

Micro- and Nanophotonic Semiconductor Devices (E030782)

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

Credits 4.0 Study time 120 h Contact hrs 60.0 h

Course offerings and teaching methods in academic year 2018-2019

A (semester 2)	English	seminar: coached	5.0 h
		exercises	
		lecture	30.0 h
		project	5.0 h

Lecturers in academic year 2018-2019

Van Thourhout, Dries	TW05	lecturer-in-charge
Stiens, Johan	VUB	co-lecturer

Offered in the following programmes in 2018-2019

	crdts	offering
Bridging Programme European Master of Science in Photonics	4	A
European Master of Science in Photonics	4	A

Teaching languages

English

Keywords

Photonics, Semiconductor, Heterojunctions, nanotechnology, Sources, detectors, modulators, quantum dot, quantum wire

Position of the course

The student will acquire an advanced theoretical framework (mathematical and quantum-mechanical tools) to design optoelectronic devices. He will get insight in the band structures of semiconductors and how they change in structures with reduced dimensions. He/she will get insights in the newest technologies to develop novel devices for the future. He/she will learn the operation principles of a large set of photonic devices such as detectors, light sources, modulators and others. The course will be a solid base to understand the operation of micro and nanophotonic semiconductor devices of today, and will allow students to design novel devices for future photonic applications.

Lecturers are organized partly in Ghent and partly in Brussels

Contents

The course is divided into three parts: a) Physics of semiconductors for photonic applications b) Photonic Semiconductor Devices and c) Micro and nano-technologies.

- * Basic properties of semiconductors: Introduction, Comparative study of whole set of semiconductors
- * Electron wave functions in semiconductors: dispersion relations
- * Heterostructures: Lattice matched and pseudomorphic structures, Quantum confinement
- * Phonons: optical, acoustical; transverse, longitudinal
- * Optical transitions: Fermi's Golden Rule, direct and indirect absorption processes, free carrier absorption, phonon absorption
- * Crystal-epitaxial growth: Crystal Growth, Epitaxial Growth
- * Definition of nano structures: bottom up and top down technologies
- * Sources: LED, Lasers (Gain, non-parabolic effects, strain effects)
- * Detectors: PIN, Avalanche, SiGe, Infrared, Metal-Schottky, Quantum Well IR, Quantum Dot IR, Thermal, Seebeck detectors
- * Modulators: Electro-absorption, quantum confined stark effect, electro optic modulation

* Advanced photonic semiconductor components: Quantum dots, wires, quantum cascade lasers ...

Initial competences

Basic knowledge quantum physics
Basic knowledge semiconductor physics

Final competences

- 1 Have insight in the operation of advanced photonic semiconductor components.
- 2 Being able to design basic semiconductor components.
- 3 Understand some advanced techniques for the fabrication of photonic semiconductor components.

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

Lecture, project, seminar: coached exercises

Learning materials and price

Syllabus (10 euro), papers from scientific literature

References

"Essentials of Semiconductor Physics", Tom Wunkebach
"Physics of Optoelectronic Devices", Shun Lien Chuang

Course content-related study coaching

Evaluation methods

end-of-term evaluation and continuous assessment

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

Oral examination

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

Oral examination

Examination methods in case of permanent evaluation

Report

Possibilities of retake in case of permanent evaluation

examination during the second examination period is possible in modified form

Extra information on the examination methods

During examination period: written open-book exam with oral defense; written open-book exam - problems
During semester: graded project reports.

Calculation of the examination mark

Project at the beginning of second half of semester. The final report of this assignment will be evaluated during an oral discussion. A partial exemption can be obtained for a maximum of 35% of the grand total. At the end of the semester - an oral examination, prepared in a written way with a minimum of 55% of the grand total with open book will be organized. Additionally an exercise exam with open book consulting will be organized the same day with a minimum of 10% of the grand total.