Course guide
2301211 - IP - Integrated Photonics

Last modified: 22/03/2024

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 1004 - UB - (ENG)Universitat de Barcelona.

Degree: MASTER'S DEGREE IN SEMICONDUCTOR ENGINEERING AND MICROELECTRONIC DESIGN (Syllabus 2024). (Optional subject).

Academic year: 2024 **ECTS Credits:** 4.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here:
https://telecos.upc.edu/ca/curs-actual/coordinadors-i-professorat

Others: Consultar aquí / See here:
https://telecos.upc.edu/ca/curs-actual/coordinadors-i-professorat

TEACHING METHODOLOGY

master classes, theoretical-practical classes and a laboratory session

LEARNING OBJECTIVES OF THE SUBJECT

K1.1 Knowledge of the fundamentals of light propagation through one-dimensional and two-dimensional waveguides.
K1.2 Knowledge of the devices that are the basic components of integrated photonic systems, including waveguides, optical couplers, micro ring resonators or nonlinear photonic devices, among others.
K1.3. Knowledge of technological platforms for integrated photonic circuits, the basic technological steps for their manufacturing and hybrid optoelectronic integration techniques
K.1.4 Knowledge of various simulation tools for the design and modeling of photonic integrated systems

STUDY LOAD

Type	Hours	Percentage
Self study	70,0	70.00
Hours small group	12,0	12.00
Hours large group	18,0	18.00

Total learning time: 100 h

CONTENTS

Block 1. Overview of integrated photonic components and integration in a common platform, suitable materials and applications

Description:
This block will give an overview of integrated optical waveguides and working principles of various integrated photonics components (passive and active) mainly based on semiconductor materials.
• Introduction: Materials, functionalities, technology and applications (1 hour)
• Passive Components (6 hours)
Waveguides (1D and 2D)
Characterisation techniques
• Components (Routing, combiners, MUX, DEMUX,…)
• Active Components (5 hours)
Amplifiers and lasers
Modulators
Detectors

Related activities:
• Lab Activity at UB lab (2 hours). Measurement of insertion losses (coupling and propagation losses) using cut-back technique

Full-or-part-time: 14h
Theory classes: 12h
Laboratory classes: 2h

Block 2. In-situ LAB sessions, mostly with OptiFDTD software

Description:
Some of the devices studied in Block 1 will be designed and simulated using open softwares.
• Effective index analysis method to solve 2D waveguides (2 hours)
• 3 layers waveguide / slab waveguide. Modes calculation (2 hours)
• Introduction to OptiFDTD (1 hours)
• Optical Couplers (4 hours).
• Optical Coupler (1 hours)
• Mach-Zehnder (1 hours)
• AWG: Arrayed Waveguide Grating (1 hours)

Full-or-part-time: 8h
Laboratory classes: 8h

Block 3. Device Fabrication Technology

Description:
The design rules and technology for large-scale photonic integrated circuits will be reviewed.
• Integrated photonics technology overview (1 hours)
• Integrated photonic devices fabrication processes (4 hours)
Dielectric materials deposition techniques and multilayer stacks
Lithography (micro- and nanotechniques)
• Etching (Dry and Wet techniques) patterning and topographies
Metallization and other materials for passive dynamic components
Testing, assembly and qualificaton
• Integrated photonics market overview and opportunities (1 hour)

Related activities:
• Lab Activity at CNM (2 hours). Visit to the CNM Clean Room and Photonics Lab

Full-or-part-time: 8h
Theory classes: 6h
Laboratory classes: 2h

GRADING SYSTEM

Exercises (50%) and one exam (50%)

Temptative list of Exercises:
1. Simulations of a specific 2D waveguide using an open source software (effective index analysis method)
2. Report with analysis of experimental data taken in the UB lab.
3. Dispersion Curves and Evanescent field using OptiFDTD
4. Analysis of Optical Couplers using OptiFDTD.
To pass the course, the student must get a minimum score of 4/10 in each of the activities and an average overall score of 5/10

BIBLIOGRAPHY

Basic:
- Saleh, B.E.A. Fundamentals of photonics. 3rd ed. Hoboken: John Wiley & Sons, 2019. ISBN 9781119506874.
- Lifante, G. Integrated photonics: fundamentals [on line]. Chichester, West Sussex: John Wiley & Sons, 2003 [Consultation: 09/04/2024]. Available on: https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/0470861401. ISBN 9780470861398.
- Reed, G.T.; Knights, A.P. Silicon photonics: an introduction [on line]. Chichester: John Wiley & Sons, 2004 [Consultation: 07/05/2024]. Available on: https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/0470014180. ISBN 9780470014189.
- Iizuka, K. Elements of photonics. New York: John Wiley & Sons, Inc., 2002. ISBN 0471839388.