Last update: 08-07-2016

230570 - LASERS - Laser Systems and Applications

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

Teaching unit: 748 - FIS - Department of Physics

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: Cristina Masoller, UPC (coord.).

Others: Muriel Botey, UPC.

Opening hours

Timetable:

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

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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.
5. 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:
  - Visits to industry and academic laboratories.
  - Hands-on training sessions on laser model simulations, where the students will simulate a simple laser model using the programming language that they are familiar with (such as matlab, fortran or c).

Learning objectives of the subject

The aim of this course is to provide the students a broad overview of the various laser systems currently being used in both scientific and industrial fields. Specific attention will be paid to cutting-edge applications such as diode lasers for telecoms and excimer and femtosecond lasers for micromachining and biomedical applications. This course also includes complementary activities such as hands-on computing sessions and visits to nearby industries which use lasers systems for material processing and laser-equipment for biomedical applications.
The course is given in the second semester.

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. Low-power laser systems for communications and information processing.

Learning time: 8h
Theory classes: 8h

Description:
1.1.-Semiconductor laser physics.
1.2.-Types of semiconductor lasers and models.
1.3.-Applications in communications and information processing.

2. Laser systems for high power applications.

Learning time: 8h
Theory classes: 8h

Description:
2.1.-Laser-based material processing. Requirements to take into account for different processes: cutting, welding, drilling, marking, surface treatment, rapid prototyping (3D printing or additive manufacturing).
2.2.-Laser systems with minimum thermal load (excimer lasers and femtosecond lasers). Non-thermal ablation and micromachining.
2.3.-Examples of applications, photonic components production based on laser manufacturing (waveguides, beam-splitters).
2.4.-Laser safety.

3. Laser systems for biomedical applications

Learning time: 6h 30m
Theory classes: 6h 30m

Description:
3.1.-Laser surgery
3.2.-Laser patterning in biomaterials
3.3.-Optogenetics
3.4.-Lab-on-a-chip devices

Planning of activities

Hands-on training sessions on laser model simulations

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

Description:
Hands-on training sessions on laser model simulations, where the students will simulate a simple laser model using the programming language that they are familiar with (such as matlab, fortran or c).

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Qualification system

- Oral or written presentation. The student will be able to chose to either give an oral presentation on a topic that he/she will chose among a list of topics proposed by the professors, or, to present a written report on the subject, in the same format as a journal article 'with abstract, introduction, results, conclusions and bibliography (40%).
- Exam (40%).
- Attending classes, lab visits and hands-on sessions (20%)

Bibliography

Basic:

Saleh, E.A.; Teich, M.C. Fundamentals of photonics. 2n. Wiley, 2007. ISBN 9780471358329.

Liu, J.M. Photonics devices. Cambridge: Cambridge University Press, 2005. ISBN 9780521551953.

Ohtsubo, J. Semiconductor Lasers: stability, instability and chaos. 3rd ed. Berlin ; New York: Springer, 2013. ISBN 9783642301469.

Schaaf, P. Laser processing of materials. Dordrecht: Springer, 2010. ISBN 9783642132803.

Rulliere, C. Femtosecond laser pulses : principles and experiments. 2nd ed. New York: Springer, 1998. ISBN 0387017690.