GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2025-2026

Photonic Integrated Circuits: from Concept to Application (E030410)

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

Credits 8.0 **Study time 240 h**

Course offerings in academic year 2025-2026

A (Year)	English	Gent

Lecturers in academic year 2025-2026

Bogaerts, Wim	TW05	lecturer-in-charge
Verstuyft, Mattias	TW05	co-lecturer

Offered in the following programmes in 2025-2026	**crdts**	**offering**
Master of Science in Silicon Photonics	8	A

Teaching languages

English

Keywords

Photonic chip, PIC design, PIC simulation, PIC fabrication and PIC measurements

Position of the course

Driven by the current needs of data centers and artificial intelligence, the field of integrated photonics is growing rapidly, resulting in a shortage of skilled researchers and engineers.
This course is designed to equip lifelong learners with the necessary skills and knowledge to make a difference in this cutting-edge field, from core technologies to diverse applications in telecommunications, data communications, sensors and biomedical technology, and quantum information processing. Both simulation and modeling of chip design are covered, as well as insight into the necessary materials and fabrication techniques to ultimately characterize and measure a working photonic chip.

Contents

- Introduction: PICs and Silicon Photonics
- Quickstart: Photonic Circuit Design + info on the design project
- Waveguides and PIC platforms
- PIC components: passive and active building blocks
- PIC fabrication processes and relation to the CMOS process flow
- Heterogeneous integration for silicon photonics
- Circuit abstraction? Why?
- Ways to describe photonic circuits? signals, ports, models
- Time domain / frequency domain circuit simulation
- Circuit Design Flow and Chip Layout
- Wavelength Filter Circuits
- Component Simulation and Component Simulation Quiz
- Programmable Photonics
- Co-integration techniques, Co-design and co-simulation considerations
- Control loops
- Design for Manufacturability
- Hands-on characterization labs
- Packaging for PICs
- Applications
- Company visits

Initial competences

- Electromagnetics;
- Course of Microphotonics: understanding of optical waveguides and waveguiding components (directional couplers, taper, splitter), basic simulation methods.

Final competences

1 Understanding of the working principles of PIC components (active and passive), and how they can be combined into circuits
2 Understanding the essential modelling and simulation techniques for PICs components and circuits, being able to select the most suitable method for a problem, and applying the techniques (with commercial tools)
3 Understanding photonic circuit formalisms, how they differ from electronic circuits. Being able to construct photonic circuits, simulate them, and generate a layout that can be fabricated.
4 Understanding the fundamental concepts of wavelength filters, and the different implementations with their strengths and weaknesses.
5 An insight into the different technology platforms for PICs, their fabrication processes, and how PICs can serve a diversity of applications.
6 Having hands-on experience in designing a photonic integrated circuit with tunable elements, the associated fabrication and packaging flow, and being able to characterize the chip using lab equipment and driver electronics.
7 An insight in the PIC Ecosystem of Ghent, Leuven and Eindhoven (and beyond)
8 Connecting with stakeholders

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, Excursion, Lecture, Independent work

Extra information on the teaching methods

Lectures, hands-on Jupyter notebooks, supervised labs (cleanroom and measurements)

Study material

Type: Slides

Name: Slides used during the course, lecture recording and Jupyter notebooks
Indicative price: Free or paid by faculty
Optional: no
Additional information: Available electronically (free)

References

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

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

Oral assessment, Written assessment

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

- End of term examination: oral closed book assessment, written assessment closed book
- Continuous assessment: assignment: design project and lab exercises

Calculation of the examination mark

30% written exam, 20% oral exam, 30% design project, 20% lab exercises