



AALBORG UNIVERSITET

**CIVILINGENIØR, CAND.POLYT. I
TRÅDLØSE
KOMMUNIKATIONSSYSTEMER, 2018**

CIVILINGENIØR
AALBORG

MODULER SOM INDGÅR I STUDIEORDNINGEN

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WIRELESS RADIO TRANSMISSION

2018/2019

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- The impact of basic channel variations of stochastic nature - to communication system behavior
- Link budget establishment for a communication system
- Modern techniques for wireless radio transmission
- The block level description of a full wireless communication system (including transmitter, channel and receiver parts) – and the corresponding procedures required for its operation

SKILLS

- Design, implement and analyze a solution to a practically occurring communication problem
- apply theories to transmit signals over stationary stochastic channel
- establish a communication system chain
- perform suitable test of implemented application to verify its consistency with established specifications.
- Must be able to communicate the result of the project work in appropriate form as relevant for scientific communication.
- Can explain the process of and criteria for peer reviewed scientific communications
- Can write a paper for a scientific conference/journal
- Can prepare and give an oral and poster presentation for a scientific conference

COMPETENCES

- make a basic design, test and verification of a wireless communication problem
 - generate a set of specifications to perform a stepwise refinement process of the given application

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Wireless Radio Transmission
Type of exam	Oral exam based on a project Individual oral examination The examination is based on questions that take their starting points in the written documentation for the project module. For further information concerning the examination procedure, refer to the Joint Programme Regulations.
ECTS	20
Assessment	7-point grading scale
Type of grading	Internal examination

Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/
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FACTS ABOUT THE MODULE

Danish title	Trådløs radiotransmission
Module code	ESNWCSK1P1
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	20
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

STOCHASTIC PROCESSES

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge of probability, statistics, linear algebra, Fourier theory, and programming

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Have knowledge about the theoretical framework in which stochastic processes are defined.
- Be able to understand the properties of the stochastic processes introduced in the course, such as wide-sense stationary (WSS) processes, Auto Regressive Moving Average (ARMA) processes, Markov models, and Poisson point processes.
- Be able to understand how WSS processes are transformed by linear time-invariant systems.
- Be able to understand the theoretical context around the introduced estimation and detection methods ((non-parametric and parametric) spectral estimation, Linear Minimum Mean Square Error (LMMSE) estimation, Wiener filter, Kalman filter, detection of signals, ARMA estimation, etc.)

SKILLS

- Be able to apply the stochastic processes taught in the course to model real random mechanisms occurring in engineering problems.
- Be able to simulate stochastic processes using a standard programming language.
- Be able to apply the taught estimation and detection methods to solve engineering problems dealing with random mechanisms.
- Be able to evaluate the performances of the introduced estimation and detection methods.

COMPETENCES

- Have the appropriate “engineering” intuition of the basic concepts and results related to stochastic processes that allow – for a particular engineering problem involving randomness – to design an appropriate model, derive solutions, assess the performance of these solutions, and possibly modify the model, and all subsequent analysis steps, if necessary.

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Stochastic Processes
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination

Criteria of assessment	As stated in Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/
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FACTS ABOUT THE MODULE

Danish title	Stokastiske processer
Module code	ESNCAK1K1F
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

WIRELESS PHY/MAC FUNDAMENTALS

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module build on a basic understanding of wireless communications fundamentals, mathematics and statistics as e.g. obtained on the BSc in Electrical Engineering or similar

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Fundamental communication theory for wireless transmission
 - Classical communication theory
 - Noise handling in wireless communications
 - Loss and channel models (Friis transmission formula)
 - Analog chains, noise factor
 - Digital chains, coding
 - Detection and demodulation theory (coherent vs non-coherent)
- Transceiver architectures, blocks and components
 - Transceiver structures and synchronization (incl. duplexing and access aspects)
 - Non-ideal components (non-linearities, compression and intercept)
 - Dynamic range and link budget
 - S-parameter description of components
 - RF/u-wave measurements of wireless communication blocks and chains
- Modeling and simulation of transceiver systems
 - Complex baseband representation of pass-band communication
 - Signal distortion due to block imperfections

SKILLS

- Establish a link budget
- Synthesize a transceiver system on a block diagram level
- Describe the modifications that a signal undergoes through a transceiver chain
- Calculate key performance characteristics for a full transceiver chain based on specifications for the individual blocks
- Simulate the transmission of digital data through a full transceiver chain – including transmitter, lossy and noisy wireless channel, and receiver

