GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2025-2026

Integrated Lasers (E030430)

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

Credits 4.0 **Study time 120 h**

Course offerings in academic year 2025-2026

A (semester 1) English Gent

Lecturers in academic year 2025-2026

Morthier, Geert	TWO5	lecturer-in-charge
Van Gasse, Kasper	TWO5	co-lecturer

Offered in the following programmes in 2025-2026	**crdts**	**offering**
Master of Science in Silicon Photonics	4	A

Teaching languages

English

Keywords

lasers, monolithic and heterogeneous integration

Position of the course

Expose the students to basic laser physics and different laser integration concepts

Contents

CHAPTER 1: GENERAL INTRODUCTION
- A bit of history
- The laser as an oscillator
- Amplification: stimulated emission and stimulated scattering
- Optical vs. electrical pumping
- Properties of laser light: temporal and spatial coherence, focusing and collimating
- Applications of laser diodes and the semiconductor laser industry

CHAPTER 2: LASER DIODES: BASIC OPERATION PRINCIPLES
- Geometry and important characteristics
- Material aspects: heterostructures, gain and absorption, low dimensional materials, gain saturation, ...
- Fabry-Perot laser diodes: cavity resonance
- Thermal aspects
- Simple linewidth derivation

CHAPTER 3: RATE EQUATIONS, DYNAMICS AND NOISE
- Derivation of laser rate equations
- Some simple analytical solutions: turn-on delay, switch-on time, small-signal modulation response
- Adding noise: Langevin functions
- Derivation of noise characteristics: intensity noise spectrum, power spectrum and linewidth

CHAPTER 4: OVERVIEW OF SEMICONDUCTOR LASER TYPES:
- Distributed Feedback and Distributed Bragg Reflector laser diodes
- Description of DFB lasers and Bragg reflectors using coupled mode equations
- Vertical Cavity Surface Emitting Laser diodes
- Tunable laser diodes

- External cavity laser diodes
- Quantum Cascade lasers

CHAPTER 5: HETEROGENEOUSLY INTEGRATED LASERS ON SOI AND SiNOI:
- Design issues
- Hetero-epitaxy, bonding, transfer printing and flip-chip
- Advantages of heterogeneously integrated lasers: narrow linewidth lasers, tunable lasers, isolator-free operation, high speed lasers.

CHAPTER 6: PACKAGING AND SYSTEM ISSUES
- Coupling to optical fiber
- Influence of parasitic reflections
- Wavelength control
- Laser diode packaging

There will be a few lab sessions (2, e.g.) on laser diode characterization as part of the course.

Initial competences

Basic semiconductor physics, basics electromagnetics

Final competences

1 Thorough understanding of laser diodes of all kinds.
2 Being able to make some decisions about laser design vs. desired characteristics, knowing how to characterize laser diode and which equipment it requires.
3 Having knowledge of the applications of laser diodes and the semiconductor laser industry.

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: Slides

Name: Slides and course notes used during the course
Indicative price: € 11
Optional: no
Additional information: Available electronically (free) or through the student organization (8 /11,5 euro member/non-member)

References

Optional: O. Svelto, Principles of Lasers (4th Edition), Plenum Press, New York.

Course content-related study coaching

Assessment moments

end-of-term assessment

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

Oral assessment, Written assessment open-book

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

Oral assessment, Written assessment open-book

Examination methods in case of permanent 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 assessment and oral closed-book assessment.

- During semester: lab report.

Calculation of the examination mark

30% written, 40% oral exam, 30% lab work.