Course guide
230572 - MANAGL - Managing Light with Devices

Last modified: 14/12/2023

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. Know the fundamentals of laser physics, the types of lasers and their main applications.
CE4. Demonstrate knowledge of the fundamentals of image formation, propagation of light through different media and Fourier Optics.
CE7. Ability to understand optical engineering as an economic and business activity considering, among others, social, ethical and sustainability aspects
CE9. Ability to synthesize and present photonics research results according to the procedures and conventions of scientific presentations in English.

Generical:
CG1. Ability to project, design and implement products, processes, services and facilities in some areas of photonics, such as photonic engineering, nanophotonics, quantum optics, telecommunications and biophotonics.
CG2. Ability to modeling, calculate, simulate, develop and implement in research and technological centers and companies, particularly in research, development and innovation tasks in all areas related to Photonics.
CG4. Ability to understand the generalist and multidisciplinary nature of photonics, seeing its application, for example, to medicine, biology, energy, communications or industry

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. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB7. Students should know how to apply the knowledge acquired and their problem-solving ability in new or little-known environments within broader (or multidisciplinary) contexts related to their area of ¿¿study.
CB8. Students should be able to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgment.
CB10. Students should possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

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