COMPETENCES

- Discuss and evaluate the impact of different transceiver blocks in a communication link
- Set up a simulation model to access and evaluate the performance of (digital data) transmission over a wireless communication link

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Wireless PHY/MAC Fundamentals
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Trådløse PHY og MAC grundbegreber
Module code	ESNWCSK1K1
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

WIRELESS SYSTEMS PERFORMANCE

2018/2019

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Link budget analysis
- Wave types
- Power vs protection margins
- Dynamic radio channel characterization
- Short terms descriptions
- Channel hardening/Diversity
- Radio Resource allocation
- Methods for fixed and dynamic channel allocation
- Cellular concept and handover
- Link and MAC control, Power control, AMC
- Wireless network performance and traffic analysis
- Dynamic routing
- Transport – congestion control – performance impact
- Wireless network architectures
- Short range infra-structures
- Cellular infra-structure

SKILLS

- Establish a link budget with account for dynamic protection margins for a given wireless communication system
- Select the relevant metrics to establish and estimate Quality of Service (QoS) performance
- Establish radio resource requirements based on traffic load
- Evaluate feasibility of routing strategies based on system properties and requirements
- Evaluate and select different wireless networking architectures based on system requirements
- Evaluate properties of dynamic channels and apply stabilization techniques

COMPETENCES

- Analyze, evaluate and model the chain from PHY to Transport layer and how it combines towards the total performance and QoS of a wireless communication system

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Wireless System Performance
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination

Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/
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FACTS ABOUT THE MODULE

Danish title	Trådløs system performance
Module code	ESNWCSK2K1
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

MULTI AGENT WIRELESS SYSTEMS

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds upon knowledge obtained during the 1st and 2nd semester

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Item the interaction of multiple communication links which are jointly considered to optimize system performance
- Wireless communications technologies for multi-user/multi-network setting.
- Specific in-depth knowledge about at least one advanced method or technology applied to wireless communications. Such as
- The generic multiple access principles as it applies to time, frequency, code and space - and know their advanced formats for multi agent support.
- Methods used to model electro-magnetic properties of antennas and propagation for wireless communication, and exploit their characteristics for terminal or system performance
- Channel characterization and processing algorithms to exploit multi link radio propagation mechanisms of multiple antenna systems

SKILLS

- Evaluate the impact on system performance, by joint treatment of links in a multi-user/multi- network scenario – or other interaction mechanisms.
- Apply multi-agent or other modern/advanced techniques to a practical problem in modern wireless communications and evaluate their applicability
- Excel in least one advanced method or technology applied to wireless communications.

COMPETENCES

- Assess and exploit the space domain, the multiple user dimensions - or other modern/advanced technologies, to provide additional degrees of freedom to the system design.
- Communicate the project work in sound scientific and academic form
- Contribute successfully to team work within the problem area and make a common presentation of the project work

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3

EXAM

EXAMS

Name of exam	Multi Agent Wireless Systems
Type of exam	Oral exam based on a project Individual oral examination with grades in accordance with the 7-point grading scale. The examination is based on questions that take their starting points in the written documentation for the project module.

	For further information concerning the examination procedure, refer to Joint Programme Regulations.
ECTS	20
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Multi agent trådløse systemer
Module code	ESNWCSK3P1
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	20
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

MULTI AGENT WIRELESS SYSTEMS

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds upon knowledge obtained during the modules Stochastic Processes (1st semester) and Wireless System Performance (2nd semester)

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Advanced Access
- CDMA for multi-user systems
- Multicarrier systems (OFDM and OFDMA)
- Space division multiple access (SDMA)
- Distributed antenna systems
- Short range communications
- Passive communications/RFID-enabled devices
- Energy-cost-performance balancing
- Network level
- Device level
- Cooperative communications
- Ad-hoc
- Cognitive radio and dynamics spectrum sharing
- Network coding
- Space and time processing
- Spatial data multiplexing and space-time coding
- Time reversal techniques

SKILLS

- Determine advantages vs disadvantages of a chosen access technique
- Compare different cooperative communication schemes and their operation in interference scenarios
- Assess different technology features on cost-resource balancing in practical settings
- Apply processing methods for time and space exploitation of the wireless radio channel

