PHYS-434

Physics of photonic semiconductor devices

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Cursus	Sem.	Type
Electrical and Electronical Engineering	MA2, MA4	Obl.
Ing.-phys	MA2, MA4	Opt.
Microtechnics	MA2, MA4	Opt.
Physicien	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

Series of lectures covering the optical properties of direct bandgap semiconductors including processes such as absorption, spontaneous and stimulated emission; the physics of heterostructures and the properties of the main light emitting devices that are light-emitting diodes and laser diodes.

Content

1. Semiconductor materials for optoelectronics
2. Light-matter interaction in semiconductors
Fermi's golden rule, absorption, optical susceptibility, Bernard-Duraffourg condition, spontaneous and stimulated emission of radiation, dielectric function, optical constants, radiative lifetime, photoluminescence spectra
3. Nanostructures and microcavities
Growth techniques, quantum wells, superlattices, quantum dots, microcavities, Purcell effect
4. Electroluminescence
Light-emitting diodes, quasi-Fermi levels, emission spectra, efficiency, radiative and nonradiative lifetimes
Applications for displays and solid-state lighting
5. Laser diodes
Stimulated emission, optical gain, transparency and threshold currents, spectral characteristics, far-field and near-field emission patterns, efficiency, waveguides
Fabry-Perot laser diodes, distributed feedback and vertical cavity laser structures
Bandgap engineering, quantum well laser diodes, separate confinement heterostructures
Quantum cascade lasers
Relaxation oscillation frequency

Learning Prerequisites

Recommended courses

Semiconductor electronic devices

Learning Outcomes

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

- Argue
- Contextualise
- Sketch
- Synthesize
- Generalize
- Structure

- Propose
- Assess / Evaluate

Transversal skills

- Use a work methodology appropriate to the task.
- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Communicate effectively with professionals from other disciplines.
- Take feedback (critique) and respond in an appropriate manner.

Teaching methods

Ex cathedra with exercises

Expected student activities

Read the bibliographical ressources in order to fully integrate and properly use the physical concepts seen in the lectures and the exercices
Be able to generalize the above-mentioned concepts to a wide variety of systems/devices

Assessment methods

written exam (100%)

Resources

Bibliography

"Optoelectronics", E. Rosencher & B. Vinter (Cambridge University Press, Cambridge, 2002)
"Wave mechanics applied to semiconductor heterostructures", G. Bastard (Les éditions de physiques, Les Ulis, 1991)
"Optical processes in semiconductors", J. I. Pankove (Dover, New York, 1971)
"Diode lasers and photonic integrated circuits", L. A. Coldren & S. W. Corzine (John Wiley & Sons, Inc., New York, 1995)

Ressources en bibliothèque

- Optical processes in semiconductors / Pankove
- Diode lasers and photonic integrated circuits / Coldren
- Wave mechanics applied to semiconductor heterostructures / Bastard
- Optoelectronics / Rosencher