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230478 - FOT - Photonics

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Teaching unit Compulsory)
ECTS credits: 6 Teaching languages: English

Teaching staff

Coordinator: Trull Silvestre, Jose Francisco

Others: Cojocaru, Crina Maria

Opening hours

Timetable: To be determined

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 INFORMATI0N 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

Study load

Total learning time: 150h	Hours large group:	65h	43.33%
	Self study:	85h	56.67%

Content

Part I: FUNDAMENTALS OF PHOTONICS	Learning time: 132h Theory classes: 34h Practical classes: 24h Self study : 74h

I1 Fundamental properties of light (classical approach)	Learning time: 10h Theory classes: 3h Practical classes: 2h Self study : 5h

Description:
I1.1 Historical introduction
I1.2 Basic magnitudes and properties from a classical point of view

I2 Basic models and equations	Learning time: 18h Theory classes: 4h Practical classes: 4h Self study : 10h

Description:
Basic models for monochromatic beams

I3 Generation and emission	Learning time: 22h Theory classes: 6h Practical classes: 4h Self study : 12h

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

I4 Introduction to quantum aspects of light	Learning time: 31h Theory classes: 10h Practical classes: 5h Self study : 16h

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

I5 Propagation	Learning time: 49h Theory classes: 12h Practical classes: 7h Self study : 30h

Description:
I5.1 Cystal optics
I5.2 Short puse propagation. Dispersion
I5.3 Propagation in free space. interferences and diffraction

I6 Detection	Learning time: 10h Theory classes: 3h Practical classes: 2h Self study : 5h

Description:
I6.1 Temporal characterization of radiation
I6.2 Spatial characterization of radiation
I6.3 Spectral characterization of radiation

PART II: APPLICATIONS OF PHOTONICS	Learning time: 10h Theory classes: 1h Guided activities: 3h Self study : 6h
Description: II1 Microscopy and image processing II2 Optical communications II3 Nanophotonics II4 Metrology and material treatment II5 Nonlinear optics II6 Quantum optics	

Qualification 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)

Regulations for carrying out activities

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

Bibliography

Basic:

Saleh, B.E.A.; Teich, M.C. Fundamentals of photonics. 2nd ed. New York [etc.]: John Wiley & Sons, 2007. ISBN 9780471358329.

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).

Hecht, E. Optics. 4th ed. San Francisco: Addison-Wesley, 2002. ISBN 0321188780.

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.