Course guide
230587 - OD - Optical Design

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

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. 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.
CE7. Ability to understand optical engineering as an economic and business activity considering, among others, social, ethical and sustainability aspects
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.
CG2. Ability to modeling, calculate, simulate, develop and implement in research and technological centers and companies, particularly in research, development and innovation tasks in all areas related to Photonics.
CG4. Ability to understand the generalist and multidisciplinary nature of photonics, seeing its application, for example, to medicine, biology, energy, communications or industry

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. 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

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.