COMPETENCES

- Compare and asses tradeoffs for performance optimization in heterogeneous (advanced) wireless communications.
- Choose the technology most suitable under given practical implications and limitations

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Multi Agent Wireless Systems
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Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Multi agent trådløse systemer
Module code	ESNWCSK3K1
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

ANTENNAS AND PROPAGATION

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds upon knowledge of Electro-magnetics, and Antennas and their connection to stochastic radio channels. Moreover the module builds on knowledge obtained during the modules Wireless PHY/MAC Fundamentals (1st semester) and Wireless System Performance (2nd semester) or similar

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Antennas
- Basic antennas
- Requirements for antennas in a scattering radio environment
- Multi-antenna/ correlation analysis
- Antenna measurement principles
- Near field (antenna design)
- Finite Difference Time Domain (FDTD) Method
- Method of Moments
- Far field (propagation)
- Ray tracing
- Phase screen methods and diffraction
- Propagation scattering modeling for multiple antenna systems

SKILLS

- Identify connection between antenna system and radio channel behavior
- Assess performance of antenna elements and antenna systems
- Select appropriate Electro-magnetic near and far field Simulation methodology for realistic antenna and propagation settings

COMPETENCES

- Apply antenna(system) and propagation conditions in new/real-world constellations for analyzing wireless communication system impact and performance optimization
- Evaluate limits of the methods and theories as applied to more general problems

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Antennas and Propagation
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed

Type of grading	Internal examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Antenner og udbredelse
Module code	ESNWCSK3K2
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

ACADEMIC INTERNSHIP

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

An academic internship agreement approved by the company, an AAU supervisor and the study board for electronics and it (ESN).

The academic internship must have a scope that correspond the ECTS load.

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.

LEARNING OBJECTIVES

KNOWLEDGE

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

SKILLS

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

COMPETENCES

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

TYPE OF INSTRUCTION

Project work

EXAM

EXAMS

Name of exam	Academic Internship
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Type of exam	Oral exam based on a project
ECTS	20
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Projektorienteret forløb
Module code	ESNWCSK3P2
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	20
Location of the lecture	Campus Aalborg
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

ACADEMIC INTERNSHIP

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

An academic internship agreement approved by the company, an AAU supervisor and the study board for electronics and it (ESN).

The academic internship must have a scope that correspond the ECTS load.

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.

LEARNING OBJECTIVES

KNOWLEDGE

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

SKILLS

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

COMPETENCES

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

TYPE OF INSTRUCTION

Project work

EXAM

EXAMS

Name of exam	Academic Internship
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Type of exam	Oral exam based on a project
ECTS	25
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Projektorienteret forløb
Module code	ESNWCSK3P3
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	25
Location of the lecture	Campus Aalborg
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

ACADEMIC INTERNSHIP

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

An academic internship agreement approved by the company, an AAU supervisor and the study board for electronics and it (ESN).

The academic internship must have a scope that correspond the ECTS load

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.

LEARNING OBJECTIVES

KNOWLEDGE

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

SKILLS

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

COMPETENCES

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

TYPE OF INSTRUCTION

Project work

EXAM

EXAMS

Name of exam	Academic Internship
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Type of exam	Oral exam based on a project
ECTS	30
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Projektorienteret forløb
Module code	ESNWCSK3P4
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	30
Location of the lecture	Campus Aalborg
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

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The master's thesis builds upon the knowledge obtained during the 1st – 3rd semester

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

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

SKILLS

- are able to reflect on a scientific basis on their knowledge,
- can argue for the relevance of the chosen problem to the education including specifically account for the core of the problem and the technical connections in which it appears
- can account for possible methods to solve the problem statements of the project, describe and assess the applicability of the chosen method including account for the chosen delimitation and the way these will influence on the results of the product
- can analyze and describe the chosen problem applying relevant theories, methods and experimental data
- are able to describe the relevant theories and methods in a way that highlights the characteristics and hereby document knowledge of the applied theories, methods, possibilities and delimitations within the relevant problem area
- have the ability to analyze and assess experimental data, including the effect the assessment method has on the validity of the results.

COMPETENCES

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

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3.

