

## 230569 - PHOTOV - Optoelectronics and Photovoltaic Technology

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|---------------------|--|
| Coordinating unit:  | 230 - ETSETB - Barcelona School of Telecommunications Engineering  |
| Teaching unit:      | 710 - EEL - Department of Electronic Engineering   |
| Academic year:      | 2017   |
| Degree:             | MASTER'S DEGREE IN PHOTONICS (Syllabus 2013). (Teaching unit Optional)<br>ERASMUS MUNDUS MASTER'S DEGREE IN PHOTONICS ENGINEERING, NANOPHOTONICS AND BIOPHOTONICS (Syllabus 2010). (Teaching unit Optional)<br>MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2009). (Teaching unit Optional)<br>MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)<br>MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional) |
| ECTS credits:       | 3  |
| Teaching languages: | English  |

### Teaching staff

|              |  |
|--------------|--|
| Coordinator: | Sandra Bermejo (UPC)   |
| Others:      | Ramon Alcubilla, UPC<br>Joaquim Puigdollers, UPC<br>Cristobal Voz, UPC |

### 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 nanofotónica, la óptica cuántica, las telecomunicaciones y la biofotonica
- 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

## 230569 - PHOTOV - Optoelectronics and Photovoltaic Technology

relacionados con la Fotónica.

CG4. (ENG) Màster en Fotònica:

Capacidad para entender el carácter generalista y multidisciplinario de la fónica 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. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

### Teaching methodology

- Lectures
- Activities

### Learning objectives of the subject

The basic concepts and tools for the understanding and analysis of optical semiconductor devices are presented. Representative devices for light generation and detection are treated. Examples of circuital aspects in light emission and detection are discussed; Special emphasis is devoted to photovoltaic solar cells, covering conventional crystalline structures, thin film cells and advanced concepts.

### 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% |

## 230569 - PHOTOV - Optoelectronics and Photovoltaic Technology

### Content

|   |   |
|---|---|
| Issue 1   | Learning time: 8h 30m<br>Theory classes: 8h 30m |
| Description:<br>Currents in a semiconductor. Generation and recombination. Radiative and non radiative recombinations. Continuity equation. Diffusion equation. |   |
| Issue 2   | Learning time: 2h<br>Theory classes: 2h         |
| Description:<br>Heterojunctions. Band diagrams. Current- voltage characteristics.   |   |
| Issue 3   | Learning time: 2h<br>Theory classes: 2h         |
| Description:<br>LED's basic structure. Emitted Power calculation.   |   |
| Issue 4   | Learning time: 2h<br>Theory classes: 2h         |
| Description:<br>Laser diodes: Population inversion. Fermi's pseudo levels.  |   |
| Issue 5   | Learning time: 2h<br>Theory classes: 2h         |
| Description:<br>Photodiodes: Diode electrostatics. PIN and Avalanche Photodiode (PIN & APD)   |   |

## 230569 - PHOTOV - Optoelectronics and Photovoltaic Technology

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|---|---|
| Issue 6   | Learning time: 2h<br>Theory classes: 2h |
| Description:<br>Properties of sunlight. Solar cell operation and PN junctions |   |
| Issue 7   | Learning time: 1h<br>Theory classes: 1h |
| Description:<br>Crystalline solar cells.                                      |   |
| Issue 8   | Learning time: 1h<br>Theory classes: 1h |
| Description:<br>Thin film solar cells.  |   |
| Issue 9   | Learning time: 1h<br>Theory classes: 1h |
| Description:<br>New concepts in solar cells.                                  |   |
| Issue 10  | Learning time: 1h<br>Theory classes: 1h |
| Description:<br>Device fabrication and characterization.                      |   |

### Planning of activities

|                   |   |
|-------------------|---|
| Laboratory visits | Hours: 2h 18m<br>Theory classes: 2h 18m |
|-------------------|---|



## 230569 - PHOTOV - Optoelectronics and Photovoltaic Technology

### Qualification system

- Exam: written 60 %
- Exercises and homeworks 40%

### Bibliography

#### Basic:

- Kasap, Safa O. Optoelectronics and photonics : principles and practices. Boston: Pearson, 2013. ISBN 9780273774174.
- Nelson, Jenny. The Physics of solar cells. London: Imperial College Press, 2003. ISBN 1860943497.