SUBJECT TEACHING GUIDE

G1479 - Optoelectronics

Degree in Telecommunication Technologies Engineering

Academic year 2025-2026

1. IDENTIFYING DATA					
Degree	Degree in Telecommunication Technologies Engineering			Type and Year	Optional. Year 4
Faculty	School of Industrial Engineering and Telecommunications				
Discipline	Speciality Optional Subjects				
Course unit title and code	G1479 - Optoelectronics				
Number of ECTS credits allocated	6	Term		Semester based (2)	
Web					
Language of instruction	Spanish	English Friendly	No	Mode of delivery	Face-to-face

Department	DPTO. TECNOLOGIA ELECTRONICA E INGENIERIA DE SISTEMAS Y AUTOMATICA
Name of lecturer	FRANCISCO JAVIER MADRUGA SAAVEDRA
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Office	Edificio Ing. de Telecomunicación Prof. José Luis García García. Planta: - 3. DESPACHO PROFESORES (S324)
Other lecturers	MARIA ANGELES QUINTELA INCERA ANTONIO QUINTELA INCERA

3.1 LEARNING OUTCOMES
- Understands theoretical concepts of light from different theories (corpuscular, wave, and quantum)
- Understands the behavior of optical devices and systems (lenses, mirrors, collimators, microscope objectives, etc.) from the theory of Geometric Optics
- Understands the fundamentals of Fourier optics from wave optics theory
- Applies the Fourier optical transform in spatial image filtering
- Defines the phenomenon of diffraction and lists the parameters that influence this phenomenon for different apertures and diffraction gratings
- Chooses the most suitable diffraction grating for a spectrometer for a specific application
- Identifies and describes industrial and biomedical applications of spectroscopy
- Defines and understands the optical phenomenon of light polarization and lists the different types of polarization
- Applies analytical and numerical models for polarization analysis
- Lists passive optical devices based on polarization and describes their utility and the technology they are based on
- Understands and explains the interaction conditions in the acousto-optic and electro-optic effects
- Lists and describes the operation of optoelectronic devices based on the acousto-optic and electro-optic effects
- Defines the phenomenon of light wave interference and determines the interference conditions
- Bases light detection in semiconductors
- Names different types of point and matrix detectors and their differences and proposes typical application scenarios for each
- Explains the fundamentals of light emission in semiconductors
- Names different relevant light sources and their main differences. Proposes typical application scenarios for each
- Bases light propagation in waveguides
- Identifies the relevant parameters of directional couplers, diffraction gratings
- Performs calculations for the design of integrated optoelectronic circuits for application in amplification, modulation, optical processing, sensing, holograms
- Calculates FOV, IFOV, and NEI for cameras and imaging systems
- Processes information from images
- Lists the different approaches for the design of optoelectronic systems (analytical, simulation, and prototyping) and their advantages and disadvantages
- Handles technical information in English related to optoelectronics
- Chooses the most suitable commercial optoelectronic devices from the performance point of view in the design of an optoelectronic system

4. OBJECTIVES
Will define the general and basic concepts related to light and optoelectronic materials and devices.
Will identify the potential of photonic information processing, and analyze and design architectures that allow it.
Will design, analyze, and in some cases assemble and verify optoelectronic circuits for applications in coupling, reading, recording, capturing, processing, visualization-presentation, lighting, detection, and measurement of information, with special emphasis on those used in ICT.
Will handle basic optoelectronic characterization instrumentation.
Will correctly interpret technical information in English related to optoelectronic devices and systems.
Will understand how a light beam propagates through all types of media.
Will base the emission of light in semiconductors and describe the most relevant differences between light sources.
Will base the detection of light in semiconductors and describe the most relevant differences between different photodiodes.

6. SUBJECT PROGRAM

CONTENTS	
1	Light-matter interaction. Optical properties of materials. Absorption, emission, refractive index. Concept of light guiding.
2	Optical devices and systems (lenses, mirrors, collimators, microscope objective, etc.). Geometric optics. Wave optics.
3	Optical phenomena and effects (diffraction, interference, polarization, birefringence, speckle, moiré, nonlinear effects, etc.).
4	Fourier optics. Image formation and holography.
5	Radiometry and photometry.
6	Photosensitive devices and light detection systems: PIN photodetectors, APD, CCD, CMOS.
7	Imaging systems and applications. Infrared radiation.
8	Electroluminescent diode (LED). Materials, structures, and applications. OLED. Laser diode. Materials, structures, and applications.
9	Optical waveguides. Wave equation. Structures and systems. Planar dielectric guides, microguides, optical fibers. Directional couplers, diffraction gratings.
10	Optoelectronic functions (Integrated optoelectronic circuits): modulation, amplification.
11	Visit to the R&D laboratory and company.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Activity integrated within continuous assessment. This activity consists of the collection of deliverables related to problems, exercises, designs, assignments, review tests, and other activities, both individual and group, in the classroom and outside o	Others	No	Yes	75,00
Activity integrated within continuous assessment. This activity consists of the collection of deliverables related to laboratory practices. These activities require attendance at the laboratory. Weight: 25%	Laboratory evaluation	No	Yes	25,00
TOTAL				100,00

Observations
Observations for part-time students
The same criteria will be applied as for the rest of the students.

8. BIBLIOGRAPHY AND TEACHING MATERIALS
BASIC
Optoelectronics and Photonics, Principles and Practices, S,O. Kasap, Printence Hall, (2001).
Optoelectronics, Emmanuel Rosenchar and Borge Vinter. Cambridge University (2002).
Fundamentals of photonics, Bahaa E. A. Saleh, Malvin Carl Tech. Wiley -Interscience, 2 Edition (2007).
Optoelectronics: infrared-Visible, UV, Devices and Applications, Dave Birtalan, 2nd ed., CRC Press (2009).
Photonics: Optical Electronics In Modern Communications, Amnon Yariv, and Pochi Yeh, Oxford University Press, 6th Edition, (2007).
S. L. Chuang, Physics of Photonic Devices, 2nd ed. Wiley, (2009).
David Voelz, Computacional Fourier optics" SPIE PRESS (2011)
Ting-Chung Poon, Taegeun Kim, Engineering optics with Matlab World scientific Publising (2006).
Gerald C. Holst & Terrence S. Lomheim CMOS/CCD sensor and camera systems. SPIE PRESS (2007)
Gerald C. Holst Electroóptical imaging system performance, 4th Edition SPIE PRESS (2006)