Course guides
230587 - OD - Optical Design

Last modified: 15/06/2021

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

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

Academic year: 2021 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Núria Tomás Corominas (coord) - UPC

Others: Núria Tomás Corominas

PRIOR SKILLS

Geometrical Optics knowledge

REQUIREMENTS

have taken courses in geometric optics in the grade from which the student comes or being enrolled in Beam Propagation and Fourier Optics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE3. (ENG) Màster en Fotònica:
Conocer los fundamentos de la física del láser, los tipos de láser y sus principales aplicaciones
CE4. (ENG) Màster en Fotònica:
Demostrar que conoce los fundamentos de la formación de imagen, de la propagación de la luz a través de los diferentes medios y de la Óptica de Fourier.
CE7. (ENG) Màster en Fotònica:
Capacidad de entender la ingeniería óptica como una actividad económica y empresarial considerando, entre otros, aspectos sociales, éticos y de sostenibilidad
CE9. (ENG) Màster en Fotònica:
Capacidad para sintetizar y exponer los resultados de investigación en fótonica según los procedimientos y convenciones de las presentaciones científicas en inglés.

Generical:
CG1. (ENG) Màster en Fotònica:
Capacidad para proyectar, diseñar e implantar productos, procesos, servicios e instalaciones en algunos ámbitos de la fotónica como los relacionados con la ingeniería fotónica, la nanofotónica, la óptica cuántica, las telecomunicaciones y la biofotónica

CG2. (ENG) Màster en Fotònica:
Capacidad para la modelización, cálculo, simulación, desarrollo e implantación en centros de investigación, centros tecnológicos y empresas, particularmente en tareas de investigación, desarrollo e innovación en todos los ámbitos relacionados con la Fotónica.
CG4. (ENG) Màster en Fotònica:
Capacidad para entender el carácter generalista y multidisciplinario de la fótonica viendo su aplicación por ejemplo a la medicina, biología, energía, comunicaciones o la industria

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.

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. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Basic:
CB6. (ENG) 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
CB7. (ENG) 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.
CB8. (ENG) 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 juicio.
CB10. (ENG) 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.

TEACHING METHODOLOGY

- Lectures
- Activities

LEARNING OBJECTIVES OF THE SUBJECT

This course focuses on the optical design process: from conceptual design to real and functional design taking into account the optomechanical aspects, but without going into the manufacturing processes.
The course aims to provide a knowledge base on optical design with an emphasis on the initial approach, the design strategy and the detection of limitations according to the actual environment in which the design is to be developed. That is why the course also covers aspects such as mechanics, detectors, emitters and the most used materials in the industry, as the influence of these factors on the final result of the design is relevant and must be linked to the chosen merit function.
Tolerances and methods for testing the system will be introduced from the point of view of the choice of system design.
Bases on ISO standards and optical software will be introduced. Free access or educationally licensed software will be used as a basis for establishing the knowledge that will be acquired throughout the course.
The index shows the different topics of the course, but their sequence is subject to the knowledge of the students. Some topics are transversal and will appear throughout the course.
We will work on the basis of examples that will be seen throughout the course and will be adapted as new concepts are introduced.

STUDY LOAD

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

Total learning time: 75 h

CONTENTS

1. Introduction to optical design .

Description:
1.1. What is meant by optical design
1.2. Conceptual design and paraxial design. Starting with geometric optics (worked on in the course "Beam propagation & Fourier Optics"), the first two stages of design will be introduced: Conceptual design and paraxial design. Examples of imaging optical systems will be developed.
1.3. Photometry, lenses and diaphragms as elements of optical design. Once the conceptual design is set, photometry will be considered. We will work on the same examples to monitor the evolution of the designs
1.4. Aberrations. Seidel aberrations will be introduced (based on what has been given in the subject Beam propagation & Fourier Optics) and the concept of the merit function will be introduced. 1.5 Collection of standard solutions

Full-or-part-time: 10h
Theory classes: 10h

2. Mechanical and construction restrictions

Description:
2.1. Material restrictions. Introduction to the materials used to build lenses.
Selection of appropriate materials based on chromatic aberrations. Update of the merit function according to the restrictions imposed by the material.
2.2. Other restrictions : manufacturing, testing methods, transmitters and detectors.
The manufacturing process and methods for testing impose many restrictions and force us to rule out theoretically possible solutions. , as well as transmitters and detectors, which can affect the system performance. These restrictions might cause changes in the merit function.
The course has its limit and stops at the time the construction process should begin

Full-or-part-time: 2h
Theory classes: 2h

3.- 3.- Introduction to Optimization

Description:
3.1. Procedures for optimizing a design: merit functions and Redesign process .
Complete optimization system of the optical system, adapting the design to all the mentioned restrictions and to the system capacity test

Full-or-part-time: 4h
Theory classes: 4h

4.- Delivery of the opto-mechanical designs ready to be implemented

Description:
4.1. ISO 10110 International Standard for the representation of optical systems.
4.2. Carrying out technical reports in the field of optical design
During the course you will develop a design and sample design as exercise for the students with special emphasis on the presentation of reports in professional format

Full-or-part-time: 4h
Theory classes: 4h

5.- Optical software.

Description:
5.1. Optical Software.
Throughout the course, the capabilities of optical software and the considerations that must be taken into account for a proper use will be explained. The software will not be provided by the course and the examples will be made with free access software or with a free educational license.

Full-or-part-time: 4h
Theory classes: 4h

ACTIVITIES

Activity

Description:
A practical sessions will be arranged in the research labs at CD6

Full-or-part-time: 2h
Theory classes: 2h

GRADING SYSTEM

- Deliveries (set of 4 exercises to be delivered) 60%
- Exam 40%.

BIBLIOGRAPHY

Basic:
- Born, M. ; Wolf, E. Principles of optics: electromagnetics theory of propagation, interference and diffraction of light. Cambridge University Press, 1999. ISBN 9780521642224.
- Hecht, E. Optics. Pearson, 2016. ISBN 9780133977226.
- Yoder Jr, Paul R. Opto-mechanical systems design [on line]. 3rd. CRC/Taylor and Francis, 2006 [Consultation: 03/05/2016]. Available on: http://site.ebrary.com/lib/upcatalunya/detail.action?docID=11022986 / http://site.ebrary.com/lib/upcatalunya/detail.action?docID=11022976. ISBN 9781482257717 (V. 1) ; 9781482257731 (V. 2).
- Smith, W.J. Modern optical engineering: the design of optical systems. McGraw-Hill, 2008. ISBN 9780071476874.
- Bäumer, S. Handbook of plastic optics [on line]. Wiley-VCH, 2005 [Consultation: 03/05/2016]. Available on: http://onlinelibrary.wiley.com/book/10.1002/9783527635443. ISBN 9783527404247.
- Karow, H.H. Fabrication methods for precision optics. New York: John Wiley, 1993. ISBN 0471512222.