Course guide
230645 - MNT - Micro and Nanotechnologies

Last modified: 11/05/2022

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

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

Academic year: 2022 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: ÁNGEL RODRÍGUEZ MARTÍNEZ

Others: ISIDRO MARTIN GARCIA

PRIOR SKILLS

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

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to use semiconductor devices taking into account their physical characteristics and limitations.
2. Ability to analyze and evaluate the performance at the physical level of the main devices and sensors, the relations between magnitudes in their terminals and their equivalent circuits.
3. Ability to establish a relationship between an electronic device and its fabrication technology, and to understand its design process.

Transversal:
4. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

5. 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.

6. 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

- 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:

- Ability to use modelling tools of semiconductor devices.
- Ability to define basic fabrication processes.
- Ability to decide between technological alternatives.

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 downscaling
- Thin film transitors (TFT)
- Junction (JFET) and Metal-semiconductor (MESFET) field effect transistors
- Devices based on heterojunctions: High Electron Mobility Transistors (HEMT) and Heterojunction Bipolar Transistors (HBT)
- Advanced topics

Full-or-part-time: 29h
Theory classes: 9h
Guided activities: 6h
Self study : 14h

2. 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

3. Fabrication technology

Description:
- Semiconductor materials
- Doping techniques
- Layer growth
- Lithography
- Epitaxy
- Process integration

Full-or-part-time: 6h 20m
Theory classes: 2h
Guided activities: 1h 20m
Self study : 3h

4. Sensors

Description:
- Mechanical
- Chemical
- Electromagnetic
- Optical
- Thermal

Full-or-part-time: 29h
Theory classes: 9h
Guided activities: 6h
Self study : 14h

5. Advanced Materials

Description:
- Carbon nanotubes
- Polymers
- Porous silicon

Full-or-part-time: 14h 30m
Theory classes: 4h 30m
Guided activities: 3h
Self study : 7h

(CAST) 6. LED's and Lasers

Description:
- Heterojunctions
- LED's
- Lasers

Full-or-part-time: 12h 40m
Theory classes: 4h
Guided activities: 2h 40m
Self study : 6h

GRADING SYSTEM

Final examination: 45 %
Partial examination: 45 %
Individual assessments: 10%

BIBLIOGRAPHY

Basic:
- Sze, S.M.; Ng, K.K. Physics of semiconductor devices. 3rd ed. Hoboken, NJ: John Wiley & Sons, 2007. ISBN 9780471143239.

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.