Course guides
230055 - COMOPT - Optical Communications

Last modified: 29/04/2020

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2010). (Compulsory subject).
BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2020 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Josep Prat Gomà

Others: Ruiz Moreno, Sergio
Soneira Ferrando, María José
Pérez Pueyo, Rosanna
Prat Goma, Josep Joan
Gene Bernaus, Juan Manuel

PRIOR SKILLS

Fundamentals on quantum physics, semiconductors and transmission systems.

REQUIREMENTS

Digital communications, Electromagnetism

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Generical:
10 ECI N3. They will have acquired knowledge related to experiments and laboratory instruments and will be competent in a laboratory environment in the ICC field. They will know how to use the instruments and tools of telecommunications and electronic engineering and how to interpret manuals and specifications. They will be able to evaluate the errors and limitations associated with simulation measures and results.

TEACHING METHODOLOGY

Theoretical lectures, application sessions, personal work, laboratory sessions

LEARNING OBJECTIVES OF THE SUBJECT

Fundamental understanding of fiber optic communications, both theoretical as well as experimental.

STUDY LOAD

Type	Hours	Percentage
Self study	85,0	56.67
Hours large group	39,0	26.00
Hours small group	26,0	17.33

Total learning time: 150 h

CONTENTS

(ENG) Chapter 1. Introduction

Description:
Optical communications technology evolution.
Evolution from point-to-point fiber optic systems to all-optical networks.
Block diagram of an optical communications system.
Introduction to optical networks.

Specific objectives:
Historical evolution of optical communications.
Introductory session, showing the block diagram of a fiber optcs communication system.

Full-or-part-time: 5h 50m
Theory classes: 2h 30m
Self study : 3h 20m

(ENG) Chapter 2. Fiber Optics

Description:
Fiber Optics description. From geometric optics to Maxwell equations.
Signal propagation in optical fibers,
Dispersion:
-Modal dispersion
-Chromatic dispersion
-Waveguide dispersion
-Polarization mode dispersion.
Attenuation.
Optical fiber types
Multi-mode: main characteristics.
Single-mode: main characteristics.
Non-linear effects in fiber optics propagation.
Optical fiber for WDM systems.
Dispersion compensation fibers.
Special fiber optics.
Fiber optics connection.
Optical fiber cables: types and characteristics.

Specific objectives:
Understanding fiber optics principles and signal propagation in optical fibers.

Full-or-part-time: 18h 20m
Theory classes: 5h 50m
Self study : 12h 30m

(ENG) Laboratory: Optical fiber and devices measures

Description:
Measuring fiber optic core diameter, numerical aperture, characterizing attenuation by using an OTDR.
Optical coupler measures.

Specific objectives:
Fiber optics hands-on.
OTDR measurements.

Related activities:
Chapter 2

Full-or-part-time: 11h
Laboratory classes: 6h
Self study : 5h

(ENG) Chapter 3. Optical sources

Description:
LED: basic concepts, types and characteristic parametres.
Laser Diode: basic concepts, types and characteristic parametres. Single and multi-mode LDs.
Tunable lasers.
Lasers in telecom systems.

Specific objectives:
Understanding the light emission processes (spontaneous and stimulated), the laser diode and its main characteristics, with special emphasis in lasers utilized for fiber optic telecom systems.

Full-or-part-time: 12h 30m
Theory classes: 4h 10m
Self study : 8h 20m

(ENG) Laboratory: Optical Sources

Description:
LED: characteristic parameters measurement.
Laser Diode: characteristic parameters measurement.

Full-or-part-time: 9h 50m
Laboratory classes: 6h
Self study : 3h 50m

Chapter 4. Optical signal modulation

Description:
Direct intensity (optical power) modulation.
-Analogic and digital modulation
-IM transmitter block diagram
External optical modulation
-External modulation transmitter block diagram.
-Amplitude, frequency and phase modulation.

Specific objectives:
Understanding the mechanisms involved in optical carrier modulation

Full-or-part-time: 14h 30m
Theory classes: 4h 30m
Self study : 10h

Laboratory: Optical transmitters

Description:
LED based optical transmitter: digital transmission main parameters measurement.
LD based optical transmitter: digital transmission main parameters measurement.

Full-or-part-time: 6h 10m
Laboratory classes: 4h
Self study : 2h 10m

Chapter 5. Optical detection.

Description:
Opto-electronic conversion.
Photodetector types.
Shot noise in optical communications. Ideal receiver.
Avalanche and thermal noises.
Direct Detection receiver.
Signal to noise ratio.
Coherent detection: heterodyne, homodyne. Principles, scheme, advantages.

Specific objectives:
Understanding the light to current conversion in different types of photo-detectors as well as the different detection techniques.
Review of the optical receiver elements and its behavior.

Full-or-part-time: 18h 10m
Theory classes: 5h 40m
Self study : 12h 30m

Laboratory: Optical receivers

Description:
Digital transmission system optical receiver measures.

Full-or-part-time: 4h
Laboratory classes: 3h
Self study : 1h

Chapter 6. Optical amplifiers

Description:
Semiconductor optical amplifier.
Doped fiber optical amplifier.
Noise in optical amplifiers.
Optically pre-amplified receivers.

Specific objectives:
Understanding optical amplifiers and their characteristics.

Full-or-part-time: 8h 10m
Theory classes: 2h 30m
Self study : 5h 40m

Chapter 7. IM-DD optical communications systems.

Description:
Block diagram. System model.
BER calculation.
System performance as a fuinction of type of fiber, bit rate, modulation format, receiver type, amplification.

Specific objectives:
Understanding the performance of the whole system after reviewing its components in previous chapters.
Design and dimensioning of a practical system with current components.

Full-or-part-time: 15h 20m
Theory classes: 6h
Self study : 9h 20m

Laboratory: Transmission systems modeling and simulation

Description:
Fiber optics digital transmission system simulations.

Full-or-part-time: 5h
Laboratory classes: 3h
Self study : 2h

Chapter 8. Future topics

Description:
WDM systems.
Optical networks fundamentals.
FTTH networks.

Full-or-part-time: 11h 50m
Theory classes: 4h 50m
Self study : 7h

GRADING SYSTEM

Theory 70% (2 midterm tests, 28% + final exam, 42%), Laboratory 30%

The laboratory practices cannot be re-evaluated.

BIBLIOGRAPHY

Basic:
- Senior, J.M. Optical fiber communications: principles and practice. 3rd ed. New York: Prentice Hall, 2008. ISBN 9780130326812.