Last update: 13-05-2015

230554 - IMAGBIO - Optical Image in Biology and Medicine

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

Teaching unit: 893 - ICFO - Institute of Photonic Sciences

Academic year: 2015

Degree: ERASMUS MUNDUS MASTER'S DEGREE IN PHOTONICS ENGINEERING, NANOPHOTONICS AND BIOPHOTONICS (Syllabus 2010). (Teaching unit Optional)
MASTER'S DEGREE IN PHOTONICS (Syllabus 2013). (Teaching unit Optional)

ECTS credits: 3 Teaching languages: English

Teaching staff

Coordinator: Juan Perez (coord),

Others: Turgut Durduran, Pablo Loza-Alvarez, Melike Lakadamyali, María García-Parajo

Degree competences to which the subject contributes

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.

Teaching methodology

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Learning objectives of the subject

The course will give a general overview of optical imaging techniques for a) studying biological objects, such as, cells in vitro, and b) as a tool to analyze tissues to help in the diagnosis of patients in the clinic. A myriad of techniques will be introduced and discussed ranging from the detection of macroscopic bio-structures to the nano-scale world.
The first part of the course will deal with the imaging techniques in the clinical practice. How can we use light to non-invasively image and monitor tissue? What kind of pathologies could be studied with light? Medical imaging techniques based on Diffuse optics and Optical Coherent Tomography (OCT) will be discussed considering aspects such as the "bench-to-bedside" technology translation.
Biology and other diagnostic medical practices require higher resolution imaging techniques capable to resolve structures at the cellular level. Confocal and novel techniques of nonlinear microscopy, that provide new information on living cells will be reviewed. We will then focus on novel fluorescence imaging techniques aimed at breaking the diffraction limit of light, thus, providing nano-scale imaging at the subcellular level. These approaches will include far-field methods such as stimulated emission depletion (STED), stochastic reconstruction microscopy (STORM) and fluorescence photoactivation light microscopy (F-PALM) and near-field (NSOM) techniques for examination of individual molecules.
We expect that during the course students will read key scientific publications from the current literature, and perform several basic experiments at the ICFO laboratories that will help them understand in depth the physical mechanisms

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involved in the techniques.

Study load

Total learning time: 75h	Hours large group:	22h 30m	30.00%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	2h 15m	3.00%
	Self study:	50h 15m	67.00%

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Content

1. Diffuse optics:

Degree competences to which the content contributes:

Description:
1.1 Paving the way to deep (>1mm to many centimeters) tissue investigation.
1.2 Photon diffusion in tissues,
1.3 Diffuse optics in biomedicine: as an example of translational, bench-to-bedside research.

2. Optical coherence tomography (OCT):

Degree competences to which the content contributes:

Description:
2.1 What is OCT?
2.2 Physics and instrumentation in OCT
2.3 Examples and applications.

3. High resolution microscopy

Degree competences to which the content contributes:

Description:
3.1 Confocal fluorescent microscopy.
3.2 Two-photon excited fluorescence microscopy.
3.3 Second and third harmonic generation microscopy.
3.4 Other advanced imaging strategies (Adaptive optics, SPIM, DSLM)

4. Far-field super resolution nanoscopy

Degree competences to which the content contributes:

Description:
4.1Microscopy beyond the diffraction limit (optics at the nanometric scale)
4.2 STED, breaking the diffraction limit.
4.3 STORM, PALM ¿ principle & technical implementation
4.4 Applications of far-field superresolution in Biology

5. Near field single molecule detection by fluorescence

Degree competences to which the content contributes:

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Description:
5.1 Experimental aspects of single molecule detection ¿ different experimental schemes.
5.2 Applications of single molecule detection in Biology & Biophysics.
5.3 Near-field approaches (NSOM), theory & technical implementations
5.4 Applications of NSOM in Biology.

Qualification system

Students will be asked to give a presentation based on one of the covered subjects of 20 minutes followed by 10 minutes of questions. In addition, a written report that summarizes the content of their talks will be requested (prepared in teams).
Evaluation of the course would then be based on 2 criteria:
A) Oral presentation (individual) 50%
B) Join report (team) 50%

Bibliography