ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000983 - Biophotonics

DEGREE PROGRAMME

09AU - Master Universitario en Ingenieria Biomedica

ACADEMIC YEAR & SEMESTER

2020/21 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	93000983 - Biophotonics
No of credits	3 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	09AU - Master Universitario en Ingenieria Biomedica
Centre	09 - Escuela Tecnica Superior de Ingenieros de Telecomunicacion
Academic year	2020-21

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Paloma Rodriguez Horche	B-117	p.rhorche@upm.es	Sin horario. At any time, by making an appointment
Antonio Perez Serrano (Subject coordinator)	B-101	antonio.perez.serrano@upm.es	Sin horario. At any time, by making an appointment

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Optics Fundamentals

4. Skills and learning outcomes *

4.1. Skills to be learned

CB06 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CB07 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio

CB08 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios

CB09 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CG-MIB05 - Utilizar técnicas de expresión oral y escrita para comunicar trabajos y conclusiones a comunidades de iguales o divulgación científica, elaboración de artículos, manuales de estilo y herramientas de edición para fomentar la capacidad de comunicación y diseminación de resultados

4.2. Learning outcomes

RA131 - knowledge of the basic principles of photonics applied to medicine

RA135 - Knowing how to select the appropriate optical components according to the medical application

RA134 - Knowing the photonic instrumentation used in biomedical applications, as well as to know its experimental management

RA132 - Knowing and understanding the basic approaches of tissue-light interaction

RA112 - To develop the ability for oral communication of results

RA109 - To develop teamwork capabilities in the pursuit of completing an assignment, from the planning and documentation phase to the presentation of results

RA118 - Perform individual and team work by searching sources of information, critical discussion and present the results in oral and public presentation

RA133 - Knowing and understanding experimental approaches of biophotonic

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

Biophotonics, often called biomedical optics, is generally conceived to bear a fundamental concept: to understand and manipulate how light interacts with biological matter. From a global viewpoint, biophotonics refers to the detection, reflection, emission, modification, absorption, creation, and manipulation of photons as they interact with biological cells, organisms, molecules, tissues, substances and even whole organisms.

Biophotonics has become an indispensable tool for basic life sciences research and for biomedical diagnosis, therapy, monitoring, imaging, and surgery.

The purpose of this course is to present the differents topics related with the biophotonics as well as their practical applications.

This course will consist mainly in practical sessions, with some theoretical sessions. For this, we can say that the course is a project-based course that introduces the student to Biophotonics.

After some introductory theoretical and lab sessions, the students will develop a project. This project will be proposed by the professors or by the student, and it will be scientifically oriented, including different topics about biophotonics and physical computing, by means of low-cost and open hardware platforms such as Arduino.

In addition, this course is intended to present the most recent scientific and technological advances in biophotocnics.

COURSE PROGRAMME

* Seminar: Understanding Consumer Electronics for biomedical applications

- Basic electronic components

- Open Software and Hardware Platforms Open (Arduino or similar)

Lab session 1: Introduction

Introduction to Basic optical elements

Lab session 2: Measuring absorbance

The purpose of this experiment is to introduce a method of quantitatively measuring absorbance of a specific solution. To determine from Beer?s law, the characteristic absorption coefficient of the solution.

Lab session 3: Light-matter interactions

In this experiment, you will measure the attenuation, scattering and diffuse reflection of a red laser beam passing through different matters, including the skin. Skin is a turbid medium. This means that light is efficiently scattered in different directions within a short distance from the skin surface.

Lab session 4: Protopype design

In this experiment, the design and implementation of a biophotonics device will be made.

5.2. Syllabus

1. Essential Basics of Biophotonics

   1.1. Basic Principles of Light

   1.2. Optical phenomena used in biosensors

2. Basic Instrumentation in Biophotonics

3. Light-Matter Interaction in Biophotonics

4. Applications of lasers in medicine; Therapeutic Applications, Medical Diagnosis, Surgery applications, Laser Safety in Biomedical

5. Advances in Biophotonics

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	**1. Essential Basics of Biophotonics** Duration: 01:00 Lecture **2. Basic Principles of Light** Duration: 01:00 Lecture			
2	**3. Basic Instrumentation in Biophotonics** Duration: 02:00 Lecture			
3	**4. Essential Basics of Light Matter Interaction in Biophotonics** Duration: 01:00 Lecture **5. Light-Tissue Interaction Mechanisms** Duration: 01:00 Lecture			
4	**6. Applications of lasers in medicine** Duration: 01:00 Lecture **7. Optical phenomena used in biosensors** Duration: 01:00 Lecture			
5	**8. Advances in Biophotonics** Duration: 01:00 Lecture			
6		**Lab session 1: Introduction** Duration: 02:30 Laboratory assignments		**Presentation of the lab results** Other assessment Continuous assessment and final examination Presential Duration: 00:20
7		**Lab session 2: Measuring absorbance** Duration: 02:30 Laboratory assignments		**Presentation of the lab results** Other assessment Continuous assessment and final examination Presential Duration: 00:20
8		**Lab session 3: Light-matter interactions** Duration: 02:30 Laboratory assignments		**Presentation of the lab results** Other assessment Continuous assessment and final examination Presential Duration: 00:20

