Course guide
230569 - PHOTOV - Optoelectronics and Photovoltaic Technology

Last modified: 12/05/2025

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).
MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).

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

LECTURER

Coordinating lecturer: ALEXANDRA BERMEJO BROTO

Others: Primer quadrimestre:
ALEXANDRA BERMEJO BROTO - 10
JOAQUIN PUIGDOLLERS GONZALEZ - 10
CRISTOBAL VOZ SANCHEZ - 10

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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

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.
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.
CG4. Ability to understand the generalist and multidisciplinary nature of photonics, seeing its application, for example, to medicine, biology, energy, communications or industry

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.
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.
CB10. Students should possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

TEACHING METHODOLOGY

- Lectures
- Activities

LEARNING OBJECTIVES OF THE SUBJECT

The basic concepts and tools for the understanding and analysis of semiconductor optical devices and other devices such as those based on optofluidics are presented. Special attention will be paid to photovoltaic cells, studying the conventional crystalline structure, fine cells and organic cells.

STUDY LOAD

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

Total learning time: 75 h

CONTENTS

Introduction to semiconductor physics

Description:
Currents in a semiconductor. Generation and recombination. Radiative and non radiative recombinations. Continuity equation. Diffusion equation.
Heterojunctions. Band diagrams. Current- voltage characteristics.

Full-or-part-time: 8h 30m
Theory classes: 8h 30m

LED

Description:
LED's basic structure. Spectrum and emitted Power calculation.

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

LASER Diode

Description:
Laser diodes: Physics and applications. DBR, DFR.

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

Photodiode

Description:
Photodiodes: Diode electrostatics. PIN and Avalanche Photodiode (PIN & APD)

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

Optofluidics devices and applications

Description:
Electro-optics (Electrowetting on dielectric) and optofluidics devices. Working principles and applications

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

Solar cells: Basic working principles

Description:
Properties of sunlight. Working principles and technology of a solar cell and PN junctions.
Sunlight and energy associated to the solar spectrum. Principles of photovoltaic energy conversion. Classification of solar cell technologies.
Physics and fabrication of high-efficiency silicon solar cells. Practical photovoltaic market applications.

Full-or-part-time: 1h
Theory classes: 1h

Thin film solar cells

Description:
Thin film solar cells.
Emerging thin-film solar cell technologies. Alternative fields for the integration of photovoltaic energy.

Full-or-part-time: 1h
Theory classes: 1h

New concepts in solar cells

Description:
New concepts in solar cells. Organic devices. Fabrication technology.
Operation principle and manufacturing of organic solar cells. Best efficiencies and limitations regarding the commercialisation of emerging technologies.

Full-or-part-time: 1h
Theory classes: 1h

ACTIVITIES

Laboratory visits

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

GRADING SYSTEM

- Exam: written 60 %
- Challenge Based Project (individual or small group) (40%)

BIBLIOGRAPHY

Basic:
- Kasap, Safa O. Optoelectronics and photonics : principles and practices. 2nd ed. Boston: Pearson, 2013. ISBN 9780273774174.
- Nelson, Jenny. The Physics of solar cells. London: Imperial College Press, 2003. ISBN 1860943497.