MICRO-471

Fundamentals of integrated photonic components

Cursus	Sem.	Type
Microengineering minor	E	Opt.
Microtechnics	MA2, MA4	Opt.
Minor in Quantum Science and Engineering	E	Opt.
Photonics minor	E	Opt.
Photonics		Opt.
Quantum Science and Engineering	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Withdrawal	Unauthorized
Session	Summer
Semester	Spring
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Lab	2 weekly
Number of positions	**20**

Il n'est pas autorisé de se retirer de cette matière après le délai d'inscription.

Remark

(pas donné en 2026-27)

Summary

This course gives an introduction to basic integrated photonics components that are at the core of photonic nanotechnologies today. The course combines theoretical description with practical lab work where students will do simulations in CST Microwave Studio.

Content

The course starts from a basic revision of Maxwell's equations in linear, homogeneous, isotropic materials, followed by in-depth derivations of the following components:
1. Introduction
2. Basics of fibers and waveguides.
3. Basics of evanescent couplers and grating couplers.
4. Basics of splitters based on multi-mode interference (MMIs).
5. Basics of interferometers.
6. Basics of resonators (Fabry-Perot and ring resonators).
7. Basics of printed antennas.

Each week, students will first gain a theoretical understanding by deriving in-class the workings and the most fundamental underlying principles of the components we'll treat, and then gain hands-on experience in finite element methods using the simulation software CST Microwave studio.
Students will enforce the gained theoretical knowledge by analyzing the results of the electromagnetic simulations (field distribution, optical parameters such as refractive index, transmission, reflection etc.)..
Through the various exercises, students will be exposed to different features of the simulation tool (parametric sweep, template-based post processing, dispersive media etc.).

Keywords

integrated photonics, waveguides, on-chip, wave optics

Learning Prerequisites

Required courses

This course requires familiarity with Maxwell's equations and electromagnetism.

Learning Outcomes

By the end of the course, the student must be able to:

- Explain the working principles of the above components.
- Analyze the simulation results.
- Argue the observed trends of the performed simulations, e.g. dependence on refractive index, wavelength, angle.
- Decide which material system to use for a given component.

Teaching methods

2 hours of class + 2 hours of simulation work each week. The exercise classes will treat in detail the components treated in class, with problem sets and simulations.
Exercise sheets will be given every other week (7 sheets in total). Solutions will be handed out.

Assessment methods

The course grading is based on a final oral exam which counts for 50% of the grade. All exercise sheets will be collected and they count for 50% of the grade.

Supervision

Office hours	Yes
Assistant.e.s	Yes
Forum	Yes

Resources

Bibliography

Saleh, Bahaa E. A. · Teich, Malvin Carl. 2. A. Verlag. John Wiley. 2007, "Fundamentals of photonics"

Ressources en bibliothèque

- Find the references at the Library

Moodle Link

- https://go.epfl.ch/MICRO-471