EPFL

MICRO-516

Nanophotonics

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Cursus	Sem.	Type
Microtechnics	MA2, MA4	Opt.
Photonics minor	E	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	Oral
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

Students understand and apply the physics of the interaction of light with semiconductors. They understand the operating mechanism of scaled photonic devices such as photodetectors, LEDs and lasers, as well as challenges and opportunities relating to their integration and dimensional scaling.

Content

- **Introduction to nanophotonics:** integration with silicon, interconnect bottleneck, energy consumption consideration of photonic systems, why scaling matters.

- **Theoretical background:** Re-cap of semiconductor basics, crystal structure, Interaction of light with matter, light absorption, emission and electro-optic effects.

- **Materials for photonics:** III-Vs, GaN, LiNb, and others of interest for photonic applications. Understanding how material properties are linked to device performance, how they can be integrated on a silicon platform and their associated processing challenges.

- **Dimensionality:** Quantum wells, quantum dots, nanowires and 2D materials. What is their significance for photonic devices? What can we achieve through scaling and what are associated challenges.

- **Micro- and nanolasers:** understand different types of optical cavities, Fabry-Perot, Microdisc and basic of photonic crystal cavities.

- **Single-photon devices:** Examples of single photon emitters and detectors and their applications for quantum information processing.

Learning Prerequisites

Important concepts to start the course

The students must be familiar with basic solid-state physics, semiconductors and band diagrams.

Learning Outcomes

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

- Describe the physical mechanisms behind the interaction of light with semiconductors and other materials, such as absorption and emission of light as well as electro-optic modulation and how it is pendent on the material properties.

• Identify which material properties are appropriate to achieve different optical functions in a given wavelength regime.

• Assess / Evaluate different mechanisms for light detection in solid-state devices, such as pin and avalanche photodiodes or super-conducting nanowire single photon detectors.

• Explain the basics of light emission in semiconductors for LEDs and Lasers, and evaluate the trade-offs between different cavity designs such as whispering gallery, Fabry-perot or photonic crystal structures.

• Assess / Evaluate how dimensionality and scaling affects photonic devices. Be able to describe the effect of quantum wells, quantum dots and low dimensional materials in photonic applications

Teaching methods

Classroom teaching and exercises

Expected student activities

Active praticipation in class in terms of polls and questions

Assessment methods

Oral exam accounts for 100% of grade. If the number of students is too large to accommodate an oral examination, we will revert to a written form of examination.

Supervision

Office hours	No
Assistants	Yes

Resources

Bibliography

In this course we will use the book: "Fundamentals of Photonics", by B.E.A Saleh and M.C. Teich, 3rd edition (different from 1st and 2nd edition). We will principally use volume 2: Photonics.
Additionally select other material will be used to complement the individual topics.

Ressources en bibliothèque

• "Fundamentals of Photonics", by B.E.A Saleh and M.C. Teich, 3rd edition

Moodle Link

• https://go.epfl.ch/MICRO-516