Course guide
2301116 - SEMPHO - Semiconductor Photonics: Applications and Technology

Last modified: 09/06/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: MASTER'S DEGREE IN PHOTONICS (Syllabus 2013). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Lazaro Villa, Jose Antonio

Others: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma
Bermejo Broto, Alexandra

PRIOR SKILLS

Basic background on engineering or science

TEACHING METHODOLOGY

Learning by:
- Hands-on practical design and laboratory technologies
- Lectures.
- Group work.
- Individual work.
- Laboratory Practices.
- Oral presentations.

LEARNING OBJECTIVES OF THE SUBJECT

Semiconductor photonics is an exciting field that combines semiconductor technology with the study of light. It focuses on the interaction between light and semiconductors, leading to various interesting applications as: High-speed data communication enabling transmission of data at high speeds over long distances using optical fibers; Compact and integrated devices leading to smaller, lighter, and more efficient devices for telecommunications, sensing, imaging, and biomedical diagnostics; Quantum technologies, where semiconductor photonics plays a role in emerging quantum technologies, including quantum communication and quantum computing; Energy efficiency, with lower power consumption in photonic circuits and energy-saving semiconductor-based light sources.

It will be covered by hands-on semiconductor photonics:
• Applications,
• Clean-Room and fabrication technologies,
• Design and laboratory measurement of semiconductor photonic devices.
after theoretical introductory sessions.

STUDY LOAD

Type	Hours	Percentage
Hours small group	12,0	16.00
Self study	51,0	68.00
Hours large group	12,0	16.00

Total learning time: 75 h

CONTENTS

Introduction to the subject and technologies

Description:
- Subject introduction
- Introduction to Semiconductor Photonics Technologies:
1) Silicon Photonics greatest applications and limitations
2) Compound Semiconductor Photonics:
2a) III-V Photonics applications and solutions for Si Photonics limitations
2b) Ultra-wide band new Semiconductor Photonics by II-VI materials.
3) Hybrid components, integration of passive and active elements.

Full-or-part-time: 12h 30m
Theory classes: 4h
Self study : 8h 30m

Applications introduction

Description:
- Examples of applications of Semiconductor Photonics to:
communication, computing, sensing, energy efficiency, robotics, quantum technologies, life sciences and health care.
- Towards full photonic computers

Full-or-part-time: 12h 30m
Theory classes: 4h
Self study : 8h 30m

Semiconductor Fabrication Techniques

Description:
- Clean Room Fabrication Techniques

Related activities:
- Clean Room Fabrication Techniques

Full-or-part-time: 18h 45m
Theory classes: 4h
Laboratory classes: 2h
Self study : 12h 45m

Design of Semiconductor Photonics Devices

Description:
- Introduction to Commercial software for Semiconductor Photonics Devices.
- Integration of technology description, example: Process Design Kit (PDK) from VLC-CNM* as a set of files used to model a fabrication process for the design tools used to design an integrated circuit.
- Develop your own design of a relative simple semiconductor photonics device
* VLC: VLC Photonics (Hitachi Group)
CNM: Instituto de Microelectrónica de Barcelona - Centro Nacional de Microelectrónica (CSIC)

Related activities:
- Design with commercial software of a semiconductor photonics device.
- Automatic design process.

Full-or-part-time: 18h 45m
Laboratory classes: 6h
Self study : 12h 45m

Laboratory Measurement and Characterization of Semiconductor Photonics Devices

Description:
- Laboratory Measurement and Characterization of semiconductor photonic devices.

Related activities:
- Laboratory measurement of semiconductor devices.

Full-or-part-time: 12h 30m
Laboratory classes: 4h
Self study : 8h 30m

GRADING SYSTEM

The final grade for the course will be obtained from the continuous assessment grade (work proposed by the teacher throughout the course and laboratory practices) and the final exam, according to the following criteria:
Laboratory Practices: 10%
Final project: 40%
Final exam 50%

BIBLIOGRAPHY

Basic:
- Chrostowski, Lukas. Silicon photonics design. 1. Cambridge: Cambridge University Press,, 2015. ISBN 9781107085459.
- Sze, S.M.; Lee, M.K. Semiconductor devices: physics and technology. 3rd ed.; int. stud. version. Singapore: Wiley, 2013. ISBN 9788126556755.

Complementary:
- Nirmal, D.; Ajayan, J.; Fay, P.J. (eds.). Semiconductor devices and technologies for future ultra low power electronics [on line]. First edition. Boca Raton, Florida ; London ; New York: CRC Press, 2022 [Consultation: 07/07/2023]. Available on: https://www.taylorfrancis.com/books/9781003200987. ISBN 9781003200987.

RESOURCES

Other resources:

Tutorial material on basic topics about the contents of the subject will be offered to those students who may request or need it.