



Course guide

230572 - MANAGL - Managing Light with Devices

Last modified: 25/05/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 731 - OO - Department of Optics and Optometry.

Degree: MASTER'S DEGREE IN PHOTONICS (Syllabus 2013). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here:
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura>

Others: Consultar aquí / See here:
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma>

PRIOR SKILLS

25

REQUIREMENTS

Principles of optics (geometrical optics approach, electromagnetic wave model, 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

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 fotonica 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 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.

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.

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.

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 after analyzing a review paper. It recalls on the optical principles and metrics that matter in the performance of optical instruments and devices.
- Topic at a choice: Work on a particular topic or application chosen from the students. 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 to do in class, at home, and Laboratory work.
- Seminars on trending topics
- Visits. The organization of complementary activities varies depending on the number of students, timetable and availability of external collaborators and facilities. Visit to a research laboratory at the Faculty of Optics and Optometry (Campus Terrassa, UPC).
- Discussions, Newsroom and Celebrations: Gender in optics and photonics (Woman's week), Barcelona Mobile world congress, 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. Low-cost, smartphone-based optical instruments. Fundamentals of radiometry, photometry, and colour management. Development of some specific applications, such as programmable optical 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

Type	Hours	Percentage
Hours large group	24,0	32.00
Self study	51,0	68.00

Total learning time: 75 h

CONTENTS

Characterizing light: Radiometry and Photometry

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.

Full-or-part-time: 4h

Theory classes: 4h

Light sources, illumination, systems

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: Colour image chain with smartphones, computer screens and projectors.

Related activities:

- Paper read and discussion on trending, breakthrough, emerging topics.
- Practical case: Colour image display on smartphones, computer screens and projectors.
- Experimental work. Visit to a research laboratory at the the Faculty of Optics and Optometry (Campus Terrassa, UPC); possible use of its equipment to carry out an experimental task.

Full-or-part-time: 3h

Theory classes: 2h 30m

Guided activities: 0h 30m

Optical modulation based on the acousto-optic effect. Devices.

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

Full-or-part-time: 4h

Theory classes: 4h

Optical modulation based on the electro-optic effect. Devices.

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.

Full-or-part-time: 4h

Theory classes: 4h

Programmable optical components and displays

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.

Full-or-part-time: 3h

Theory classes: 3h



Optical sensors and Cameras

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

Full-or-part-time: 4h 30m

Theory classes: 3h 30m

Guided activities: 1h

GRADING SYSTEM

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

BIBLIOGRAPHY

Basic:

- 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.
- Liu, J.M. Photonic devices. Cambridge: Cambridge University Press, 2005. ISBN 0521551951.
- Holst, G.C. CCD arrays, cameras, and displays. 2nd ed. Winter Park, FL : JCD ; Bellingham, Wash., USA: SPIE Optical Engineering, 1998. ISBN 0964000040.
- Saleh, B.E.A.; Teich, M.C. Fundamentals of photonics. 2nd ed. Hoboken: John Wiley & Sons, 2019. ISBN 9781119506874.
- Chigrinov, V.G. Liquid crystal devices: physics and applications. Boston: Artech House, 1999. ISBN 0890068984.

RESOURCES

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

Other resources:

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