UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola Tècnica Superior d'Enginyeria de Telecomunicació de Barcelona

telecos BCN

230738 – NANOTECHNOLOGIES AND ELECTRON DEVICES

Credits: 5 ECTS

LECTURERS

Coordinating lecturer: Angel Rodríguez Martínez / Isidro Martín García

Others:

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

MASTER's COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

- Use semiconductor devices taking into account their physical characteristics and limitations.
- Analyze and evaluate the physical functioning of the main devices and sensors, of the relations between magnitudes in their terminals and of their equivalent circuits.
- Relate an electronic device with its manufacturing technology and identify its design process.

Transversal:

1. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialization and critically assessing the results obtained.
2. Third language

TEACHING METHODOLOGY

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

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 made on MOS field-effect transistors and on other relevant Field Effect Transistors (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

- Hours large group: 39
- Hours small group: 0
- Hours self-study: 86

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 transitors (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.

Learning time: 31h 40m

Theory classes: 10 h
Guided activities: 6h 40m
Self-study : 15h

2. Fabrication technology

Description:

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

Learning time: 6h 20m

Theory classes: 2h
Guided activities: 1h 20m
Self-study: 3h

3. LED's and Lasers

Description:

- Heterojunctions
- LED's
- Lasers

Learning time:: 12h 40m

Theory classes: 4h
Guided activities: 2h 40m
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)

Learning time: 33h 30m
Theory classes: 10h 30m
Guided activities: 7h
Self-study: 16h

5. Sensors

Description:

- Mechanical
- Chemical
- Electromagnetic
- Optical
- Thermal

Learning time: 29h
Theory classes: 9h
Guided activities: 6h
Self-study: 14h

GRADING SYSTEM

- Partial and/or final exam (written knowledge control test):	81 %
- Specific exercises to be done in class or at home:	9 %
- Individual papers, presented in writing or orally:	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.