

## Course guide

### 230738 - NED - Nanotechnologies and Electron Devices

**Last modified:** 25/05/2023

**Unit in charge:** Barcelona School of Telecommunications Engineering  
**Teaching unit:** 710 - EEL - Department of Electronic Engineering.

**Degree:** MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).  
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).  
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2022). (Compulsory subject).

**Academic year:** 2023    **ECTS Credits:** 5.0    **Languages:** English

#### LECTURER

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**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

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Basic knowledge of semiconductor theory: band diagram, intrinsic and extrinsic semiconductors, carrier concentrations, P/N junction electrostatics and P/N junction current-voltage characteristics.

Basic knowledge of the theory of main semiconductor devices: Diodes, BJT, JFET, MOSFET.

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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##### Specific:

CMEE12. Use semiconductor devices taking into account their physical characteristics and limitations.

CMEE13. Analyze and evaluate the physical operation of the main devices and sensors, of the relationships between magnitudes at their terminals and of their equivalent circuits.

CMEE14. Relate an electronic device with its manufacturing technology and understand its design process.

##### Transversal:

CTMEE4. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically assess the results of said management.

#### TEACHING METHODOLOGY

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- Lectures
- Application classes
- Group work
- Individual work
- Exercises
- Oral presentations
- Other activities: visit to laboratories

## LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The aim of this course is the understanding of physical and technological basis of electronic devices in order to use innovative solutions to electronic design problems. Emphasis is on MOS field-effect transistors and their behaviors (Fin FET, TFT, etc), Power devices, Nano devices and sensors.

Learning results of the subject:

- Understand the basic properties of semiconductors and the equations that allow their description.
- Understand the operation of the main devices and in particular those of daily use.
- Understand the origin of the limitations of these devices and the solutions to these limitations.
- Have the necessary elements to be able to understand the future evolution of micro and nanotechnologies.

## STUDY LOAD

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

**Total learning time:** 125 h

## CONTENTS

### 1. Field effect transistors and advanced devices

#### Description:

- Review of Metal-oxide-semiconductor field effect transistor (MOSFET) standard model
- MOSFET Short channel effects
- MOSFET small-signal model
- Thin film transistors (TFT)
- Junction (JFET) and Metal-semiconductor (MESFET) field effect transistors
- Devices based on heterojunctions: High Electron Mobility Transistors (HEMT) and
- Advanced topics: FinFET's, GA-FET's, etc.

**Full-or-part-time:** 32h 30m

Theory classes: 10h

Guided activities: 6h 40m

Self study : 15h 50m

### 2. Fabrication technologies

#### Description:

- Semiconductor materials
- Doping techniques
- Layer growth
- Lithography
- Epitaxy
- Process integration
- Advanced materials

**Full-or-part-time:** 6h 20m

Theory classes: 2h

Guided activities: 1h 20m

Self study : 3h

### 3. LED's and lasers

**Description:**

- Heterojunctions
- LED's
- Lasers

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

Theory classes: 2h

Guided activities: 3h

Self study : 6h

### 4. Power devices

**Description:**

- Diodes
- Bipolar transistors
- Thyristors (SCR, DIAC, TRIAC, etc.)
- Metal-oxide-semiconductor field effect transistor (MOSFET)
- Insulated gate bipolar transistor (IGBT)

**Full-or-part-time:** 33h 30m

Theory classes: 10h 30m

Guided activities: 7h

Self study : 16h

### 5. Sensors

**Description:**

- Mechanical
- Chemical
- Electromagnetic
- Optical
- Thermal

**Full-or-part-time:** 29h

Theory classes: 9h

Guided activities: 6h

Self study : 14h

## GRADING SYSTEM

Final examination: 40.5 %

Partial examination: 40.5 %

Individual assessments: 10%

Assignments: 9 %

## BIBLIOGRAPHY

**Basic:**

- Sze, S.M.; Li, Y.; Ng, K.K. Physics of semiconductor devices. 4th ed. Hoboken, NJ: Wiley, 2021. ISBN 991004941614906711.

**Complementary:**



- Mitin, V.V.; Kochelap, V.A.; Strocio, M.A. Quantum heterostructures: microelectronics and optoelectronics. Cambridge, UK: Cambridge University Press, 1999. ISBN 0 521 63177 7.
- Mitin, V.V.; Kochelap, V.A.; Strocio, M.A. Introduction to nanoelectronics: science, nanotechnology, engineering, and applications. Cambridge: Cambridge University Press, 2008. ISBN 978-0-521-88172-2.
- Baliga, B.J. Power semiconductor devices. Boston: PWS, 1996. ISBN 0534940986.
- Widman, D.; Mader, H.; Friedrich, H. Technology of integrated circuits. Berlin: Springer, 2000. ISBN 3-540-66199-9.