Last update: 13-05-2015

# 230559 - MICROMW - Optical Micromanipulation Workshop

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

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

Academic year: 2015

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

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

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## 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.

BIBLIOGRAPHY

Basic

· Grier D G 2003 A revolution in optical manipulation Nature 424 810-816

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· Dholakia K and Reece P 2006 Optical micromanipulation takes hold Nanotoday 1 18-27
· Neuman K C and Block S M 2004 Optical trapping Rev. Sci. Instrum. 75 2787-2809
· Appleyard D C, Vandermeulen K Y, Lee H, and Lang M J 2007 Optical trapping for undergraduates Am. J. Phys. 75 5-14

Advanced
· Lang M J and Block S M 2003 LBOT-1: Laser-based optical tweezers Am. J. Phys. 71 201-215
· Block S M 1998 Constructing optical tweezers in Cell Biology: A Laboratory Manual, ed D Spector, R Goldman and L Leinward (Cold Spring Harbor, NY, Cold Spring Harbor Press)
· Berg-Sorensen K and Flyvbjerg H 2004 Power spectrum analysis for optical tweezers Rev. Sci.Instrum. 75 594-612
· Martín-Badosa E, Montes-Usategui M, Carnicer A, Andilla J, Pleguezuelos E and Juvells I 2007 Design strategies for optimizing holographic optical tweezers setups J. Opt. A: Pure Appl. Opt. 9, S267-S277
· Verdeny I, Farré A, Mas J, López-Quesada C, Martín-Badosa* E and Montes-Usategui* M 2011 Optical trapping: a review of essential concepts Opt. Pur. Apl. 44, 527-551

## Study load

| | | | |
|---|---|---|---|
| Total learning time: 75h | Theory classes: | 22h 30m | 30.00% |
| | Practical classes: | 0h | 0.00% |
| | Laboratory classes: | 0h | 0.00% |
| | Guided study: | 2h 15m | 3.00% |
| | Self study: | 50h 15m | 67.00% |

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## Content

### 1. Introduction: micromanipulation with optical tweezers

Degree competences to which the content contributes:

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

### 2. Building an optical tweezers setup

Degree competences to which the content contributes:

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

Degree competences to which the content contributes:

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

Degree competences to which the content contributes:

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.

## Bibliography