Course guides
230478 - FOT - Photonics

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: 2021 ECTS Credits: 6.0 Languages: English

LECTURER
Coordinating lecturer: Trull Silvestre, Jose Francisco
Others: Cojocaru, Crina Maria

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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

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
## 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: \[ \text{NOTA} = (0.4 \times EP + 0.5 \times EP2 + 0.10 \times T) \]

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: \[ \text{NOTA} = (0.90 \times EF + 0.10 \times T) \]

EXAMINATION RULES.

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

BIBLIOGRAPHY

Basic:

Complementary: