Last update: 19-04-2018

230573 - MEASUR - Measuring with Light

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

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

Academic year: 2018

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

ECTS credits: 3 Teaching languages: English

Teaching staff

Coordinator: Santiago Royo (UPC-CD6, coord.)

Others: Ferran Laguarta (UPC-CD6)
Juan Campos (UAB-GO)

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.

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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

Harnessing light for the measurement of real world phenomena offers a variety of different techniques and methodologies. Different setups and approaches provide paths for the characterization of surface shapes, hidden defects, optical aberrations or material properties. Noncontact in nature, a variety of working principles (from geometrical, Fourier and physical optics) allows covering a broad range of applications both in research, medicine and in industry.
Optical metrology techniques are general tools which can be useful to both lab scientists and application engineers. However, only the most basic techniques are usually presented in general undergraduate. In our subject students will be provided with theoretical, practical and hands-on experience on the basic principles of a selection of the most relevant optical metrology techniques. They will also briefly peek inside experimental and numerical techniques which boost the performance of several of them. We will review the different major families of techniques and applications while presenting to the student the most relevant applications of each technique in the industrial and research arenas.

BIBLIOGRAPHY:

· Basic
· Malacara, D. (1992). 'Optical shop testing'. 3rd ed. New York : John Wiley & Sons. ISBN: 0471522325
· Gasvik, K.J. (2002). 'Optical metrology'. 3rd ed. Chichester : John Wiley & Sons. ISBN:9780470843000
· Mercer, C. (2003) 'Optical metrology for fluids, combustion and solids' Kluwer Academic Publishers ISBN:1402074077
· Rastogi, P.K. (1997). 'Optical measurement techniques and applications'. Boston: Artech House. ISBN: 089006516
· Advanced
· Min Gu "Advanced optical imaging theory", Springer Series in Optical Sciences 75, Springer-Verlag ISBN 9783540662624
· Surface Texture (Surface Roughness, Waviness, and Lay), ANSI/ASME Standard B46.1-1995

Updated topical specific bibliography and teaching materials will be distributed through the ATENEA web platform.

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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%

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Content

1. Introduction

Learning time: 2h
Theory classes: 2h

Description:
1.1 Basic concepts involved in optical surface metrology.
1.2 Surface characterization: shape and texture.
1.3 General overview of surface metrology techniques.

2. Single point techniques

Learning time: 6h
Theory classes: 6h

Description:
2.1. Triangulation techniques.
2.2. Confocal and chromatic confocal.
2.3. Single point interferometry.
2.4. Self-mixing interferometry.
2.5. Time of flight imaging. Lidar. Ladar.

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3. Imaging techniques	Learning time: 14h 30m Theory classes: 14h 30m

Description:
3.1. Imaging in high numerical aperture conditions.
3.2. Noninterferometric wavefront sensing.
3.3. Wavefront fitting techniques.
3.4. Fringe projection techniques.
3.5. Phase-shifting techniques.
3.6. Confocal profilometry.
3.7. Interferometric imaging.
3.8. Profilometry of stratified media.
3.9. Optical metrology of laser induced photonics structures
3.9.1. Methods for refractive index profilometry
3.9.2. Characterization of propagation losses in laser written waveguides.
3.9.3. Metrology of laser-induced photonics structures
3.10. Polarimetry
3.9.1. Applications
3.9.2. Polarization state generators, and analyzers. Mathematical description of Stokes polarimeters
3.9.3. Classes of polarimeters. Optimization of polarimeters
3.11. Computer generated holograms in Optical testing
3.9.1. Computer generated holograms (CGHs)
3.9.2. Plotting CGHs
3.9.3. Interferometers using CGHs

Planning of activities

Activity	Hours: 2h 18m Theory classes: 2h 18m

Description:
- A practical session showing some of the most relevant techniques included the course contents will be held, with an estimated duration of 4 hours.
- Seminars based on the contents of the course may be included in the subject, depending on availability of relevant speakers.

Qualification system

- A personal written exam at the end of the course including all contents with a weight of 60%.
- A number of deliverables and exercises based on the topics of the course distributed at the end of some sessions, in order to work the contents of the session (40%)
- Optionally, students may present one report describing the basics and development of the practical session of the subject, for a 10% weight. For the students choosing this option the weight of the exam is reduced to 50%.

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Bibliography

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Malacara, D. Optical shop testing. 3rd ed. New York [etc.]: John Wiley & Sons, 2007. ISBN 9780471484042.

Rastogi, P.K. Optical measurement techniques and applications. Boston: Artech House, 1997. ISBN 0890065160.

Gåsvik, Kjell J. Optical metrology. 3rd ed. Chichester [etc.]: John Wiley, 2002. ISBN 0470843004.

Mercer, Carolyn R. Optical metrology for fluids, combustion, and solids. Boston: Kluwer Academic, 2003. ISBN 1402074077.

American Society of Mechanical Engineers. Surface texture : surface roughness, waviness and lay. American Society of Mechanical Engineers, 2009. ISBN 9780791832622.

Complementary:

Gu, Min. Advanced optical imaging theory. Berlin: Springer, 2000. ISBN 3540662626.