

# Course Specifications

Valid as from the academic year 2024-2025

## Modulation and Detection (E012130)

**Course size** (nominal values; actual values may depend on programme)

Credits 6.0 Study time 180 h

## Course offerings and teaching methods in academic year 2025-2026

A (semester 1) Dutch Gent

B (semester 1) English Gent lecture

seminar

## Lecturers in academic year 2025-2026

Noels, Nele		TW07 le	lecturer-in-charge	
Offered in the following pro	ogrammes in 2025-2026		crdts	offering
	Naster of Science in Electrical Engineering(main subject formation Technology)	t	6	В
	Master of Science in Electrical Engineering(main subject	t Electronic	6	В
	ectrical Engineering (main subject Communication and	Information	6	В
3,,,	ectromechanical Engineering(main subject Control Eng	jineering and	6	В
Master of Science in Ele Engineering)	ectromechanical Engineering(main subject Electrical P	ower	6	В
Master of Science in El	ectrical Engineering (main subject Electronic Circuits a	nd Systems)	6	В
Master of Science in El	ectromechanical Engineering(main subject Maritime Er	ngineering)	6	В
Master of Science in Ele Construction)	ectromechanical Engineering(main subject Mechanical		6	В
Master of Science in Ele Engineering)	ectromechanical Engineering(main subject Mechanical	Energy	6	В
Master of Science in Co	omputer Science Engineering		6	В
Master of Science in El	ectrical Engineering		6	Α
Master of Science in Ph	notonics Engineering		6	В

## Teaching languages

English, Dutch

#### Keywords

Digital communication, modulation, detection, equalization, multi-user systems, MIMO systems

## Position of the course

This course builds on the acquired basic knowledge of communication theory and signal processing.

We study the operation and performance of advanced transmitter and receiver structures for digital communications over various channel types. We cover key concepts and techniques, and we review the application of these concepts in a system context. Students learn methodologies to design, analyse and evaluate receiver structures by themselves.

The course provides an understanding of the underlying decision and estimation theory and connects to information theory.

#### Contents

• Decision and estimation theory: likelihood function, sufficient statistic, ML and

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- MAP criteria, performance bounds; special focus on AWGN vector channel
- Channel characterization and modelling: fading and dispersion, coherence time and bandwidth; physical, mathematical and statistical channel models
- Communication over dispersive channels and fading channels: time, frequency and spatial diversity; linear, decision-feedback and optimal equalization; spreadspectrum and OFDM
- Communication over MIMO channels: transmitter and receiver structures with multiple antennas; spatial multiplexing, diversity-multiplexing trade-off; combining and precoding
- Multi-user (MU) systems: interference between users; duplexing, multiplexing and multiple access; FDD, TDD, FDM(A), TDM(A), CDM(A), OFDM(A), SDM(A), MU-MIMO

#### Initial competences

Communication Theory: partim Communication Techniques (or equivalent)

#### Final competences

- 1 Design of receiver structures for digital communication
- 2 Performance evaluation of receiver structures for digital communication
- 3 Analysis of techniques for transmission over different channel types: dispersive channels, fading channels, MIMO channels and MU channels
- 4 Understanding the effect of channel properties (fading, dispersion) on communication link reliability
- 5 Implementation of different parts of a "physical-layer" digital communication system, in MATLAB or Python, in order to perform computer simulations

#### Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

#### Conditions for exam contract

This course unit cannot be taken via an exam contract

#### Teaching methods

Group work, Seminar, Lecture, Independent work

#### Extra information on the teaching methods

Theory is taught in classical lectures.

During the seminars, exercises are solved by the students under the supervision of a teacher

The students independently work on a (group) assignment, with interim guidance offered upon request.

#### Study material

Type: Slides

Name: lecture notes and/or slides (about 10 EUR), also freely available via the online learning platform Indicative price: € 10 Optional: no

## References

Bernard Sklar, Fredric Harris - Digital Communications: Fundamentals and Applications. 3<sup>rd</sup> Edition. Pearson (2021)

John G. Proakis, Masoud Salehi - Fundamentals of Communication Systems. 2<sup>nd</sup> Edition. Prentice Hall (2013)

David Tse, Pramod Viswanath - Fundamentals of Wireless Communication.

Cambridge University Press (2005) - free online available

#### Course content-related study coaching

The lecturer and assistants are available during contact hours, on appointment and via e-mail.

#### Assessment moments

end-of-term and continuous assessment

#### Examination methods in case of periodic assessment during the first examination period

Written assessment

#### Examination methods in case of periodic assessment during the second examination period

Written assessment

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## Examination methods in case of permanent assessment

Oral assessment, Assignment

## Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

#### Extra information on the examination methods

The period-specific written evaluation is a closed-book exam; however, it is allowed to bring 4 double-sided, handwritten and non-photocopied A4 sheets of notes. The non-period-specific evaluation is based on written reports and an oral defence.

#### Calculation of the examination mark

The final score calculation is the same for both sessions: group work 30%; exam 70%  $\,$ 

Failure to participate in the evaluation of one or more parts of the assessment (exam, group work) will result in failing the entire course and the final grade, if higher than 7/20, will be reduced to the highest non-passable mark (7/20). If students obtain less than 8/20 for at least one of the parts of the assessment (exam, group work), they cannot obtain a pass mark for the course unit as a whole. Should the final mark be higher than 10/20, this is reduced to the highest fail mark (i.e., 9/20).

If there is clearly a different input from the different group members, then the final grade for the group work may be different for each student of the group.

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