

## Course guide

### 230478 - FOT - Photonics

**Last modified:** 25/05/2023

**Unit in charge:** Barcelona School of Telecommunications Engineering  
**Teaching unit:** 748 - FIS - Department of Physics.

**Degree:** BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Compulsory subject).

**Academic year:** 2023    **ECTS Credits:** 6.0    **Languages:** English

#### LECTURER

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**Coordinating lecturer:** Consultar aquí / See here:  
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura>

**Others:** Consultar aquí / See here:  
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma>

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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##### Specific:

1. Knowledge and understanding of the interaction between radiation and matter in photonic systems. Knowledge of photonic devices and ability for using them. Knowledge of applications in nanotechnology, materials science, communications and biophysics.

##### Generical:

2. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

##### Transversal:

1. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
3. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
4. EFFECTIVE USE OF INFORMATION RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.
5. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

#### TEACHING METHODOLOGY

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There will be three theoretical and two practical weekly sessions. The theoretical lectures will be devoted to a careful presentation of the basic concepts and the main results which will be illustrated with some examples. The practical sessions will be devoted to the solution of a variety of exercises and problems.

## LEARNING OBJECTIVES OF THE SUBJECT

After attending the course the student will be able to:

- Know the main properties of light and the basic concepts involved in its characterization
- Identify different aspects concerning the emission of radiation and light-matter interaction
- Apply Maxwell's equations for the resolution of light propagation problems, in particular those related with interference, diffraction and dispersion
- Describe the light propagation in anisotropic and structured media
- Identify different aspects of radiation detection
- Apply the studied concepts to the field of photonics
- Identify and describe the most relevant applications in the field of photonics

## STUDY LOAD

Type	Hours	Percentage
Self study	85,0	56.67
Hours large group	65,0	43.33

**Total learning time:** 150 h

## CONTENTS

### Part I: FUNDAMENTALS OF PHOTONICS

**Full-or-part-time:** 132h

Theory classes: 34h

Practical classes: 24h

Self study : 74h

### I1 Fundamental properties of light (classical approach)

**Description:**

I1.1 Historical introduction

I1.2 Basic magnitudes and properties from a classical point of view

**Full-or-part-time:** 10h

Theory classes: 3h

Practical classes: 2h

Self study : 5h

### I2 Basic models and equations

**Description:**

Basic models for monochromatic beams

**Full-or-part-time:** 18h

Theory classes: 4h

Practical classes: 4h

Self study : 10h

### I3 Generation and emission

**Description:**

- I3.1 Radiation by a dipole and a set of dipoles
- I3.2 Light-matter interaction models
- I3.3 Light sources

**Full-or-part-time:** 22h

Theory classes: 6h

Practical classes: 4h

Self study : 12h

### I4 Introduction to quantum aspects of light

**Description:**

I4.1 Light-Matter interaction from a quantum approach (comparison with classical model):

- Einstein model
- Semiclassical theory

I4.2 Introduction to the quantum theory of light. Photons. Properties

I4.3 Applications:

- Momentum of light
- Lasers

**Full-or-part-time:** 31h

Theory classes: 10h

Practical classes: 5h

Self study : 16h

### I5 Propagation

**Description:**

- I5.1 Crystal optics
- I5.2 Short pulse propagation. Dispersion
- I5.3 Propagation in free space. interferences and diffraction

**Full-or-part-time:** 49h

Theory classes: 12h

Practical classes: 7h

Self study : 30h

### I6 Detection

**Description:**

- I6.1 Temporal characterization of radiation
- I6.2 Spatial characterization of radiation
- I6.3 Spectral characterization of radiation

**Full-or-part-time:** 10h

Theory classes: 3h

Practical classes: 2h

Self study : 5h



## PART II: APPLICATIONS OF PHOTONICS

### Description:

II1 Microscopy and image processing  
II2 Optical communications  
II3 Nanophotonics  
II4 Metrology and material treatment  
II5 Nonlinear optics  
II6 Quantum optics

### Full-or-part-time: 10h

Theory classes: 1h  
Guided activities: 3h  
Self study : 6h

## GRADING SYSTEM

The evaluation is obtained from the mark of a first partial exam (EP) at the middle of the semester, a second partial exam at the end of the semester (EP2) and the realization of a proposed task (T)

The final score will follow from:  $NOTA = (0.4 * EP + 0.5 * EP2 + 0.10 * T)$

There is a second evaluation option including an exam of the whole content of the course (EF) and the realization of a proposed task (T)

The final score will follow from:  $NOTA = (0.90 * EF + 0.10 * T)$

## EXAMINATION RULES.

The students doing the final exam will loose the mark of the first partial

## BIBLIOGRAPHY

### Basic:

- Hecht, E. Optics. 5th ed. San Francisco: Addison-Wesley, 2017. ISBN 9781292096933.
- Saleh, B.E.A.; Teich, M.C. Fundamentals of photonics. 3rd ed. Hoboken: John Wiley & Sons, 2019. ISBN 9781119506874.
- Cabrera, J.M.; López, F.J.; Agulló-López, F. Óptica electromagnética: vol I: fundamentos. 2a ed. Madrid: Addison-Wesley : Universidad Autónoma de Madrid, 1998. ISBN 8478290214 (V.1).

### Complementary:

- Cabrera, J.M.; Agulló López, F.; Jesús López, F. Óptica electromagnética: vol II: materiales y aplicaciones. 2a ed. Madrid: Addison Wesley/Universidad Autónoma de Madrid, 2000. ISBN 84-7829-042-7 (V.2).
- Loudon, R. The quantum theory of light. 3rd ed. Oxford: Clarendon Press, 2000. ISBN 0198501765.