Last update: 06-05-2019

230055 - COMOPT - Optical Communications

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

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

ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: 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

Total learning time: 150h	Hours large group:	39h	26.00%
	Hours small group:	26h	17.33%
	Self study:	85h	56.67%

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Content

(ENG) Chapter 1. Introduction

Learning time: 5h 50m

Theory classes: 2h 30m
Self study : 3h 20m

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.

(ENG) Chapter 2. Fiber Optics

Learning time: 18h 20m

Theory classes: 5h 50m
Self study : 12h 30m

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.

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(ENG) Laboratory: Optical fiber and devices measures

Learning time: 11h

Laboratory classes: 6h
Self study : 5h

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

Related activities:
Chapter 2

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

(ENG) Chapter 3. Optical sources

Learning time: 12h 30m

Theory classes: 4h 10m
Self study : 8h 20m

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.

(ENG) Laboratory: Optical Sources

Learning time: 9h 50m

Laboratory classes: 6h
Self study : 3h 50m

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

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Chapter 4. Optical signal modulation

Learning time: 14h 30m

Theory classes: 4h 30m
Self study : 10h

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

Laboratory: Optical transmitters

Learning time: 6h 10m

Laboratory classes: 4h
Self study : 2h 10m

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

Chapter 5. Optical detection.

Learning time: 18h 10m

Theory classes: 5h 40m
Self study : 12h 30m

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.

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Laboratory: Optical receivers	Learning time: 4h Laboratory classes: 3h Self study : 1h

Description:
Digital transmission system optical receiver measures.

Chapter 6. Optical amplifiers	Learning time: 8h 10m Theory classes: 2h 30m Self study : 5h 40m

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

Specific objectives:
Understanding optical amplifiers and their characteristics.

Chapter 7. IM-DD optical communications systems.	Learning time: 15h 20m Theory classes: 6h Self study : 9h 20m

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.

Laboratory: Transmission systems modeling and simulation	Learning time: 5h Laboratory classes: 3h Self study : 2h

Description:
Fiber optics digital transmission system simulations.

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Chapter 8. Future topics	Learning time: 11h 50m Theory classes: 4h 50m Self study : 7h

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

Qualification 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.