GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2023-2024

Micro- and Nanophotonic Semiconductor Devices (E030782)

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

Credits 4.0 **Study time 120 h**

Course offerings and teaching methods in academic year 2023-2024

A (semester 2)	English	Gent	lecture seminar
0 (semester 2)	English	Gent	

Lecturers in academic year 2023-2024

Van Thourhout, Dries	TWO5	lecturer-in-charge

Offered in the following programmes in 2023-2024	**crdts**	**offering**
Bridging Programme Master of Science in Photonics Engineering	4	A
Master of Science in Photonics Engineering	4	A, 0

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.

Contents

The course is divided into three arts: a) Physics of semiconductors for photonic applications b) Photonic Semiconductor Devices and c) Micro and nano-technologies.
* Basic properties of semiconductors: Introduction, Comparitive 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- en 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 fotonic 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

Seminar, Lecture

Learning materials and price

Book "Physics of Optoelectronic Devices" (see below) - available electronically through UGent library

References

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

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

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

Oral 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

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 65% of the grand total with open book will be organized.