Photonic Integrated Circuits

Academic Year: (2024 / 2025) **Review date: 28-04-2023**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: CARPINTERO DEL BARRIO, GUILLERMO

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Electronic, Photonic and Electro-optic Components (304 - 12415)

OBJECTIVES

COMPETENCES
- That the students can apply their knowledge and ability to solve problems in new or unfamiliar in wider or multidisciplinary environments related to their field of study.
- That the students know how to communicate their conclusions and knowledge as well as the ultimate reasons that support them to both specialized and non-specialized audiences, in a clear way and avoiding ambiguities.
- That the students possess learning skills that allow them following their long-life learning in a self-conducted and self-sufficient way.
- Handling of tools aiming to design photonic devices and systems.
- To be aware of the current trends in different applications of photonic technologies and learned experiences from real cases.
- Capacity of designing photonic devices, passive and active, and of evaluating its performance.

LEARNING OUTCOMES
Upon finishing he course, the students must be able to:
- Know the different photonic integration platforms.
- Know the different photonic integrated components, their function and characteristics.
- Know how to use commercial design software to design and simulate integrated photonics.

DESCRIPTION OF CONTENTS: PROGRAMME

Photonic integration techniques allow to miniaturize photonic systems on a single chip. The different integration technologies, based on Silicon and Indium Phosphorus, will be described, discussing their advantages and disadvantages. The waveguides and their basic parameters will be described, the limitations in arcs, and interfaces will be identified. Several devices will be designed from 2D approaches when possible. It will show its presence in transceivers, optical interconnections and sensor systems. In an application environment, the parameters to be considered, the available technologies will be identified and some of its blocks will be designed with specific tools.

1. Introduction
    - Historical environment: Development of integrated optics
    - Technological environment: Silicon, InP, Polymers. Active / passive integration.
    - Application Environment: Communications, Instrumentation, Biomedicine.
    - Business Environment: Technology leaders in the market.

2.- Basic Blocks
    - Passive elements
        - Light guidance: straight guides, curved guides, slotted guides, ARROW
        - Couplers: Y Couplers, Interference Couplers
        - Directional Couplers: Evanescents and Bragg Networks

Active Elements
Phase modulators
Light Generation on material: Optical Semiconductor Amplifiers.
Light Detection: Photodiodes.

3.- Basic modules in integrated optics
Integrated optical filters
Fiber couplers, Bragg couplers
Integrated optical modulators
DFB, DBR lasers
Photodetectors balanced

4.- Design project using commercial tools

LEARNING ACTIVITIES AND METHODOLOGY

LEARNING ACTIVITIES
- Lecture
- Recitation
- Tutorial
- Individual student work

TEACHING METHODOLOGIES
- Lecture class with support of audiovisual media, in which the main concepts of the subject are developed and the literature is provided to supplement student learning.
- Critical reading recommended by the subject teacher texts: reports, manuals, scientific articles, either for subsequent class discussion, either to expand and consolidate the knowledge of the subject.
- Solving practical cases, problems, etc.. posed by the teacher individually or in group
- Presentation and discussion in class, under teacher moderation issues related to the content of the material and case studies

ASSESSMENT SYSTEM

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

- Attendance and active participation in class (5%)
- Qulity of the slides to report the design exercise solution (20%)
- Public presentation of the solution for the design exercise (25%)
- Final exam (50%)

BASIC BIBLIOGRAPHY

- Larry A. Coldren, Scott W. Corzine, Milan L. Mashanovitch Diode Lasers and Photonic Integrated Circuits, Wiley, 2012

- Lukas Chrostowski, Michael Hochberg Silicon Photonics Design: From Devices to Systems, Cambridge University Press, 2015

ADDITIONAL BIBLIOGRAPHY

- Saleh & Teich Fundamental of Photonics, Wiley.