GHENT UNIVERSITY

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	lecturer-in-charge

Offered in the following programmes in 2025-2026	crdts	offering
Bridging Programme Master of Science in Electrical Engineering(main subject Communication and Information Technology)	6	B
Bridging Programme Master of Science in Electrical Engineering(main subject Electronic Circuits and Systems)	6	B
Master of Science in Electrical Engineering (main subject Communication and Information Technology)	6	B
Master of Science in Electromechanical Engineering(main subject Control Engineering and Automation)	6	B
Master of Science in Electromechanical Engineering(main subject Electrical Power Engineering)	6	B
Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)	6	B
Master of Science in Electromechanical Engineering(main subject Maritime Engineering)	6	B
Master of Science in Electromechanical Engineering(main subject Mechanical Construction)	6	B
Master of Science in Electromechanical Engineering(main subject Mechanical Energy Engineering)	6	B
Master of Science in Computer Science Engineering	6	B
Master of Science in Electrical Engineering	6	A
Master of Science in Photonics Engineering	6	B

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

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; spread-spectrum 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. 3rd Edition. Pearson (2021)
John G. Proakis, Masoud Salehi - Fundamentals of Communication Systems. 2nd 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

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.