Problem based project oriented project work individual or in groups of 2-3 persons

EXAM

EXAMS

Name of exam	Master's Thesis
Type of exam	Oral exam based on a project

	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.
ECTS	50
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	ESNWCSK4P2
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	50
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The master's thesis builds upon the knowledge obtained during the 1st – 3rd semester

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

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

SKILLS

- are able to reflect on a scientific basis on their knowledge,
- can argue for the relevance of the chosen problem to the education including specifically account for the core of the problem and the technical connections in which it appears
- can account for possible methods to solve the problem statements of the project, describe and assess the applicability of the chosen method including account for the chosen delimitation and the way these will influence on the results of the product
- can analyze and describe the chosen problem applying relevant theories, methods and experimental data
- are able to describe the relevant theories and methods in a way that highlights the characteristics and hereby document knowledge of the applied theories, methods, possibilities and delimitations within the relevant problem area
- have the ability to analyze and assess experimental data, including the effect the assessment method has on the validity of the results.

COMPETENCES

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

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3.

Problem based project oriented project work individual or in groups of 2-3 persons

EXAM

EXAMS

Name of exam	Master's Thesis
Type of exam	Oral exam based on a project

	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.
ECTS	30
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	ESNWCSK4P1
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	30
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

WIRELESS COMMUNICATION IN DYNAMIC SETTINGS WITH FOCUS ON ANTENNA SYSTEM

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge obtained during the 1st semester

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Digital communication of analog or digital data over a stochastic fading channel.
- A basic wireless communication system and identify the individual blocks and their interaction. Thus, comprising the ends of the communication links, the transmission technique, the access technology as well as the fading channel
- Performance enhancing properties of multi antenna system or other technology, in a wireless communication system, with focus on the lower layers of the communication chain

SKILLS

- Extract the specific operating conditions of selected system block(s) in context of the over all communication chain
- Compare and evaluate the individual stochastically varying links between two communicating entities.
- Evaluate the space and frequency dispersive behavior of the channel.
- Must be able to evaluate and select among different multi antenna techniques for channel stabilization and capacity enhancement.

COMPETENCES

- Analyze, evaluate and model a given wireless communication problem
- Communicate the project work in sound scientific and academic form
- Contribute successfully to team work within the problem area and make a common presentation of the project work

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3.

EXAM

EXAMS

Name of exam	Wireless Communication in Dynamic Settings with focus on Antenna Systems
Type of exam	Oral exam based on a project Individual oral examination with grades in accordance with the 7-point grading scale. The examination is based on questions that take their starting points in the written documentation for the project module. For further information concerning the examination procedure, refer to the Joint Programme Regulations.
ECTS	25

Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Trådløs kommunikation under dynamiske forhold samt antennesystem
Module code	ESNWCSK2P1
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	25
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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

WIRELESS COMMUNICATION IN DYNAMIC SETTINGS WITH FOCUS ON RADIO SYSTEM

2018/2019

PREREQUISITE/RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds upon knowledge obtained during the 1st semester

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

- Digital communication of analogue or digital data over a stochastic fading channel.
- A basic wireless communication system and identify the individual blocks and their interaction. Thus, comprising the ends of the communication links, the transmission technique, the access technology as well as the fading channel
- Radio resources management in a multi-cell system, considering a space and frequency dispersive channel
- Channel allocation principles and its application to planning of wireless communication systems

SKILLS

- Extract the specific operating conditions of selected system block(s) in context of the over all communication chain
- Compare and evaluate the individual stochastically varying links between two communicating entities.
- apply and assess stabilization methods to compensate for these variations – and their impact on the wireless communication system capacity. Such as
 - Scheduling
 - Link adaptation
 - Channel allocation

COMPETENCES

- Analyze, evaluate and model a given wireless communication problem
- Communicate the project work in sound scientific and academic form
- Contribute successfully to team work within the problem area and make a common presentation of the project work

TYPE OF INSTRUCTION

As described in the introduction to Chapter 3

EXAM

EXAMS

Name of exam	Wireless Communication in Dynamic Settings with focus on Radio System
Type of exam	Oral exam based on a project Individual oral examination with grades in accordance with the 7-point grading scale. The examination is based on questions that take their starting points in the written documentation for the project module. For further information concerning the examination procedure, refer to the Joint Programme Regulations.

ECTS	25
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	As stated in the Joint Programme Regulations http://www.en.tech.aau.dk/education-programmes/Education+and+Programmes/

FACTS ABOUT THE MODULE

Danish title	Trådløs kommunikation in dynamiske forhold samt radiosystem
Module code	ESNWCSK2P2
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	25
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
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