Photonic

Academic Year: (2024 / 2025) **Review date: 17-01-2025**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: LAMELA RIVERA, HORACIO

Type: Compulsory ECTS Credits : 6.0

Year : 3 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).

LEARNING OUTCOMES

CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG3: Knowledge of basic and technological subject areas which enable acquisition of new methods and technologies, as well as endowing the technical engineer with the versatility necessary to adapt to any new situation.
CG13: Understanding and command of basic concepts of linear systems and related functions and transformers. Electrical circuit theory, electronic circuits, physical principles of semiconductors and logic families, electronic and photonic devices, materials technology and their application in resolving problems characteristic of engineering.
ECRT11: Ability to use different sources of energy and in particular, solar photovoltaic and thermal energy, as well as the fundamentals of electro-technics and power electronics.
ETEGITT10: Ability to select specialized electronic circuits and devices for the transmission, routing, and terminals, in fixed as well as mobile environments.
RA1: Knowledge and understanding of the general fundamentals of engineering, scientific and mathematical principles, as well as those of their branch or specialty, including some knowledge at the forefront of their field.
RA2: Analysis. Graduates will be able to solve engineering problems through an analysis process, identifying the problem, recognising specifications, establishing different methods of resolution, selecting the most appropriate one and implementing it correctly. They must be able to use various methods and recognize the importance of social constraints, human health, safety, the environment, as well as commercial constraints.
RA5: Applications. Graduates will have the ability to apply their knowledge and understanding to solve problems, conduct research, and design engineering devices or processes. These skills include knowledge, use and limitations of materials, computer models, process engineering, equipment, practical work, technical literature and information sources. They must be aware of all the implications of engineering practice: ethical, environmental, commercial and industrial.

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.
- Ability to perform a Final Work of the course, regarding the Study of the Different Applications of Photonics which are developing and making now as they are having actually a great Future

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, through a Final Work of the course, the Study of Different Applications of Photonics as they are having actually a great Future following the work doing now in the Fiber Optical Communications, the Free Space Optical Communications and the Laser Satellite Communications, the Local Area Optical Communications (LANs), and the multiple Applications that are having now the LIDAR (Laser Imaging Detection and Ranging) Systems, as well as the multiple Biomedical Applications as the Diagnostic and Therapy of Cancer and the Medical Applications as Cardiovascular deseases.

ASSESSMENT SYSTEM

% end-of-term-examination:	30
% of continuous assessment (assigments, laboratory, practicals…):	70

- The evaluation and assessment process will be based on:

Evaluation of the acquired knowledge by the Students through the Realization and Presentation of a Final Work of Photonics.

Laboratory Practices.

Final Exam to evaluate the acquired knowledge by the students during the whole course.

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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