Biophotonics

Academic Year: (2019 / 2020) **Review date: 29-04-2019**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: MARTIN MATEOS, PEDRO

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

The students are expected to have attended the mandatory courses of the Master. It is also highly recommended to have skills in physics, optics, electromagnetism. Basic knowledge of Biology and Chemistry it is also desirable.

OBJECTIVES

Basic Skills
CB6. Knowledge and understanding that provide a basis or opportunity for originality in developing and / or applying ideas, often in a research context.
CB7. That the students can apply their knowledge and ability to solve problems in new or unfamiliar in wider or multidisciplinary environments related to their field of study.
CB8. That the students can integrate their knowledge, as well as handle the complexity of making judgements from an incomplete or limited information, but which could include reflections about the social and ethic responsibilities that could be linked to the application of their judgements and knowledge.
CB10. That the students possess learning skills that allow them following their long-life learning in a self-conducted and self-sufficient way.

General Skills

CG2. Ability to propose, design, implement and maintain a system with photonic components for a specific application

Specific Skills

CE2. Handling of tools aiming to design photonic devices and systems.
CE3. To be aware of the current trends in different applications of photonic technologies and learned experiences from real cases.
CE5. Capacity of selecting novel photonic components, technologies and subsystems.
CE6. Capacity of designing photonic devices, passive and active, and of evaluating its performance
CE8. Capacity of effectively searching information, as well of identifying the state of the art in a technological problem in the field of photonic devices and systems.

DESCRIPTION OF CONTENTS: PROGRAMME

T1. Introduction to Biophotonics. Objectives for the course. Definitions. Types of Light-Tissue and light-cells interaction. The NIR (therapeutic) window. Examples of biomedical applications. (1 Session)

T2. Light-Tissue Interaction. Optical Properties of Tissues with strong (multiple Scattering). Linear (elastic) and non-linear (inelastic) scattering. (1 Session)
T3. Methods to Obtain the Optical Parameters of Tissues. Absorption and scattering coefficients. Photon diffusion coefficient. Short pulse propagation in tissues. Diffuse photon-density waves. (1 session +laboratory session 1)

T4. Light-induced Processes in Tissues. Fluorescence and endogenous and exogenous fluorophores.

Non-radiative processes: Photochemical, Thermal, Photoablation¿.) (1 session)

T5. Spectroscopy of Tissues and Cells (I). Linear Spectroscopy: Absorption and dispersion spectroscopy. Continuous-wave, time domain and frequency domain Instruments. Example of real biomedical application instruments. (1 session)

T6. Spectroscopy of Tissues and Cells (II). Non-linear Spectroscopy. Brillouin and Raman Scattering in tissues and cells. Example of real biomedical application instruments. (1 session)

T7. Spectroscopy of Tissues and Cells (III). Fluorescence Spectroscopy. Example of real biomedical application instruments. (1 session)

T8. Bioimaging: An Important medical tool. Transmission Microscopy, Fluorescence Microscopy, Confocal Microscopy, Optical Coherence Tomography. Other Imaging techniques. (1 session)

T9. Photonic Biosensors. Principles of photonic biosensing. Use of Photon Radiation for Non-invasive biomedical instrumentation and medical diagnostic. Example of real biomedical application instruments (1 session+ laboratory session 2)

T10. Advanced concepts for biophotonics. Optogenetics: Interrogating brain with light. Tissue Engineering with Light. Light-Activated Therapy. Laser STweezers and Laser Scissors: Manipulating cells and single molecules. (1 session)

LEARNING ACTIVITIES AND METHODOLOGY

Learning activities
¿ Lectures
¿ Laboratory demonstration and experiments.
¿ Case Studies. The student will team-up in groups to work on selected topics that will be presented and discussed in class.

ASSESSMENT SYSTEM

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

¿ Ordinary Call:
¿ Laboratory work (20%)
¿ Case Studies Work (40%).
¿ At the end of the course the students must fill a brief questionnaire (exam) about the topics of the subject (40%).

¿ Extraordinary Call:
¿ The student may follow the continuous evaluation procedure with the same structure as in the ordinary call, or go for a final exam (100% of the final grade).

BASIC BIBLIOGRAPHY

- P.N. Prasad Introduction to Biophotonics, Wiley Interscience, 2003

- V. Tuchin. Tissue Optics. Light Scattering Methods and Instruments for Medical Diagnosis. , SPIE Press. , 2000

ADDITIONAL BIBLIOGRAPHY

- R.B. Northrop. Noninvasive Instrumentation and Measurement in Medical Diagnosis. , CRC Press, 2002