Last update: 08-07-2016

230559 - MICROMW - Optical Micromanipulation Workshop

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

Teaching unit: 1004 - UB - (ENG)Universitat de Barcelona

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: Mario Montes Usategui (coord.)

Others: Estela Martín Badosa (UB)

Opening hours

Timetable: mario_montes@ub.edu
estela.martinb@ub.edu

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.

CE6. (ENG) Màster en Fotònica:
Haber realizado un conjunto de prácticas de laboratorio de nivel avanzado, similar al de futuros trabajos experimentales de investigación

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

230559 - MICROMW - Optical Micromanipulation Workshop

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
- Experimental sessions

Learning objectives of the subject

This is an eminently practical course on optical tweezers/traps that consists on four laboratory projects. Each session is divided into two parts, an initial and brief introduction, in which the theoretical background is discussed with the students, and an extended laboratory stay with a very hands-on approach. We expect that all students build and align a simple optical tweezers setup, calibrate and measure forces, and generate traps and manipulate samples on a holographic setup.

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%

Last update: 08-07-2016

230559 - MICROMW - Optical Micromanipulation Workshop

Content

1. Introduction: micromanipulation with optical tweezers	Learning time: 4h 30m Theory classes: 4h 30m

Description:
Basic tweezers theory: trapping force. Force measurement. Novel holographic techniques. Applications

2. Building an optical tweezers setup	Learning time: 8h Theory classes: 8h

Description:
Main components of an optical tweezers setup: laser, steering optics, high numerical aperture objective. System constraints. Alignment of the optical setup. Trapping and moving a sample.

3. Calibration of an optical trap	Learning time: 4h Theory classes: 4h

Description:
Direct and indirect methods of force calibration. Harmonic potential approximation. Calibration based on comparison with viscous forces. Calibration based on the power spectrum method. Back-focal plane interferometry and position sensing devices.

4. Holographic optical tweezers: advanced micromanipulation	Learning time: 6h Theory classes: 6h

Description:
Review of spatial light modulators and digital holography. Holographic optical tweezers setup: constraints. 3D micromanipulation with a single holographic trap. Generating exotic traps.

Qualification system

Written report (100 %): The students will be evaluated mainly by the outcome of their practical work in the lab. They will have to present a written formal report of their activities and results, which will be graded accordingly. Also, the laboratory sessions may need thorough preparation and advanced study on the part of the student, work that we intend to take into account as well to set the final scores.

230559 - MICROMW - Optical Micromanipulation Workshop

Bibliography

Basic:

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Dholakia, K.; Reece, P. "Optical micromanipulation takes hold". Nano today. February 2006, núm.1, p.18-27.

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Block, S. M. Constructing optical tweezers in cell biology: a Laboratory Manual [on line]. Nova York: Cold Spring Harbor Press, 1998 [Consultation: 06/05/2016]. Available on: <http://www.cshlpress.com/chap_cells.tpl#laser>. ISBN 0879695218.

Berg-Sorensen, K.; Flyvbjerg, H. "Power spectrum analysis for optical tweezers". Review of scientific instruments [on line]. 2004, volum75, núm.594 [Consultation: 09/05/2016]. Available on: <http://scitation.aip.org/content/aip/journal/rsi/75/3/10.1063/1.1645654>.

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