UNIVERSITAT POLITÈCNICA DE CATALUNYA

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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: 2015 - 2016
Degree: Master's Degree in Photonics
Erasmus Mundus Master's Degree in Photonics Engineering, Nanophotonics and Biophotonics
ECTS credits: 3 **Teaching languages:** English

Academic staff

Coordinator:	Santiago Royo (UPC)	santiago.royo@upc.edu
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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. 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.
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.
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
Activities:
- One or more practical sessions applying the course's contents will be arranged in the research labs at CD6

Objectives and short description of the course

Advances and innovations in lighting sources, displays and optical sensors have been dramatic lately. A broad range of newly developed devices have already taken their places in our daily lives such as infrared cameras that provide satellite pictures, infrared sensors in home, on-line control of industrial processes or high-efficiency metal halide and light-emitting diode (LED) sources. Others are poised to revolutionize different research areas and industries, providing ultra-fast measurements and very-high optical and spectroscopic resolution to monitor processes, measure compositions and atmospheric makeup and to show details and reveal information never seen before.
The purpose of this course is to provide the students with the fundamental knowledge of the devices that can be used to generate, modulate and detect optical signals, focusing in the most relevant applications in the industrial and research arenas. They will be provided with useful skills to decide the most convenient device to manage light. The latest developments in this exciting field will be also presented. Starting from the basics of photometry

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and polarization, the performance of different sources and detectors and the basics of light modulation using active devices will be presented.

Study load

Total learning time: 75h	Hours large group:	22.5h	30%
	Hours medium group:	0h	0%
	Hours small group:	0h	0%
	Guided activity:	2.25h	3%
	Self study:	50.25h	67%

Course index

1. **Characterizing light: Spatial and spectral measurements**
   - 1.1 Review of radiometric and photometric magnitudes and units
   - 1.2 Mathematical relationships between photometric magnitudes
   - 1.3 Spectral power distribution and color. Colorimetry
   - 1.4 Spectrometers and colorimeters. Measurement geometries

2. **Light Sources**
   - 2.1 Luminous efficacy, color temperature and color rendering
   - 2.2 Incandescent and electroluminiscent light sources
   - 2.3 Lasers
   - 2.4 LEDs, OLEDs and LEPs
   - 2.5 Illumination systems and its characterization.

3. **Displays**
   - 3.1 Displays
   - 3.2 Projectors
   - 3.3 Spectral and color properties of displays and projectors
   - 3.4 Calibration of color displays

4. **Photodetectors**
   - 4.1 Photodiodes
   - 4.2 Photomultipliers

5. **Image sensors**
   - 5.1 Image sensors: CCD and CMOS technology.
   - 5.2 Noise sources
   - 5.3 Color and multispectral imaging
   - 5.4 InGaAs sensors
   - 5.5 Characterization of image sensors

6. **Optical modulation based on the electrooptic effect**
   - 6.1 The electrooptic effect
   - 6.2 Devices and characteristics
   - 6.3 Applications

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7. **Optical modulation based on the magnetooptic effect**
   - 7.1 The magnetooptic effect
   - 7.2 Devices and characteristics
   - 7.3 Applications

8. **Optical modulation using liquid crystals**
   - 8.1 Liquid crystals
   - 8.2 Types of liquid crystals
   - 8.3 Spatial light modulators
   - 8.4 Phase-only modulators
   - 8.5 Applications

9. **Deformable mirrors**
   - 9.1 Wavefront management using deformable mirrors
   - 9.2 Types of deformable mirrors
   - 9.3 Active and adaptive optical systems

Qualification system

Students will be assigned a number of tasks related to the contents of the course and their interests along the course. These tasks will represent 60% of the total course evaluation.
A final examination at the end of the course delivers the remaining 40% of the final mark.

Bibliography

- J.M. Liu, Photonicdevices, Cambridge Univ. Press (2005)
- B.E.A. Saleh and M.C. Teich, Fundamentals of Photonics,(Wiley,2nd Ed., 2007)
- V.G. Chigrinov, Liquid crystal devices, Artech House (1999)
- G.C. Holst, CCD arrays, cameras, and displays, 2nd Ed. SPIE Press JCD Publishing, (1998)
- R.K. Tyson, Introduction to adaptive optics, SPIE TutorialTT41 (2000)
- R.S. Berns, Principles of color technology, 3rd Ed. John Wiley and Sons, Inc. USA (2000)
- J.M. Palmer and B.G. Grant B.G., The art of radiometry, SPIE Press, USA (2010)
- H.R. Kang, Color technology for electronic imaging devices, SPIE Press. USA (1997)
- H.C. Lee, Introduction to color imaging science, Cambridge University Press. UK (2005)

Additional updated bibliography may be provided through the ATENEA site.