

## 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 2024-2025**

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

**Lecturers in academic year 2024-2025**

Van Thourhout, Dries

TW05

lecturer-in-charge

**Offered in the following programmes in 2024-2025**

[Bridging Programme Master of Science in Photonics Engineering](#)  
[Master of Science in Photonics Engineering](#)

crdts	offering
4	A
4	A, O

**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, 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**

Seminar, Lecture

### **Study material**

Type: Handbook

Name: Physics of Photonic Devices, 2nd edition  
Indicative price: € 180  
Optional: yes  
Language : English  
Author : Shun Lien Chuang  
ISBN : 978-0-47029-319-5  
Available in the Library : Yes  
Usability and Lifetime within the Course Unit : intensive  
Additional information: The book is available through the 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.