Devices and optic transmission media

Academic Year: (2023 / 2024) **Review date: 26-04-2023**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: SANCHEZ MONTERO, DAVID RICARDO

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Electronic Components and Circuits
Electromagnetic Fields

OBJECTIVES

The goal of the course is to allow the student knowing the basic optical devices and transmission media for optical communications, and acquiring the ability to design and evaluate their performance as part of telecommunications links.

To achieve this goal, the following the following abilities will be acquired:
-A knowledge of how optical emitters and receivers work and their main applications
-A knowledge of optical transmission media
-A knowledge of photonics components in long haul, Metropolitan and Access Networks
-An ability to design and evaluate an optical communications link, based either on fiber optics or in free space
-An ability to recognize different multiplexing techniques for increasing network bandwidth

DESCRIPTION OF CONTENTS: PROGRAMME

THEORY:

- M0: Introduction to optical communications
  - General structure of a communication system.
  - Advantages and disadvantages of optical fibres.
  - Light propagation in a medium.
  - Physical structure of optical fibres
  - Introduction to the electromagnetic waves. Regions of the eelectromagnetic spectrum.

M1: Optical sources: LED and laser
- 1.1. Introduction.
- 1.2. Types of emitters: LEDs y LASER.
- 1.3: Operation principle of emitters based on semiconductors.
- 1.4: LED. Eficiencies. Electrical & optical characteristics
- 1.5: LASER. Eficiencies. Electrical & optical characteristics

M2: Propagation, attenuation, dispersion in optical fibers
- 2.1. Introduction: Physical structure, operation principle.
- 2.2. Propagation, Singlemode/Multimode character.
- 2.3: Attenuation, transmission windows.
- 2.4: Dispersion: modal, chromatic, PMD. Bandwidth and distance limitation.

M3: Optical detectors
- 3.1. Introduction: Symbol y characteristics of photodiodes.
- 3.2. Signal conditioning circuits.
- 3.3: Structure and operation principle.
- 3.4: Types of optical detectors.
- 3.5: Noise considerations in optical detectors.

M4: Passive optical components and optical amplifiers
- 4.1. Modulators.
- 4.2. Couplers.

- 4.3: Splitters, isolators, circulators y filters.
- 4.4: Multiplexers, demultiplexers, intervalers. OADMs.
- 4.5: Optical amplifiers.
- 4.6: Optical switches.

M5: Optical transmission
- 5.1. Elements of an optical communication link.
- 5.2. Power balance.
- 5.3: Time balance. Bandwidth

M6: Multiplexing techniques and devices
- 6.1. Multiplexing techniques: TDM, FDM, CDM
- 6.2. Optical Time Division Multiplexing: SONET/SDH
- 5.3: Wavelength Division Multiplexing: CWDM y DWDM

LABORATORY:

- P1: Characterization of a LED. Attenuation and numerical aperture measurement.
- P2: Passive optical components characterization.
- P3: Characterization of a POF based optical communication link.

LEARNING ACTIVITIES AND METHODOLOGY

- Theory: lectures 2 ECTS.

o Fiber-optic, emitter and receivers theoretical concepts related to its application in optical communications, and a knowledge of power budget estimation and pulse broadening by applying signal processing tools, lineal system concepts, semiconductor and optoelectronics physics , propagation equations and optics

o Examples on lecture of using theoretical concepts and practical use of fiber optics, for being able to select a specific fiber-optic technology depending on the requirements of the network (solving new problems as part of lifelong learning recognition)

o Communication skills are enhanced through reading of materials and written reports in English and Spanish.

- Practical exercises in lectures. 2 ECTS

o Problems are developed for being able to estimate dispersion impact on transmission bit rate, attenuation on long haul transmission, students solve them individually or in groups of 2-3 students

o Practical examples on power budget estimation and pulse broadening

o Identification of fiber-optic technologies by analyzing manufacturer data sheets and installed networks

o To extract conclusions, they must also analyze, and interpret data. The teacher provides individual questionnaires related to lab sessions and theoretical concepts which are fill in by each student. There is a discussion and general correction in class and afterwards they form groups of 2-3 and prepare a new report prior to the session lab.

- Lab sessions. 2 ECTS

- Students must design and execute lab experiments with teacher support, such as:

o characterizing fiber-optics, emitter drivers and receivers,

o fiber-optic link evaluation

o software simulations of optical transmission system

- Being able to measure losses and characterize optoelectronic components and optical systems

- To extract conclusions, they must also analyze, and interpret data, comparing their results con manufacturer data sheets. The students in groups of 2-3 prepare a report prior to the session lab. After measuring on the lab, they must analyze and interpret measured data and prepare a final report.

- Students are required to use commercial software and provide solutions to real-world problems.

- They develop collaborative work, capacity to apply theoretical concepts, and capacity to make an experiment in time meeting desired needs.

ASSESSMENT SYSTEM

The evaluation allows knowing the degree of satisfaction of the knowledge goal, thus all work of the students will be evaluated by using continuous evaluation of their activities by using exercises, exams, lab projects, and other activities.

The following scoring will be used:

a) Short exams and reports: 40%.
- Reports for the circuits to be developed at the lab sessions
- Evaluation of the report. Each questionnaire is evaluated separately. The evaluation should be discussed in public at practical lectures. Afterwards they should elaborate a new memory with corrected results before the lab session in groups of 2-3 students.
-short exams, to assess theory concepts, problem solving abilities and knowledge of contemporary issues affected by novel technologies.

b) Academic activities with the teacher. Lab experiments: 20%.
- Activities must be delivered on time. A theoretical report with expected results must be carried to the lab session
- Evaluation of tools usage and circuits and link performance
- Evaluation of the collaborative work of the members distinguishing roles.
A final report with data and measurements interpretation should be delivered by the group.
- Evaluation of the final report (or lab project memory). Project memory organization and written correctness should be evaluated.
Responsibility of the result is shared by all members.

c) Final exam with questions and problems: 40%. At least a score of 4 points out of 10 should be obtained

As an alternative to the continuous evaluation, a final exam with the total value of the assessment.

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

BASIC BIBLIOGRAPHY

- A. YARIV S Optical Electronics, Saunders College Publishing, 1991
- B.E.A. SALEM, M.C. TEICH Fundamentals of Photonics, John Wiley and Sons Inc, 1991
- J. Senior Optical Fiber Communications: Principles and Practice, Prentice Hall.

ADDITIONAL BIBLIOGRAPHY

- D. Kartalopoulos Introduction to DWDM technology: Data in a rainbow, Wiley Interscience, IEEE.
- E. UDD Fiber Optic Sensors: An Introduction for Engineers and Scientists, Wiley.
- J. Capmany et al Fundamentos de comunicaciones ópticas, Síntesis, 2001