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230571 - OPTOMECH - Building Optomechanical Systems

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 731 - OO - Department of Optics and Optometry

Academic year: 2016

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

ECTS credits: 3 Teaching languages: English

Teaching staff

Coordinator: Josep Arasa (coord) - UPC

Degree competences to which the subject contributes

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.

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.
2. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.
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.

Teaching methodology

- Lectures
- Activities

Learning objectives of the subject

This course is focused in the optical design process, covering the opto-mechanical aspects, starting in the concept and finishing just before manufacture. The course also covers the constraints in the design process produced by mechanical, detectors, emitters and materials. The influence in the optical system is linked through the merit function. Related topics like testing are introduced only from the point of view of the proper election in the system design. Knowledge from ISO norm and optical software are also provided.

Study load

Total learning time: 75h	Hours large group:	22h 30m	30.00%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	2h 15m	3.00%
	Self study:	50h 15m	67.00%

Content

1. Optical design.	Learning time: 6h Theory classes: 6h

Description:

1.1.- Conceptual design and paraxial approach. Starting from geometrical optics (considered in the course "Beam propagation & Fourier Optics") the two first stages of the design are introduced; Conceptual design & paraxial approach. Four examples of imaging optical systems are used to fix troubles.
1.2.- Photometric, pupils and field apertures as design elements are introduced. Once the general design basis is fixed, the photometric weight is considered; the same four examples are updated.
1.3.- Design aberration base. Seidel aberration are developed (taking as starting point course "Beam propagation & Fourier Optics") and the requirement of the Merit function concept is introduced.

2. Mechanical and building constrains.	Learning time: 4h Theory classes: 4h

Description:

2.1.- Material constrains. Introduction of the material used to build lenses. Chromatic aberration is used to explain how to select the right material, prior merit function is updated with the new constrains.
2.2.- Manufacturing and testing constrains. The manufacturing process and the testing process, itself, force to skip a large number of solutions, the course is stopped in the building process at this level.
2.3.- Emitters and receivers constrains. Emitters and receivers, also, introduces restrictions in the performances that can be achieved, these constrains must be interpreted as changes in the merit function.

3.- Detailed Opto-mechanical design.	Learning time: 3h Theory classes: 3h

Description:

3.1.- Redesign process. A full optimization process of the optical system is carried out,
3.2.- Fitting the optical design with the manufacturer availability surface test plates.
3.3.- Tolerance analysis and assembling. Index of manufacturing processes. Uses of compensators

4.- Delivering ready to print opto-mechanical design.	Learning time: 3h Theory classes: 3h
Description: 4.1.- ISO 10110 norm. The international drawing norm for optical designs 4.2.- Additional information required	

5.- Optical software.	Learning time: 6h 30m Theory classes: 6h 30m
Description: 5.1.- Optical software. Optical software capabilities are explained along all the course. Software is not provided by the course	

Planning of activities

Activity	Hours: 2h 18m Theory classes: 2h 18m
Description: One or more practical sessions applying the course?s contents will be arranged in the research labs at CD6	

Qualification system

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

To pass the course will require a quite accessible level of knowledge but high final grades will be obtained only by demonstrating enough proficiency.

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Bibliography

Basic:

Hecht, E. Optics. Pearson, 2016. ISBN 9780133977226.

Born, M. ; Wolf, E. Principles of optics: electromagnetics theory of propagation, interference and diffraction of light. Cambridge University Press, 1999. ISBN 9780521642224.

Smith, W.J. Modern optical engineering: the design of optical systems. McGraw-Hill, 2008. ISBN 9780071476874.

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).

Karow, H.H. Fabrication methods for precision optics. New York: John Wiley, 1993. ISBN 0471512222.

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.