Course guide
230582 - VOB - Visual Optics and Biophotonics

Last modified: 14/12/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 731 - OO - Department of Optics and Optometry.

Degree: MASTER'S DEGREE IN PHOTONICS (Syllabus 2013). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE3. Know the fundamentals of laser physics, the types of lasers and their main applications.
CE4. Demonstrate knowledge of the fundamentals of image formation, propagation of light through different media and Fourier Optics.
CE6. Have carried out a set of advanced laboratory works, similar to that of future experimental research work.
CE9. Ability to synthesize and present photonics research results according to the procedures and conventions of scientific presentations in English.

Generical:
CG1. Ability to project, design and implement products, processes, services and facilities in some areas of photonics, such as photonic engineering, nanophotonics, quantum optics, telecommunications and biophotonics.
CG4. Ability to understand the generalist and multidisciplinary nature of photonics, seeing its application, for example, to medicine, biology, energy, communications or industry

Transversal:
CT4. SOLVENT USE OF INFORMATION RESOURCES. Manage the acquisition, structuring, analysis and visualization of data and information in the field of the specialty and critically assess the results of this management.
CT1. ENTREPRENEURSHIP AND INNOVATION. Knowing and understanding the mechanisms on which scientific research is based, as well as the mechanisms and instruments for transferring results between the different socioeconomic agents involved in R&D&I processes.
CT5. ENGLISH. Accredit an adequate level of this language, both orally and in writing, in line with the needs that the graduates will have.
CT3. TEAMWORK. Be able to work as a member of an interdisciplinary team, either as another member, or performing management tasks in order to contribute to developing projects with pragmatism and a sense of responsibility, assuming commitments taking into account the available resources.

Basic:
CB6. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB7. Students should know how to apply the knowledge acquired and their problem-solving ability in new or little-known environments within broader (or multidisciplinary) contexts related to their area of ¿¿study.
CB8. Students should be able to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgment.
CB10. Students should possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

TEACHING METHODOLOGY

- Lectures
- Activities: - Laboratory and vision center visits
- Seminars
The student will have the possibility of performing measurements using experimental setups and commercial instruments.

LEARNING OBJECTIVES OF THE SUBJECT

Visual optics and biophotonics is an innovative and multidisciplinary area that uses light-based technologies to image, examine and treat the eye and its visual performance, improving diagnosis, therapy, and follow-up care of certain diseases. Therefore, it plays a crucial role for a better visual healthcare. Examples include lasers being used routinely in laser-refractive surgery, clinical instruments developed to measure aberrations and retinal image quality, and advanced image techniques such as optical coherence tomography (OCT) and others using adaptive optics, which can provide high resolution images of the ocular structures. The course focuses on the new methods for ocular refraction correction, such as intraocular lenses and refractive surgery, the evaluation of the ocular aberrations and retinal image quality, the study of optical and photonic tools currently used for the diagnosis of diseases related with ocular structures (cornea, lens and retina), such as the Scheimpflug camera and the OCT, the last one very used in the diagnosis of glaucoma, and concludes with the study of therapeutic lasers used in ophthalmology (excimer laser for refractive surgery, femtosecond laser for cataract surgery, Nd:YAG for retinal photocoagulation etc.).

STUDY LOAD

Type	Hours	Percentage
Hours large group	24,0	32.00
Self study	51,0	68.00

Total learning time: 75 h

CONTENTS

Visual optics and biophotonics

Description:
1. Introduction to visual optics and biophotonics. An overview of the human eye. (2h)
2. Schematic and advanced eye models. (1.5h)
2. Refractive anomalies and accommodation. Presbyopia. Means of correction: ophthalmic, contact, and intraocular lenses. Refractive surgery. (4h)
3. Human eye aberrations and measurement techniques. Evaluation of ocular aberrations. Wavefront sensors for the eye: Hartmann-Shack Wavefront sensor and Laser Ray tracing. (2h)
4. Retinal image quality measurement. Double pass technique and intraocular scatter measurements. (2h)
5. Adaptive Optics for vision. Customized vision correction. (3h)
6. Measurement of the optical properties of the cornea and lens. Basic optical instrumentation. Corneal topography, Scheimpflug and Purkinje images. (2h)
7. Conventional and high resolution retinal imaging. Ophthalmoscopy, scanning laser ophthalmoscope (SLO) and Optical Coherence Tomography (OCT). (2h)
8. Lasers in Ophthalmology. (4h)

Related activities:
Laboratory and vision center visits, seminars

Full-or-part-time: 22h 30m
Theory classes: 22h 30m

GRADING SYSTEM

- Homework assessments (35%)
- Written exam (50%)
- Oral presentation of a scientific journal paper (15%)

BIBLIOGRAPHY

Basic:
- Porter, Jason. Adaptive optics for vision science : principles, practices, design and applications. Canadà: Wiley-Interscience, 2006. ISBN 9780471679417.
- Goss, David A; West, Roger W. Introduction to the optics of the eye. Boston [etc.]: Butterworth-Heinemann, 2002. ISBN 075067346X.
- Atchison, David A; Smith, George. Optics of the human eye [Recurs electrònic] [on line]. Oxford [etc.]: Butterworth Heinemann, 2000 [Consultation: 21/04/2017]. Available on: http://www.sciencedirect.com/science/book/9780750637756. ISBN 0750637757.
- Popp, Jürgen. Handbook of biophotonics. Weinheim, Germany : [Chichester: Wiley-VCH ; John Wiley, distributor, cop. 2011-. ISBN 9783527410484.
- Henson, David B. Optometric instrumentation. 2nd ed. Oxford [etc.]: Butterworth-Heinemann, cop. 1996. ISBN 0750607270.
- Rabbetts, Ronald B; Bennett, Arthur G. Clinical visual optics. 4th ed. Edinburgh [etc.]: Elsevier/Butterworth Heinemann, 2007. ISBN 9780750688741.
- Schwartz, Steven H. Geometrical and visual optics : a clinical introduction. New York: McGraw-Hill, cop. 2002. ISBN 0071374159.