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230564 - NANO - Nanophotonics

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

Teaching unit: 893 - ICFO - Institute of Photonic Sciences

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: Niek van Hulst (ICFO)

Others: Romain Quidant (ICFO)
Frank Koppens (ICFO)
Jordi Martorell (ICFO)

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:

CE2. (ENG) Màster en Fotònica:
Demostrar que comprende las peculiaridades que comporta el modelo cuántico para la interacción luz-materia.

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.

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

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

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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.
CT3. (ENG) Màster en Fotònica:
TRABAJO EN EQUIPO. Ser capaz de trabajar como miembro de un equipo interdisciplinar ya sea como un miembro más, o realizando tareas de dirección con la finalidad de contribuir a desarrollar proyectos con pragmatismo y sentido de la responsabilidad, asumiendo compromisos teniendo en cuenta los recursos disponibles

Teaching methodology

- Lectures
- Activities

Learning objectives of the subject

NanoPhotonics is where optics and nanotechnology meet. NanoPhotonics plays an important role in current (and future) ultra-small and ultra-sensitive sensing, imaging, optical circuitry, data storage. Both fundamental concepts and applications will be treated in details.

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- Basic concepts

Learning time: 4h 30m
Theory classes: 4h 30m

Description:
Different regimes of optics; far-field versus near field, evanescent waves; optical response of a sub-wavelength objects; diffraction limit; imaginary wavevectors.

2- Fabrication of nanophotonic structures

Learning time: 1h
Theory classes: 1h

Description:
Top-down (photo-litho, e-beam, FIB, nano-inprint); bottom-up (colloids synthesis, self-assembly, coordination chemistry).

3- Optical adressing the nanoscale

Learning time: 2h
Theory classes: 2h

Description:
Confocal microscopy, scanning probe microscopy, near field microscopy, non-linear microscopy, nano-antennas, antenna-nanoscopy, single emitter probing.

4- Plasmonics

Learning time: 3h
Theory classes: 3h

Description:
Optical properties of metals (dielectric function, extended plasmons versus particle plasmons), individual and coupled metallic nanoparticles with plasmonic resonances for local field enhancement, extraordinary optical transmission through holes, bio-chemical sensing, nanoscale microscopy, enhanced radiative decay, enhanced Raman, etc.

5- Single photon emitters

Learning time: 2h
Theory classes: 2h

Description:
Nanoparticles, molecules, quantum, diamond NV-centers, quantum jumps, photon statistics, (anti)bunching, coupling to antennas, decay rate engineering.

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6- NanoPhotonic wires	Learning time: 1h Theory classes: 1h

Description:
Molecular complexes, excitonic systems, nanoscale energy transfer, coherent energy transfer, fs coherent control.

7- NanoPhotonics with 2D materials	Learning time: 3h Theory classes: 3h

Description:
Graphene band structure, doping; graphene plasmonics.

8- Light scattering	Learning time: 1h Theory classes: 1h

Description:
By nano-particles, photonic crystals and circular nano/micro-resonators. Applications of WGM resonators: Sensing, Non-linear optics.

9- Nanophotonics applied to thin film Solar cells	Learning time: 2h Theory classes: 2h

Description:
Solar cells: basic concepts. Light management using photonics crystals and plasmonic particles to enhance solar cell performance. Nano/micro-fiber array solar cells.

10- Nonlinear Nanophotonics	Learning time: 1h Theory classes: 1h

Description:
Second and third order nonlinear interaction within photonic structures (ordered and disordered), Metal nanoparticles and quadratic nonlinear optics.

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11- Applications	Learning time: 2h Theory classes: 2h

Description:
Biology, materials science, telecom and photonics.

Qualification system

- Exam and/or presentation (70%)
- Attending and active participation in class (30%)

Bibliography

Basic:

Novotny, L.; Hecht, B. Principles of nano-optics. 2nd ed. Cambridge: Cambridge University Press, 2012. ISBN 9781107005464.

Others resources: