Course guide
230055 - COMOPT - Optical Communications

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.
Degree: BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2023 ECTS Credits: 6.0 Languages: Catalan, Spanish, English

LECTURER
Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS
Fundamentals on quantum physics, semiconductors and transmission systems.

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
<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Hours large group</td>
<td>39,0</td>
<td>26.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>26,0</td>
<td>17.33</td>
</tr>
<tr>
<td>Self study</td>
<td>85,0</td>
<td>56.67</td>
</tr>
</tbody>
</table>

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 optics 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:** 28h
Theory classes: 9h 30m
Self study: 18h 30m
**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

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**Chapter 3. Optical sources**

**Description:**
- LED: basic concepts, types and characteristic parameters.
- Laser Diode: basic concepts, types and characteristic parameters. 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:** 30h
- Theory classes: 10h
- Self study: 20h

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**Chapter 4. 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.

**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
Chapter 5. 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 6. IM-DD optical communications systems.

Description:
Block diagram. System model.
BER calculation.
System performance as a function 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: 30h
Theory classes: 10h
Self study: 20h

(ENG) Laboratory: Optical Sources

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

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

Laboratory: Optical receivers

Description:
Digital transmission system optical receiver measures.

Full-or-part-time: 4h
Laboratory classes: 3h
Self study: 1h
Laboratory: Transmission systems modeling and simulation

Description:
Fiber optics digital transmission system simulations.

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

GRADING SYSTEM

Continuous evaluation (40%) -includes controls/exercises-
Laboratory (20%)
Final Exam (40%)

BIBLIOGRAPHY

Basic: