisor and the study board for Electronics and IT (ESN).

The Project-Oriented Study in an External Organisation must have a scope that corresponds to the ECTS load.

LEARNING OBJECTIVES

KNOWLEDGE

- Has knowledge about the organisation of the company and business procedures and policies.
- Has knowledge about performance measures in the company.
- Has developed a fundamental business sense.
- Has knowledge of the competence profile of the programme and how the project oriented study in an external organisation contributes to the competence profile.
- Has gained deepened knowledge into engineering theories and methods within the programme

SKILLS

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

COMPETENCES

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

TYPE OF INSTRUCTION

Project work

EXAM

EXAMS

Name of exam	Project-Oriented Study in an External Organisation
Type of exam	Oral exam based on a project
ECTS	25

Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Projektorienteret forløb i en virksomhed
Module code	ESNICTEK3P3N
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	25
Language of instruction	English
Location of the lecture	Campus Copenhagen
Responsible for the module	Tatiana Kozlova Madsen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

MASTER'S THESIS

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The project builds on knowledge obtained during the 3rd semester project

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

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

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge on state-of-the-art and prospective technology solutions within the ICT field, allowing for technology and service development, and understanding of the contexts in which technologies and services are conceived and developed, including user requirements, market circumstances, and policy and regulation.
- Must have well-founded knowledge of relevant theories and methodologies at specific level as well as at synthesis level, forming the basis for the analysis and development of technology and service solutions that relate to application areas and social and business challenges.

SKILLS

- Must be able to apply the mentioned knowledge and methods to analyse, design, develop and propose innovative applications, services and solutions within specific application areas of ICT, that
    - are technologically well-founded,
    - meet end-user requirements, and
    - are validated from a market and business perspective
- Must be able to analyse the potential and the implications of new technologies for the end users and stakeholders and contribute to ICT strategies and decision-making.
- Must be able to analyse relevant methods to solve the problem, describe and assess the application of the chosen methods and discuss how the chosen methods influence the project results

COMPETENCES

- Must have competencies in innovation and entrepreneurship within the field of ICT
- Must have the competency to identify and delimit relevant problems within ICT with an engineering approach and apply relevant theories, methods and experimental data
- Must have the competency to contribute to the creative use of technologies to resolve user needs and improve organizational processes

TYPE OF INSTRUCTION

The project is carried out individually or in a small group 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

EXAMS

Name of exam	Master's Thesis

Type of exam	Master's thesis/final project
ECTS	45
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	ESNICTEK4P2
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	45
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

MASTER'S THESIS

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The project builds on knowledge obtained during the 3rd semester project

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

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

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge on state-of-the-art and prospective technology solutions within the ICT field, allowing for technology and service development, and understanding of the contexts in which technologies and services are conceived and developed, including user requirements, market circumstances, and policy and regulation.
- Must have well-founded knowledge of relevant theories and methodologies at specific level as well as at synthesis level, forming the basis for the analysis and development of technology and service solutions that relate to application areas and social and business challenges.

SKILLS

- Must be able to apply the mentioned knowledge and methods to analyse, design, develop and propose innovative applications, services and solutions within specific application areas of ICT, that
    - are technologically well-founded,
    - meet end-user requirements, and
    - are validated from a market and business perspective
- Must be able to analyse the potential and the implications of new technologies for the end users and stakeholders and contribute to ICT strategies and decision-making.
- Must be able to analyse relevant methods to solve the problem, describe and assess the application of the chosen methods and discuss how the chosen methods influence the project results

COMPETENCES

- Must have competencies in innovation and entrepreneurship within the field of ICT
- Must have the competency to identify and delimit relevant problems within ICT with an engineering approach and apply relevant theories, methods and experimental data
- Must have the competency to contribute to the creative use of technologies to resolve user needs and improve organizational processes

TYPE OF INSTRUCTION

The project is carried out individually or in a small group 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

EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	50
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	ESNICTEK4P3
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	50
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

MASTER'S THESIS

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The project builds on knowledge obtained during the 3rd semester project

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge on state-of-the-art and prospective technology solutions within the ICT field, allowing for technology and service development, and understanding of the contexts in which technologies and services are conceived and developed, including user requirements, market circumstances, and policy and regulation.
- Must have well-founded knowledge of relevant theories and methodologies at specific level as well as at synthesis level, forming the basis for the analysis and development of technology and service solutions that relate to application areas and social and business challenges.

SKILLS

- Must be able to apply the mentioned knowledge and methods to analyse, design, develop and propose innovative applications, services and solutions within specific application areas of ICT, that
    - are technologically well-founded,
    - meet end-user requirements, and
    - are validated from a market and business perspective
- Must be able to analyse the potential and the implications of new technologies for the end users and stakeholders and contribute to ICT strategies and decision-making.
- Must be able to analyse relevant methods to solve the problem, describe and assess the application of the chosen methods and discuss how the chosen methods influence the project results

COMPETENCES

- Must have competencies in innovation and entrepreneurship within the field of ICT
- Must have the competency to identify and delimit relevant problems within ICT with an engineering approach and apply relevant theories, methods and experimental data
- Must have the competency to contribute to the creative use of technologies to resolve user needs and improve organizational processes

TYPE OF INSTRUCTION

The project is carried out individually or in a small group 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

EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	30

Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	ESNICTEK4P1
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	30
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

ALGORITHMIC CONTENT EXPOSURE

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The course builds on knowledge obtained in the modules “Internet technologies and service architectures” and “Machine Learning”.

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must have knowledge of principles for algorithmic selection of content, e.g. as used in recommender systems
- 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 optimise 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 algorithmically managed exposure 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

COMPETENCES

- Must have the competency to analyse and evaluate systems and solutions for algorithmically managed exposure of content, e.g. recommender systems
- Must have the competency to advice content providers and non-technical persons on systems for algorithmic management of content.
- 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 in § 17.

EXAM

EXAMS

Name of exam	Algorithmic Content Exposure
Type of exam	Written or oral exam
ECTS	5

Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Algoritmisk eksponering af indhold
Module code	ESNICTEK3K6N
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

GREEN ICT - SUSTAINABLE BUSINESS DEVELOPMENT

2020/2021

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The course builds on knowledge obtained in the module “Innovation and Business Models” (formerly “Entrepreneurship, Innovation and Business Models”).

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Must be able to understand the concept of sustainability and perspectives relating to CSR
- Must have knowledge about various levels of ICT effects on the environment
- Must be able to identify existing, new and emerging hardware, software and communication technologies for energy saving
- Must have knowledge about the role of ICT in energy consumption and energy efficiency
- Must have knowledge about different energy/GHG management standards and guidelines
- Must have knowledge about sustainability maturity models
- Must have knowledge about methods for assessing the potential environmental impacts of ICT products and services

SKILLS

- Must be able to recognise 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 theories, methodologies for analysing sustainable business development
- Must be able to understand and evaluate sustainability/CSR policies and practices
- Must be able to apply the green ICT strategies
- Must be able to estimate energy consumption impacts attributable to the introduction of various ICT services, considering both direct and indirect energy use
- Must be able to evaluate the rebound and induction effect within the ICT field
- Must be able to judge the usefulness of the different scientific methods for analysis of the ICT related energy efficient systems

COMPETENCES

- 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 in § 17.

EXAM

EXAMS

Name of exam	Green ICT - Sustainable Business Development
Type of exam	Written or oral exam
ECTS	5

Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Grøn IKT - Bæredygtig forretningsudvikling
Module code	ESNICTEK3K7N
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design

CYBER SECURITY AND TRUST

2020/2021

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

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 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 unauthorised use has occurred.
- Must be able to design and implement different levels of trust in open architectures.

COMPETENCES

- 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 in §17, Structure and contents of the programme.

EXAM

EXAMS

Name of exam	Cyber Security and Trust
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Cyber-sikkerhed og tillid
Module code	ESNICTEK3K4
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Copenhagen
Responsible for the module	Ove Kjeld Andersen

ORGANISATION

Study Board	Study Board of Electronics and IT
Department	Department of Electronic Systems
Faculty	Technical Faculty of IT and Design