GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2023-2024

Physics of Semiconductor Devices (E024641)

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 2023-2024

A (semester 2)	Dutch	Gent		
B (semester 2)	English	Gent	lecture	
			peer teaching	
			seminar	
			practical	
			group work	0.0h
			independent work	0.0h

Lecturers in academic year 2023-2024

Bauwens, Pieter	TW06	staff member
Bakeroot, Benoit	TW06	lecturer-in-charge
Lauwaert, Johan	TW06	co-lecturer

Offered in the following programmes in 2023-2024	crdts	offering
Bridging Programme Master of Science in Engineering Physics	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
European Master of Science in Nuclear Fusion and Engineering Physics	6	B
Master of Science in Engineering Physics	6	A
Master of Science in Engineering Physics	6	B
Master of Science in Photonics Engineering	6	B

Teaching languages

English, Dutch

Keywords

semiconductor devices, diode, heterostructures, metal-oxide-semiconductor (MOS) structures, MOS field effect transistor (MOSFET), bipolar transistor, memory devices, solar cells

Position of the course

The goal of this course is to gain insight in the working principles of semiconductor devices which form the foundation of electronics. We start with an overview of semiconductor physics, after which we treat the basic building blocks (diode, metal-(insulator-)semiconductor) and the basic semiconductor processing steps. In a second part, the most important semiconductor devices (MOSFETs, bipolar transistors, memory devices...) are treated - including modern variations. Furthermore, this course aims to critically assess papers in the scientific literature and to be able to self-study other semiconductor devices.

Contents

- Additions to semiconductor physics
- Advanced study of p-n junction diodes including heterojunctions
- The metal-semiconductor structure
- The metal-insulator-semiconductor structure
- Overview of the technology of semiconductor devices
- Metal-oxide-semiconductor field-effect transistors (MOSFETs)
- Bipolar transistors including heterostructures
- Charge coupled devices
- Semiconductor memory devices
- Solar cells
- A special component: thorough self-study of a semiconductor device

Initial competences

Basic electromagnetism, basic solid-state physics and basic electrical circuits and networks.

Final competences

1 Thorough insight in the working principles of the building blocks (diodes, metal-semiconductor, and metal-insulator-semiconductor structures) of semiconductor devices: equilibrium, DC, AC, and large signal behavior.
2 Insight in the operation (equilibrium, DC, AC, and large signal) of the basic semiconductor devices: the MOSFET and the bipolar transistor including modern structures.
3 Recognise the most important process steps used in semiconductor device technology.
4 Analysing semiconductor devices: drawing band diagrams, assessing IV, CV characteristics, and switching behavior, comparing competing semiconductor devices.
5 Critical assessment of articles from scientific literature discussing semiconductor devices.

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, Practical, Independent work, Peer teaching

Extra information on the teaching methods

The peer teaching or microteaching is done in groups of 2 to 3 students. The purpose is to study an article from recent scientific literature on a semiconductor device and to present the topic to the peers. One student lecture takes about 20 to 30 minutes, followed by a question & answer session of about 10 to 15 minutes.

Learning materials and price

Syllabus (English via student association 5 to 8 €), handouts PowerPoint presentations (on the electronic learning platform), and book"Physics of Semiconductor Devices", 3rd Ed., John Wiley & Sons, 2007 (free online, via lib.ugent.be).

References

- S.M. SZE and Kwok K. Ng, Physics of semiconductor devices, 3rd. ed., John Wiley & Sons, 2007.
- S.M. Sze and M.K. Lee, Semiconductor Devices - Physics and Technology, 3rd. ed., Wiley & Sons, 2013.
- Richard S. Muller and Theodore I. Kamins, Device Electronics for Integrated Circuits, 3rd ed., John Wiley and Sons, 2003.
- Yuan Taur and Tak H. Ning, Fundamentals of Modern VLSI Devices, 2nd ed., Cambridge University Press, 2013.

Course content-related study coaching

Assessment moments

end-of-term and continuous assessment

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

Oral assessment, Written assessment with open-ended questions

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

Oral assessment, Written assessment with open-ended questions

Examination methods in case of permanent assessment

Participation, Presentation, Peer and/or self 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

During examination period: Two exams: 1. Theory: oral closed-book exam, written preparation; 2. Exercises: written open-book exam.
Continuous assessment: 1. evaluation of lab work; 2. Evaluation of the microteaching (also peer-evaluation with required participation). Resit examination period: the lab work cannot be redone; there is an alternative possible for the microteaching.
Frequency: From week 7: 1 lab work in two time slots; from then on: the timeslots (i.e. two regular lecture hours) are reserved for student lectures and guest lectures (number of timeslots depends on the number of students).

Calculation of the examination mark

The final mark is determined based on the following weighting coefficients: theory + exercises = 2/3; lab work + microteaching = 1/3. The score on the lab work is transferred to the resit examination period, the score on the microteaching is transferred if the score is at least 10/20, or it has to be redone in alternative form when the score is below 10/20.