

## 230565 - ULTRA - Ultrafast and Ultraintense Laser Light

Coordinating unit:	230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit:	748 - FIS - Department of Physics
Academic year:	2017
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:	Jose Trull, UPC
Others:	Jens Biegert, 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 fotonica según los procedimientos y convenciones de las presentaciones científicas en inglés.

#### Generic:

- CG1. (ENG) Màster en Fotònica:  
Capacidad para proyectar, diseñar e implantar productos, procesos, servicios e instalaciones en algunos ámbitos de la fotonica como los relacionados con la ingeniería fotonica, la nanofotonica, la óptica cuántica, las telecomunicaciones y la biofotonica

#### 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.

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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

The course will give an overview on the challenges to produce ultra-short and ultra-intense laser light as well as highlight the different physical effects and possibilities pertaining to their usage. We will highlight state of the art methods and novel possibilities at the frontier of science

### 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- Ultrashort laser and X-ray pulses (J. Biegert)	Learning time: 7h 30m Theory classes: 7h 30m
<p>Description:</p> <ul style="list-style-type: none"> <li>1.1. Basic concepts for ultrabroadband pulses</li> <li>1.2. Issues in amplification / OPCPA</li> <li>1.3. Few-cycle pulse propagation</li> <li>1.4. Few-cycle pulses / the absolute phase / frequency combs</li> <li>1.5. High-harmonic generation, X-ray and Attosecond pulse generation</li> </ul>	
2- Pulse characterization (J. Trull)	Learning time: 7h 30m Theory classes: 7h 30m
<p>Description:</p> <ul style="list-style-type: none"> <li>2.1. General issues</li> <li>2.2. Short pulse characterization</li> <li>2.3. Reconstructions methods</li> <li>2.4. Spatio-temporal characterization</li> <li>2.5. Pulse shaping techniques</li> </ul>	
3- Coherent control and intense matter interaction (J. Biegert/J. Trull)	Learning time: 7h 30m Theory classes: 7h 30m
<p>Description:</p> <ul style="list-style-type: none"> <li>3.1. Basic concepts</li> <li>3.2. Coherent control schemes</li> <li>3.3. Optimal control theory</li> <li>3.4. Attosecond coherent control</li> </ul>	

### Planning of activities

Visit to the Attoscience lab at ICFO during the activities week	Hours: 2h 18m Theory classes: 2h 18m
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### Qualification system

- Homework + exam (35% + 35%)
- Attending and participation in class (30%)

Homework will be given for the three main sections of the course plus a final exam. Active participation in the class is an important aspect and will influence the final grades significantly.

### Bibliography

#### Basic:

Diels, Jean-Claude. Ultrashort laser pulse phenomena [on line]. 2nd. Academic Press, 2006 [Consultation: 19/05/2016]. Available on: <<http://www.sciencedirect.com/science/book/9780122154935>>. ISBN 9780122154935.

Milonni, P.W.; Eberly, J.H. Lasers physics. Hoboken, NJ: John Wiley & Sons, 2010. ISBN 9780470387719.

Trebino, R. Frequency-resolved optical gating : the measurement of ultrashort laser pulses. Boston: Kluwer Academic, 2000. ISBN 9781402070662.