9		**Lab session 4: Prototype design** Duration: 02:30 Laboratory assignments		
10		**Lab session 4: Prototype design** Duration: 02:30 Laboratory assignments		
11		**Lab session 4: Prototype design** Duration: 02:30 Laboratory assignments		
12	**Group work presentation** Duration: 02:00 Additional activities			**Final Project presentation in oral and public presentation and critical discussion of results** Group presentation Continuous assessment Presential Duration: 00:20
13	**Group work presentation** Duration: 02:00 Additional activities			
14				
15				
16				
17				**Final exam. Individual project presentation.** Written test Final examination Presential Duration: 02:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
6	Presentation of the lab results	Other assessment	Face-to-face	00:20	15%	0 / 10	CB09 CB10 CB06 CG-MIB05 CB08 CB07
7	Presentation of the lab results	Other assessment	Face-to-face	00:20	15%	0 / 10	CB09 CB10 CB06 CG-MIB05 CB08 CB07
8	Presentation of the lab results	Other assessment	Face-to-face	00:20	15%	0 / 10	CB09 CB10 CB06 CG-MIB05 CB08 CB07
12	Final Project presentation in oral and public presentation and critical discussion of results	Group presentation	Face-to-face	00:20	55%	5 / 10	

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
6	Presentation of the lab results	Other assessment	Face-to-face	00:20	15%	0 / 10	CB09 CB10 CB06 CG-MIB05 CB08 CB07
7	Presentation of the lab results	Other assessment	Face-to-face	00:20	15%	0 / 10	CB09 CB10 CB06 CG-MIB05 CB08 CB07

8	Presentation of the lab results	Other assessment	Face-to-face	00:20	15%	0 / 10	CB09 CB10 CB06 CG-MIB05 CB08 CB07
17	Final exam. Individual project presentation.	Written test	Face-to-face	02:00	55%	5 / 10	CB10 CB06 CG-MIB05 CB08 CB07 CB09

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

Students will be qualified through continuous evaluation by default. According to the Normativa de Evaluación del Aprendizaje de la Universidad Politécnica de Madrid, students willing to renounce to continuous evaluation must notify in writing, through the Register of the Departamento de Tecnología Fotónica y Bioingeniería, to the coordinator before the eighth week of the course.

Evaluation will assess if students have acquired all the competences of the subject. Thus, evaluation through final assessment will be carried out considering all the evaluation techniques used in continuous evaluation (EX, ET, TG, etc.), and will be celebrated in the exam period approved by Junta de Escuela for the current academic semester and year. Evaluation activities that assess learning outcomes that cannot be evaluated through a single exam can be carried out along the semester.

In any case (continuous evaluation or final assessment modality), the student will overcome the subject when a grade higher or equal to 50% of the total score is obtained.

Performing all laboratory sessions, as well as obtaining an overall qualification equal or greater to 50% in their evaluation, is required to pass the course in any evaluation modality.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
slides	Web resource	Slides and other documentation available in Moodle
Datasheets for devices, circuits and subsystems	Web resource	Datasheets for components that could potentially be used in the design of the project
Laboratory Guide	Others	Laboratory manual
Biophotonic Lab	Equipment	Lab Brigathier Mathé of the Departamento de Tecnología Fotónica y Bioingeniería.
Biomedical Photonics Handbook, Second Edition. Editado por Tuan Vo-Dinh. CRC Press. 2014	Bibliography	Basic bibliography
David A. Boas, Constantinos Pitris, Nimmi Ramanujam. Handbook of Biomedical Optics. CRC Press. 2011	Bibliography	Complementary bibliography
Jeong-Yeol Yoon. Introduction to Biosensors: From Electric Circuits to Immunosensors. Springer Science+Business Media New York 2013	Bibliography	Complementary bibliography
Shuichi Kinoshita. Bionanophotonics: An Introductory Textbook. Pan Stanford 2013	Bibliography	Complementary bibliography
Gerd Keiser. Biophotonics, Concepts to Applications. Springer 2016.	Bibliography	Complementary bibliography

9. Other information

9.1. Other information about the subject

The course Biophotonics contributes to the Sustainable Development Goals (SDA) of the United Nations Agenda 2030 in different ways. On the one hand, it contributes to Objective 3: Health and Well-being, since the techniques and devices studied in the course are used in the prevention and treatment of different diseases and injuries. In particular, it is related to SDA3, objectives 3.1, 3.2, 3.8, 3.9 and 3.d. On the other hand, the experimental part of the course consists of the design and practical realization of electronic circuits with biophotonic devices based on open source platforms and hardware, and students are encouraged to publish their results following this philosophy. For this reason, the course contributes to SDA Objective 4: Education and its sub-objectives 4.4 and 4.7 by improving professional and technical skills and instilling in students the development and sharing of knowledge to promote sustainable development. The publication of results on open platforms helps to increase access to ICTs in LDCs which is directly related to SDA9, objectives 9.a, 9.b and 9.c, and SDA17, objectives 17.6 and 17.7.