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230572 - MANAGL - Managing Light with Devices

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

Teaching unit: 731 - OO - Department of Optics and Optometry

Academic year: 2019

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: María S. Millán (UPC)

Opening hours

Timetable: Upon request, according to student and professor time availability.

Prior skills

Principles of optics (such as geometrical and electromagnetic wave models, polarization), which are described in the courses of Introduction to Photonics and Beam Propagation. General physics and mathematics basics are assumed to be part of the background knowledge of the student

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
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.
3. 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.
2. 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. 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 on the subject and activities conducted by the teacher with the participation of students during the class time.

Activities:
- Optics Today: Paper read and discussion on trending, hot, emerging topics.
- Optipedia: a dictionary built from the student contributions to recall the principles and metrics that matter in the performace of optical instruments and devices.
- Topic at a choice: Work on a particular application. It may include: statement, constraint definition, approaches and solutions, case/s of application, references (paper/s with examples of such application). Oral presentation and/or written report.
- Numerical exercises and short questions to illustrate the applications of the topics. To be worked by students, and then, solved and commented in class or through the platform.
- Simple optical experiments in class and Laboratory work. Students will have the opportunity of visiting a research laboratory and using its equipment to carry out an experimental task. Lab session programmed at the premises of the Faculty of Optics and Optometry (Campus Terrassa, UPC).
- Seminars on trending topics and visits. The organisation of complementary activities varies depending on the number of students, timetable and availability of external collaborators and facilities.
- Viewpoint, Newsroom and Celebrations: Gender in optics and photonics (Woman's week), Nobel Prize winners, The International Day of Light, and so on.

Learning objectives of the subject

This course aims to provide the students with fundamental and practical knowledge of the devices that can be used to generate (light sources), modulate (illumination systems, optical modulators, filters, adaptive optical devices and displays), direct (scanners, optical couplers, interconnects), and detect optical signals (sensors and cameras, analysers), as well as of the combined (customized) optical systems. Focus on their most relevant applications to the industrial and research environments. To provide tips to choose the most appropriate device for a given application. Fundamentals of radiometry and photometry (review). Development of some specific applications, such as programmable optical

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components and machine vision. Development of critical thinking and reasoning. External collaboration: regularly, a researcher with expertise in a specific field introduces a trending topic.

Study load

Total learning time: 75h	Hours large group:	24h	32.00%
	Self study:	51h	68.00%

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Content

Characterizing light: Radiometry and Photometry

Learning time: 4h

Theory classes: 4h

Description:
1.1. Review of radiometric and photometric magnitudes and unities
1.2. Radiation pattern. Power/Flux and intensity. Illuminance and Luminance
1.3. Mathematical relationships between photometric magnitudes
1.4. Colour specification (review) and management. Measurement geometries. Spectrometers.
1.5. Exercises and practical cases.

Related activities:
- Exercises and practical cases.
- OPTIPEDIA
- DISPLAYS (Experimental): Classrom Projector, smartphone camera/screens, printer, laptop and computer screens.

Light sources, illumination, systems

Learning time: 3h

Theory classes: 2h 30m
Guided activities: 0h 30m

Description:
2.1. Spectral and spatial characterization, luminous efficacy.
2.2. Incandescent, LED and OLED sources.
2.3. Polar representation of intensity profiles and calculation of the flux.
2.4. Illumination systems and characterization.
2.5. Practical case: Image chain with smartphones, computer screens and projectors.

Related activities:
- Paper read and discussion on trending, breakthrough, emerging topics.
- Practical case: Image display on smartphones, computer screens and projectors.
- Laboratory work. Students will have the opportunity of visiting a research laboratory and using its equipment to carry out an experimental task. Lab session programmed at the premises of the Faculty of Optics and Optometry (Campus Terrassa, UPC).

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Optical modulation based on the acousto-optic effect. Devices.	Learning time: 4h Theory classes: 4h

Description:
3.1. Interaction of light and sound (Acousto-optic effect).
3.2 Representation schemes
3.3. Acousto-optic devices and characteristics
3.4. Exercises and practical cases.

Related activities:
Exercises and practical cases.
Seminar

Optical modulation based on the electro-optic effect. Devices.	Learning time: 4h Theory classes: 4h

Description:
4.1. Electro-optic effect
4.2. Devices and characteristics
4.3. Optical couplers
4.4. Exercises and practical cases.

Related activities:
Exercises and practical cases.

Programmable optical components and displays	Learning time: 4h Theory classes: 4h

Description:
5.1. Liquid crystal devices (LCD),
5.2. Pixelated spatial light modulators and displays. Characterization and linear response
5.3. Application: Programmable diffractive optical elements
5.4. Exercises

Related activities:
Exercises
- DISPLAYS (Experimental): Classrom Projector, smartphone camera/screens, printer, laptop and computer screens.

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Optical sensors and Cameras	Learning time: 3h 30m Theory classes: 3h Guided activities: 0h 30m

Description:
6.1. Array sensors and image sensors
6.2. Visible and NIR cameras
6.3. Applications: industrial quality inspection, surveillance, security

Related activities:
Topic at a choice: Work on a particular application.
Oral presentation and/or written report.
Seminar

Qualification system

- Exams: Oral Presentation and Summary of a Topic at a choice (30%) and Written exercise (30%).
- Practical task: experimental work and report (30%)
- Attending seminars and visits, class attendance, questionnaires and participation (10%)

Bibliography

Basic:

Liu, J.M. Photonic devices. Cambridge: Cambridge University Press, 2005. ISBN 0521551951.

Saleh, B.E.A.; Teich, M.C. Fundamentals of photonics. 2nd ed. New York: John Wiley & Sons, 2007. ISBN 9780471358329.

Chigrinov, V.G. Liquid crystal devices: physics and applications. Boston: Artech House, 1999. ISBN 0890068984.

Holst, G.C. CCD arrays, cameras, and displays. 2nd ed. Winter Park, FL : JCD ; Bellingham, Wash., USA: SPIE Optical Engineering, 1998. ISBN 0964000040.

Fiete, R.D. Modeling the imaging chain of digital cameras [on line]. Bellingham, Washington: SPIE Press, 2010 [Consultation: 10/07/2019]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=728496>. ISBN 9780819483362.

Others resources:

Additional bibliography and scientific papers will be provided and updated through the ATENEA platform

Audiovisual material

Telèfons mòbils particulars i projector de l'aula

Private mobile phones and smartphones, classroom projector (to display of images prepared by the teacher) for simple experiments during the class