Course guide
230567 - INTEGR - Integrated Photonics

Last modified: 11/04/2025

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

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

Academic year: 2025 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: DANIEL NAVARRO URRIOS

Others: Primer quadrimestre:
MAURICIO MORENO SERENO - 10
DANIEL NAVARRO URRIOS - 10

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE2. Demonstrate the understanding of the peculiarities of the quantum model for light-matter interaction.
CE9. Ability to synthesize and present photonics research results according to the procedures and conventions of scientific presentations in English.
CE4. Demonstrate knowledge of the fundamentals of image formation, propagation of light through different media and Fourier Optics.

Generical:
CG1. Ability to project, design and implement products, processes, services and facilities in some areas of photonics, such as photonic engineering, nanophotonics, quantum optics, telecommunications and biophotonics.
CG4. Ability to understand the generalist and multidisciplinary nature of photonics, seeing its application, for example, to medicine, biology, energy, communications or industry
CG2. Ability to modeling, calculate, simulate, develop and implement in research and technological centers and companies, particularly in research, development and innovation tasks in all areas related to Photonics.

Transversal:
1. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

2. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

3. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

4. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

Basic:
CB6. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB7. Students should know how to apply the knowledge acquired and their problem-solving ability in new or little-known environments within broader (or multidisciplinary) contexts related to their area of ¿¿study.
CB10. Students should possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.
CB8. Students should be able to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgment.

TEACHING METHODOLOGY

- Lectures

LEARNING OBJECTIVES OF THE SUBJECT

The objective of this course is to give in depth knowledge of devices that are basic components of integrated-photonic integrated-systems, including optical couplers, micro-ring resonators or nonlinear photonic devices. The fabrication processes, technology steps and designing tools will be described in detail. Emphasis in state of the art materials (Si or III-V compounds) will be made in the descriptions of photonics devices.

STUDY LOAD

Type	Hours	Percentage
Hours large group	24,0	32.00
Self study	51,0	68.00

Total learning time: 75 h

CONTENTS

1. Introduction

Description:
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Full-or-part-time: 4h 30m
Theory classes: 4h 30m

2.- Passive integrated photonic components

Description:
2.1.- Waveguides (rib, strip-loaded, slot').
2.2.- Optical couplers.
2.3.- Add/drop micro-rings.
2.4.- Tapers, MMIs, MZI.
2.5.- Prism coupling and Periodic Coupling. Gratings for biosensing.

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

3.- Active integrated photonic components

Description:
3.1.- Light sources: lasers and LEDs.
3.2.- Optical amplifiers: waveguides and SOA.
3.3.- Detectors for visible and infrared ranges.
3.4.- Modulators: Electro-optic and acusto-optics devices.

Full-or-part-time: 6h
Theory classes: 6h

4. Integrated micro and nanophotonics technology

Description:
4.1.- Technological platforms for photonic integrated circuits (PIC).
4.2.- Basic technology steps (deposition, lithography, etching). Polymer technologies.
4.3.- Optoelectronic hybrid integration.
4.4.- Microlens and MOEMS for Optical Communications.
4.5.- Simulation tools for designing photonic integrated systems.

Full-or-part-time: 4h
Theory classes: 4h

ACTIVITIES

Simulation work

Full-or-part-time: 2h 18m
Theory classes: 2h 18m

Experimental work

Description:
One experimental session that will enable the characterization, using an advanced optical setup, the quality-factors of optical cavites coupled to integrated waveguides.

Full-or-part-time: 2h
Laboratory classes: 2h

GRADING SYSTEM

- Exam: written (50%)
- Simulation work based on OptiFDTD (25%)
- Works related with waveguides and experimental characterization of optical cavities coupled to waveguides (25%)

BIBLIOGRAPHY

Basic:
- Salech, B.E.A.; Teich, M.C. Fundamentals of photonics. Hoboken: John Wiley & Sons, 2019. ISBN 9781119506874.
- Lifante, G. Integrated photonics: fundamentals [on line]. Chichester, West Sussex: John Wiley & Sons, 2003 [Consultation: 20/06/2016]. Available on: http://onlinelibrary.wiley.com/book/10.1002/0470861401. ISBN 9780470861400.
- Iizuka, K. Elements of photonics. New York: Wiley-Interscience, 2002. ISBN 0471839388.
- Pollock, C.R. Fundamentals of optoelectronics. Boston: Richard D. Irwin, 1995. ISBN 0256101043.
- Tamir, T. Integrated optics. Berlin: Springer-Verlag, 1975. ISBN 3540072977.
- Herzig, H.P. Micro-optics : elements, systems and applications. London ; Bristol: Taylor & Francis, 1997. ISBN 0748404813.
- Motamedi, M.E. MOEMS : micro-opto-electro-mechanical systems. Bellingham, WA: SPIE--The International Society for Optical Engineering, 2005. ISBN 0819450219.