Photonic

Academic Year: (2022 / 2023) **Review date: 16-06-2021**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: LAMELA RIVERA, HORACIO

Type: Compulsory ECTS Credits : 6.0

Year : 4 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

The students need to have completed de courses of Physics, 1st year (1st Semester), Components and Electronic Circuits, 2nd year 1st Semester) and Electromagnetic Fields, 2nd year (2nd Semester).

OBJECTIVES

- Ability to understand the basic concepts of wave optics and electromagnetic optics, diffraction and spectral analysis needed to analyse the working principles of the photonic devices studied through the course.
- Ability to understand the basic concepts needed to study and analyze the photonic and optoelectronic devices for emission and light detection. This implies to understand the knowledge of its modulation characteristics, bandwidth of the optical and optoelectronics emitters as well as for the optical detectors.
- It will be studied deeply as well the characteristics of the ultrafast and integrated photonic devices used in optical communications and optical signal processing.
- Ability to work cooperatively in a team, knowing how to adapt the requirements and working conditions of the subsystem developed by the students that they operate correctly within a global photonic system. This aspect will be covered by means of the development of examples and practical studies. To make the practical exercices, they will be done through LtSpice, which is a tool of electronic simulation used to implement the content of the practices of Photonics.

DESCRIPTION OF CONTENTS: PROGRAMME

- Concepts of wave optics, electromiagnetic optics, and Fourier optics for signal processing.

Basic conceptos of geometrical optics, wave optics, and polarized ligth.
Interference, interferometric systems. Interferometric devices and optical filters.
Difraction and Fourier optics.
Fiber optics (FO). Different types of fiber optics. Transmission characteristics of FO: attenuation and bandwidth.

- Conceps of lasers and optical electronics.

Emission and detection of light radiation.
Optical Amplifiers and optical resonators. Solid State optical amplifiers. Laser Emitters and characteristics.
Photon in Semiconductors.
Light emitting sources in semiconductors. SOAs Optical Amplifiers, LEDs and Diode Lasers. Spatial, Spectral, modulation and Bandwidth characteristics.
Optical Detectors in Semiconductors. PIN and APD Photodiodes. Spectral characteristics, speed and banwidth characteristics.

- Concepts of ultrafast and integrated photonic devices to be applied in optical communications and signal processing.

Techniques for ultrashort pulse generation:Techniques based on gain modulation and mode-locking.
Optical Light Modulators for ultrahigh speed and integrated devices.
Vertical Cavity Semiconductor Light Emitters (VCSEL) and Laser Arrays. Smart pixels arrays.

Optical integrated devices for filtering and signal processing.

Optical and holographic connections. Optical Analog and Digital Computation. Vector Matrix Multipliers. Optical and Optoelectronic Neural Networks.

LEARNING ACTIVITIES AND METHODOLOGY

- The learning activities and methodology are based on:

Magistral classes were the basic and fundamental concepts of the course will be included. The students will handle material used during the regular classes, and they will hace access to one Text-book of reference.

Practical Classes, to motivate the students to solve practical examples and exercices. This will allow the students to evaluate the level of comprehension of the concepts of the course.

Laboratory Exercices and Practices, where the students will study the working principles of light emitters as LEDs and diode lasers as well as PIN and APDs photodiodes as light detectors in Laboratory practices. These laboratory practices will be complemented by studying the speed and bandwidth of these devices. These Practices will be done by using the LTSpice circuit simulator, where the Students will be developing equivalent models of the Diode Lasers for a better understanding of its operation and performances through a large signal equivalent circuit of a Semicondutor Laser, in order to analyse the optical absorption, the spontaneous emisión, the stimulated emission and the amplification in a Diode Laser. And with a small signal equivalent circuit of a Semiconductor Laser to study the frequency response of a Diode Laser, by obtaining the maximum modulation frequency.

Finally, there will be practical laboratory classes of laser interferometry, diffraction and Fourier optics to understand the emission characteristics and spatial radiation as well as the spectral characterisctics to be used in optical communications and optical signal processing.

ASSESSMENT SYSTEM

- The evaluation and assessment process will be based on:

  To solve Exercices and Problems.

  Laboratory Practices.

  Final Exam to evaluate the knowledges acquired by the students during the whole course

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- E. HECHT, A. ZAJAC. Optics, Addisin Wesley Iberoaméricanac, 1974
- J.C.A. CHAIMOWICZ Optoelectronics: An Introduction, Butterworth-Heinemann, 1989
- J.C.A. CHAIMOWICZ Optoelectronics: An Introduction, Butterworth-Heinemann, 1989
- SALEM B.E.A. and M.C. TEICH Fundamentas of Photonics, John Wiley and Sons Inc., 1991
- T. P. PEARSALL Photonics Essentials, McGraw-Hill, 2003

ADDITIONAL BIBLIOGRAPHY

- A. YARIV Optical Electronics, Saunders College Publishing, 1991
- H. LAMELA Circuitos Electronicos en Tecnología Láser, Fondo Social Europeo (Curso 12), 1995
- J.M. ALBELLA MARTIN, J.M. MARTINEZ-DUART, J.J. JIMENEZ LIDON Optoelectrónica y Comunicación Optica, CSIC Nuevas Tendencias, 1988
- J.T. VERDEYEN Laser Electronics, Prentice Hall International Editions, 1989