Last update: 13-05-2015

230550 - INTRO - Introduction to Photonics. Optics and Lasers

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 721 - FEN - Department of Physics and Nuclear Engineering
Academic year: 2015
Degree: MASTER'S DEGREE IN PHOTONICS (Syllabus 2013). (Teaching unit Compulsory)
ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Ramon Vilaseca, UPC.

Others: Jordi Mompart, UAB.

Opening hours

Timetable: ramon.vilaseca@upc.edu
jordi.mompart@uab.cat

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. 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.
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

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Learning objectives of the subject

This course presents a general overview of the world of Photonics, introducing the fundamental aspects and physical phenomena concerning light and its interaction with matter (excluding pure propagation phenomena in uniform materials, in particular beam propagation, image formation and Fourier Optics, as they are considered in the course "Beam propagation & Fourier Optics"). At the same time, in many of the subjects the state-of-the art in research and the variety of applications of Photonics in Science & Technology are pointed out.
The course is given in the first semester, to allow the student better follow the different Master courses, in any of the itineraries he/she can choose)

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BIBLIOGRAPHY:
The course will include only parts of these references, at an appropriate level
- Fundamentals of Photonics, B. E.A. Saleh and M.C. Teich (Wiley, 2nd ed., 2007).
- Optoelectronics & Photonics: Principles & Practices, Safa O. Kasap (2nd ed., 2012)
- Principles of Lasers, O. Svelto (Springer, 5th ed., 2010).
- The Quantum Theory of Light, R. Loudon (Oxford Sci. Publ., 3rd ed. 2000)

Study load

Total learning time: 125h	Theory classes:	37h 30m	30.00%
	Practical classes:	0h	0.00%
	Laboratory classes:	0h	0.00%
	Guided study:	3h 45m	3.00%
	Self study:	83h 45m	67.00%

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Content

1.- Light.

Learning time: 1h

Large group/Theory: 1h

Description:

1.1.- Light from geometric and electromagnetic approaches (short review). Wave equation and electromagnetic waves. Classical properties of light and related quantities.

1.2.- Quantum properties of light (introduction): photons, particle character and states of light, uncertainty and measurement.

2.- Light-matter interaction. Basic physical phenomena.

Degree competences to which the content contributes:

Description:

2.1.- At atomic scale: linear interaction phenomena between light and one atom or molecule. Classical and semiclassical approaches.

2.2.-Consequences at macroscopic scale: complex refractive index, dispersion and light velocities. Main physical phenomena (introduction) arising in the interaction of light with: dielectrics, semiconductors and metals (excitons, polaritons, plasmonics). Idem with confined materials and structures (quantum dots, etc.), and with metamaterials.

2.3.- Introduction to Nonlinear optics and dynamics. Perturbative phenomena, notion of solitons.

3.- Light-matter interaction. Basic applications

Degree competences to which the content contributes:

Description:

3.1.- Photoemitters by spontaneous emission (introduction): Thermal, LED's, etc.

3.2.- Photoemitters by stimulated emission: Lasers. Fundamentals, types, performances. Short-pulse generation

3.3.- Photodetectors (introd.): Power ¿or point- photodetectors (thermal, quantum), position & image detectors.

3.4.- Reading, measuring and sensing with light. Beyond the optical resolution limit.

3.5.- Action over the center of mass (short introduction): cooling & trapping of atoms, optical tweezers.

1.6.- Bounded and non-uniform media (introduction):

3.7.- Light propagation and information transmission in optical fibers.

3.8.- Light propagation in photonic crystals. (Random materials)

4.- Scientific and technological applications, research trends (broad overview)

Degree competences to which the content contributes:

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Description:
4.1.- Photonics applications in different sectors: industry (sensors, metrology, material processing, lightning & energy), information technologies & telecomm., vision, chemistry (analysis, remote sensing),...
4.2.- New fields: Nanophotonics, Biophotonics, Quantum information, etc.

Qualification system

- Homework + exam (70%).
- Attending seminars, lab visits, possible oral or video presentation, class attendance (30%).

Regulations for carrying out activities

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Bibliography