Last update: 06-05-2019

230482 - BIOPHOT - Biomedical Photonics

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications
731 - OO - Department of Optics and Optometry

Academic year: 2019

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Teaching unit Optional)

ECTS credits: 6 Teaching languages: English

Teaching staff

Coordinator: Artigas Garcia, David

Others: Vilaseca Ricart, Meritxell
Royo Royo, Santiago

Opening hours

Timetable: Appointment by email

Prior skills

Optics, photonics, electromagnetic fields and waves

Requirements

Course on photonics

Degree competences to which the subject contributes

Specific:

FOT1. 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:

3. 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.

09 CSC EF. ABILITY TO CONCEIVE, DESIGN, IMPLEMENT, AND OPERATE COMPLEX PHYSICAL ENGINEERING SYSTEMS.
Ability to conceive, design, implement, and operate complex systems in the fields of micro and nano technology, electronics, advanced materials, photonics, biotechnology, and space and nuclear sciences.

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.

2. 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.

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Teaching methodology

lectures
Discussion of specific cases
independent learning

Learning objectives of the subject

Understanding the main physical phenomena of light-tissue interaction.
Knowing specific cases of applications to biomedicine.
Knowing the different microscopy, diagnosis and therapy techniques.
Being able to understand the operational principles of an optical set up.
Being able to design an optical system with biomedical applications.

Study load

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

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Content

Biomedical Photonics	Learning time: 147h Theory classes: 63h Self study : 84h

Description:
The course will give an overview of the physical mechanism involved in the Light?Tissue interaction, and the differences with non-living mater. This knowledge will then be used to understand how photonics is used in medicine and biology. To do that, we will focus on a given physical effect, analyse its effect on tissue and how this interaction have resulted in a new therapy and diagnosis technique in medicine, or in new imaging and analysis tools in Biology. In every case, details of the state of the art technology will be discussed.

CONTENT:

1. Introduction

2. Optical Microscopy.
   2.1 Basic concepts in microscopy.
   2.2 Increase of the contrast by optical techniques: Oblique illumination, Dark field, Phase contrast, Differential interference contrast and Interference reflection microscopy.
   2.3 Fluorescence microscopy.
   2.4 3D imaging: Laser scanning Confocal, Multiphoton, light sheet microscopy.

3. Effects of Tissue on light.
   3.1 Tissue optics: absorption, scattering, photon transport theory, models etc.
   3.2 Diagnostic techniques
      3.2.1 Optical Coherent Tomography (OCT)
      3.2.2 Reflectance and fluorescence spectroscopy
      3.2.3 Raman spectroscopy
      3.2.3 Pulsioximeter and vein-viewer
      3.2.4 Optical diffuse Tomography
      3.2.5 Photoacoustic imaging
      3.2.6 Novel diagnostic techniques
   3.3 Simulations (TracePro)

4. Effects of absorbed Light on tissue: Laser therapy.
   4.1 Photothermal effects. Application to surgery and dermatology.
   4.2 Ablation. Application to refractive surgery.
   4.3 Photomechanical effects. Application to ophthalmology.
   4.4 Photochemical effects: Photodynamic therapy. Application in cancer and dermatology.

Qualification system

2 partial exams: 70%
Simulation work: 20%
Presentation of a journal paper: 10%

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Bibliography

Basic:

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Niemz, Markolf H.. Laser-Tissue Interactions [en línia] [on line]. 3rd ed. Berlin, Heidelberg: Springer, 2007 [Consultation: 15/07/2015]. Available on: <http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10230157>. ISBN 9783540721925.

Porter, Jason. Adaptive optics for vision science : principles, practices, design and applications. Canadà: Wiley-Interscience, 2006. ISBN 9780471679417.

Popp, Jürgen. Handbook of biophotonics. Weinheim, Germany : [Chichester: Wiley-VCH ; John Wiley, distributor, cop. 2011-. ISBN 9783527410477.

Berns, Roy S. Billmeyer and Saltzman's Principles of color technology. 3rd ed. New york, [etc.]: John Wiley & Sons, 2000. ISBN 047119459X.

Lee, Hsien-Che. Introduction to color imaging science. Cambridge [etc.]: Cambridge University Press, 2009. ISBN 9780521103138.

Gulrajani, M. L. Colour measurement : principles, advances and industrial applications. Cambridge ; Philadelphia: Woodhead, 2010. ISBN 1845695593.