Last update: 06-05-2019

230653 - EIO - Electronic Instrumentation and Optoelectronics

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 710 - EEL - Department of Electronic Engineering

Academic year: 2019

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

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Sandra Bermejo, Mireya Fernández, Juan Ramos

Others: Sandra Bermejo, Mireya Fernández, Juan Miguel López, Juan Ramos

Prior skills

Basic analog and digital electronics. Fundamentals of Physics and mathematics, differential equations

Degree competences to which the subject contributes

Specific:

1. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic

2. Ability to develop electronic instrumentation, as well as transducers, actuators and sensors.

Transversal:

3. 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.
4. 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
- Theory classes
- Laboratory classes
- Exercises
- Tests

Learning objectives of the subject

Learning objectives of the subject:

The aim of the Electronic Instrumentation part is to understand the principles of measurement theory to specify and use electronic instruments and measuring systems. There will be considered also technical and regulatory standards. Moreover, it will be described and analyzed the different types of sensors for measuring physical quantities related to Information Communication Technologies. The signal conditioning circuits for the sensors will be mounted and test in the

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laboratory classes. Finally the characteristics of data acquisition systems to register the signals obtained from the sensors will be studied and applied to laboratory classes.
The aim of the Optoelectronics subject is to know optoelectronic devices from a semiconductor point of view. Each device is described in its basic form, and then various improvements and drive circuitry are indicated. First objective is to understand basic semiconductor physics and metal-semiconductor and PN junction performance. Next aims are know the light emission process in LEDs and LASERs devices and their operating parameters, and to understand basic performance of light sensor/receivers as Photoconductors, Solar Cells, Photodiodes and Charge Coupled Devices. Finally other optoelectronics and high frequency devices are also briefly studied and fabrication technology is showed visiting UPC laboratories.

Learning results of the subject:

- Ability to specify, design and use electronic instrumentation and measurement systems.
- Ability to understand the sensors characteristics and its applications
- Ability to design signal conditioning circuits and actuators
- Ability to understand and to explain as semiconductor devices are able to convert electrical current in light and light in electrical current.
- Ability to relate, to quantify, and to characterize the light and the electrical current produced in optoelectronic semiconductor devices.
- Ability to understand materials and geometries used in the construction of optoelectronic devices.
- Ability to analyse and to compare optoelectronic devices from their operating parameters
- Ability to analyse basic operation circuits for optoelectronic devices.

Study load

Total learning time: 125h	Hours large group:	26h	20.80%
	Hours medium group:	0h	0.00%
	Hours small group:	13h	10.40%
	Guided activities:	0h	0.00%
	Self study:	86h	68.80%

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Content

1. Introduction to measurement theory

Learning time: 9h

Theory classes: 2h
Self study : 7h

Description:
- Instrumentation system topology
- Basic terminology
- Sources of uncertainty and categories
- Uncertainty evaluation and management in measurements

2. Basic instruments

Learning time: 11h

Theory classes: 2h
Laboratory classes: 4h
Self study : 5h

Description:
- Measurement of electrical magnitudes
- Time and frequency estimators
- Measurement instruments basics
- Programmable instrumentation system

3. Sensor technologies

Learning time: 8h

Theory classes: 1h
Laboratory classes: 2h
Self study : 5h

Description:
- Modulating sensors
- Generating sensors

4. Signal conditioning circuits

Learning time: 11h

Theory classes: 1h
Laboratory classes: 2h
Self study : 8h

Description:
- Signal conditinoning circuits for modulating sensors (DC & AC)
- Signal conditioning circuits for generating sensors

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5. Data acquisition systems	Learning time: 11h Theory classes: 1h Laboratory classes: 2h Self study : 8h

Description:
- Signal multiplexing
- A/D D/A conversión

6. Smart sensors	Learning time: 8h Theory classes: 1h Laboratory classes: 2h Self study : 5h

Description:
- Concept
- Digital processing algorithms
- Field buses
- IEEE 1451 standard

7. Semiconductor basics	Learning time: 7h Theory classes: 2h Self study : 5h

Description:
1. Semiconductor fundamentals
2. Semiconductor crystal structures
3. Energy bands

8. Carriers: Recombination, emission, and absortion	Learning time: 7h Theory classes: 2h Self study : 5h

Description:
1. Carrier fundamentals
2. Density of states and carriers distribution
3. Carrier concentrations
4. Carrier recombination and generation

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9. Carrier transport

Learning time: 7h

Theory classes: 2h
Self study : 5h

Description:
1. Carrier electrical currents
2. Drift transport and mobility
3. Diffusion transport
4. Conductivity and resistivity
5. Drift?diffusion model

10. Junctions

Learning time: 6h

Theory classes: 1h
Self study : 5h

Description:
1. Equilibrium PN homojunction.
2. Bias PN homojunction
3. Diode I?V equation
4. Transient and small?signal PN homojunction
5. Heterojunctions
6. Metal?semiconductor junctions

11. LEDS

Learning time: 7h

Theory classes: 2h
Self study : 5h

Description:
1. Principles
2. Basic Structures
3. Output Spectrum
4. Efficiencies
5. Modulation Effects
6. LED examples

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12. LASERS

Learning time: 6h

Theory classes: 1h
Self study : 5h

Description:

1. Principles
2. Heterostructure Laser Diodes
3. Quantum Well Laser Diodes
4. Other Semiconductor Laser Diodes
5. Basic Semiconductor Laser Diode Characteristics

13. Photodiodes

Learning time: 7h

Theory classes: 2h
Self study : 5h

Description:

1. Semiconductor Light Absorption
2. Photoconductive parameters
3. PN Junction photodetection modes
4. PN Junction Photodiode
5. Quantum Efficiency and Responsivity
6. PIN Photodiode
7. APD Avalanche Photodiode
8. Photodiode Circuits

14. Solar Cells

Learning time: 7h

Theory classes: 2h
Self study : 5h

Description:

1. Semiconductor light absorption
2. Solar radiation spectrum
3. Photovoltaic performance
4. Equivalent circuit
5. Photovoltaic parameters
6. Solar cell structures

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Planning of activities

LABORATORY

Hours: 34h 20m
Guided activities: 8h 20m
Practical classes: 13h
Self study: 13h

Description:
- Software for programmable instrumentation.
- Signal conditioning circuits and sensors for weather station.
- Data acquisition and processing
- Small project

EXERCISES

Description:
Exercises to strengthen the theoretical knowledge.

SHORT ANSWER TEST (CONTROL)

Description:
Mid term control.

EXTENDED ANSWER TEST (FINAL EXAMINATION)

Description:
Final examination.

Qualification system

The course is divided into 2 parts: Instrumentation and Optoelectronics . Each part has a weight of 50% in the final score.
The Instrumentation qualification (100 %) takes account:
- 40 % lab work
- 60 % final exam Instrumentation
The Optoelectronics qualification (100 %) takes account:
- 40 % continuous assessment or exam control in the middle of the course
- 60 % continuous assessment or final exam

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Bibliography

Basic:

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Pallás Areny, R.; Webster, J.G. Sensors and signal conditioning. 2nd ed. New York: John Wiley and Sons, 2001. ISBN 0471332321.

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Pierret, R.F. Advanced semiconductor fundamentals. Rearding, MA: Addison, 1987. ISBN 0201053381.

Complementary:

Prasad, S.; Schumacher, H.; Gopinath, A. High-speed electronics and optoelectronics: devices and circuits [on line]. Cambridge: Cambridge University Press, 2009 [Consultation: 17/07/2017]. Available on: <http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10333194>. ISBN 9780511579080.

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