

## Course guide

# 230603 - TSF - Fundamentals of Telecommunication Systems

**Last modified:** 11/04/2025

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

**Degree:** MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).  
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).

**Academic year:** 2025    **ECTS Credits:** 5.0    **Languages:** English

### LECTURER

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**Coordinating lecturer:** JORGE PEREZ ROMERO

**Others:** Primer quadrimestre:  
JOAN MANUEL GENE BERNAUS - 10  
JORGE PEREZ ROMERO - 10

### PRIOR SKILLS

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Basic background on Digital Communications, Electromagnetic Radiation and Propagation, Guided EM Waves

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

1. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.
2. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
3. Ability to design and dimension transport, broadcast and distribution networks for multimedia signals

**Transversal:**

4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

### TEACHING METHODOLOGY

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- Lectures
- Application classes
- Individual homework
- Short answer test
- Extended answer test

## LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The aim of this course is to present the basic fundamentals of the communication systems for both wired and wireless systems. In the case of wireless systems this course particularly addresses the study, design and evaluation of the basic features of mobile communication systems.

In the case of wired systems this course provides basic background on the field of fiber-optic communication systems. In particular, a brief review of the most fundamental devices, namely optical fibers, laser diodes, photodetectors, optical modulators, and optical amplifiers, will give the students the basic knowhow on their functionalities and operation from a system's perspective. Another goal of this course is to get the students acquainted with the quality parameters of an optical transmission like signal-to-noise ratio (SNR) or bit error rate (BER).

Learning results of the subject:

- Ability to design and evaluate the fundamental communication techniques for networks, services and applications in mobile telecommunications environments.
- Ability to identify and model complex radio systems.
- Ability to identify the most relevant parameters of optical fibers, laser diodes, photodiodes, optical modulators, and optical amplifiers and to operate such devices.
- Ability to analyse and design a basic fiber-optic communications system, including the estimation of both the SNR and BER for optical data transmission systems.
- Ability to design and develop mobile communication systems, including channel modeling, link budget and dimensioning.
- Ability to design and develop copper-based cable and optical fiber systems for communication purposes.
- Ability to apply advanced knowledge in photonics and optoelectronics.

## STUDY LOAD

Type	Hours	Percentage
Self study	86,0	68.80
Hours large group	39,0	31.20

**Total learning time:** 125 h

## CONTENTS

### 1. Introduction to cable transmission

#### Description:

- Evolution of cable telecommunication systems
- Conductor line technology and applications
- Evolution of fiber-optic based telecommunication systems

#### Full-or-part-time: 2h

Theory classes: 1h

Self study : 1h

## 2. Optical Fibers

### Description:

- Basic propagation light guiding concepts
- Single-mode and multimode fibers
- Attenuation and dispersion
- Other physical transmission impairments
- Performance of fiber optics

**Full-or-part-time:** 17h

Theory classes: 5h

Self study : 12h

## 3. Optical Transmitters

### Description:

- Basics on laser semiconductors
- Lasers for optical fiber communications
- Modulation of light properties
- Optical Intensity modulation
- Carrier modulation formats
- Optical transceiver modules
- WDM optical transmitters

**Full-or-part-time:** 14h

Theory classes: 4h

Self study : 10h

## 4. Optical Receivers

### Description:

- Basics on photodetectors
- PIN and APD photodetectors
- Photodetection noise
- Optical detection techniques
- Receiver sensitivity

**Full-or-part-time:** 14h

Theory classes: 4h

Self study : 10h

## 5. Optical Amplifiers

### Description:

- Semiconductor optical amplifiers (SOA)
- Erbium-doped fiber amplifiers (EDFA)
- System applications

**Full-or-part-time:** 7h 30m

Theory classes: 2h 30m

Self study : 5h

## 6. Optical Fiber Telecommunication Systems

### Description:

- Intensity modulation/direct detection
- Coherent systems
- Wavelength Division Multiplexed (WDM) networks

**Full-or-part-time:** 8h

Theory classes: 3h

Self study : 5h

## 7. Introduction to mobile communications systems

### Description:

- Definitions
- Types of Radiocommunication systems
- Mobile communications: Systems and technologies

**Full-or-part-time:** 2h

Theory classes: 1h

Self study : 1h

## 8. Characterisation of the mobile radio channel

### Description:

- Introduction
- Propagation in the mobile environment (Path Loss, Slow fading, Multi-path propagation)
- Noise
- Interference

**Full-or-part-time:** 11h

Theory classes: 3h

Self study : 8h

## 9. Link Budget and Radio Engineering techniques

### Description:

- Quality target
- Performance model of the radio link
- Link budget
- Radio engineering techniques
- Power control
- Channel coding and interleaving
- Diversity
- Spatial Multiplexing

**Full-or-part-time:** 12h 30m

Theory classes: 3h 30m

Self study : 9h

## 10. Mobile Radio Access

### Description:

- Introduction
- Multiple access techniques (FDMA, TDMA, CDMA, OFDMA)
- Duplexing techniques (FDD, TDD)
- Mobile radio access management

**Full-or-part-time:** 18h

Theory classes: 6h

Self study : 12h

## 11. Cellular Systems

### Description:

- Model of a cellular system
- Control and management of cellular systems
- Dimensioning of a cellular system
- Dimensioning of FDMA/TDMA cellular systems
- Dimensioning of CDMA cellular systems
- Multi-layer cellular structures

**Full-or-part-time:** 19h

Theory classes: 6h

Self study : 13h

## GRADING SYSTEM

Delivery of exercises and active participation during lectures: 50%

Mid-term exam: 25%

Final exam: 25%

## BIBLIOGRAPHY

### Basic:

- Keiser, G. Optical fiber communications. 5th ed. New York: McGraw-Hill, 2013. ISBN 9781259006876.
- Stüber, G. L. Principles of mobile communication [on line]. 3rd ed. New York, NY: Springer, 2012 [Consultation: 14/06/2021]. Available on: <http://dx.doi.org/10.1007/978-1-4614-0364-7>. ISBN 9781461403647.
- Sallent Roig, O.; Pérez Romero, J. Fundamentos de diseño y gestión de sistemas de comunicaciones móviles celulares [on line]. Barcelona: Iniciativa Digital Politècnica, UPC, 2014 [Consultation: 14/06/2021]. Available on: <http://hdl.handle.net/2099.3/36630>. ISBN 978-84-9880-482-9.
- Saleh, B.E.A.; Teich, M.C. Fundamentals of photonics. 3rd ed. Hoboken: John Wiley & Sons, 2019. ISBN 9781119506874.
- Senior, J.M. Optical fiber communications: principles and practice. 3rd ed. New York: Prentice Hall, 2008. ISBN 9780130326812.

### Complementary:

- Lee, William C. Y. Mobile communications design fundamentals [on line]. 2nd. ed. John Wiley & Sons, 1993 [Consultation: 21/09/2020]. Available on: <https://onlinelibrary.wiley.com/doi/book/10.1002/9780470930427>. ISBN 0471574465.
- Agrawal, G.P. Lightwave technology: components and devices. Hoboken, NJ: Wiley Interscience, 2004. ISBN 0471215732.