Course guide
230738 - NED - Nanotechnologies and Electron Devices

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.
Degree: MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2022). (Compulsory subject).
Academic year: 2022 ECTS Credits: 5.0 Languages: 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
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
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
- 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

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>39,0</td>
<td>31.20</td>
</tr>
<tr>
<td>Self study</td>
<td>86,0</td>
<td>68.80</td>
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</tbody>
</table>

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:

Complementary: