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230476 - INSTR - Instrumentation

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

Teaching unit: 748 - FIS - Department of Physics
710 - EEL - Department of Electronic Engineering

Academic year: 2019

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Teaching unit Compulsory)

ECTS credits: 6 Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: Casas Piedrafita, Jaime Oscar

Others: Garcia Garcia, Jose Eduardo
Pradell Cara, Trinitat

Opening hours

Timetable: In agreement with the student

Degree competences to which the subject contributes

Specific:

1. Knowledge of experimental data analysis techniques. Knowledge of statistical methods for experimental data treatment. Ability to process, analyze and graphically present experimental data.
2. Knowledge of experimental techniques and procedures in the field of physics, engineering and nanotechnology. Ability to design experiments using the scientific method and criteria of efficiency, rationality and cost.

Generical:

3. They will have acquired knowledge related to experiments and laboratory instruments and will be competent in a laboratory environment in the ICC field. They will know how to use the instruments and tools of telecommunications and electronic engineering and how to interpret manuals and specifications. They will be able to evaluate the errors and limitations associated with simulation measures and results.
4. ABILITY TO CONCEIVE, DESIGN, IMPLEMENT, AND OPERATE COMPLEX PHYSICAL ENGINEERING SYSTEMS. Ability to conceive, design, implement, and operate complex systems in the fields of micro and nano technology, electronics, advanced materials, photonics, biotechnology, and space and nuclear sciences.
5. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

Transversal:

6. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.
7. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

Teaching methodology

This course is divided into four parts: basic instrumentation, sensors, advanced experimental techniques, and virtual instrumentation.
The first three parts are mainly descriptive. The content is supplemented with demonstrations and/or visits to see relevant equipment.
The virtual instrumentation part is developed in laboratory sessions where students learn the basics of virtual instrumentation using LabVIEW software.

Learning objectives of the subject

- Knowing the structure, operation and the essential characteristics of a measurement system.
- Understand the basic principle of operation of basic electronic instruments and their main limitations.
- Knowing the physical principle which the operation of the main types of sensors is based.
- Learning the basics of the more common advanced instrumental techniques.
- Knowing the basics of virtual instrumentation by using the Labview software.

Study load

Total learning time: 150h	Hours large group:	39h	26.00%
	Hours small group:	18h	12.00%
	Self study:	93h	62.00%

Content

Introduction to instrumentation and data processing

Learning time: 16h
Theory classes: 6h
Self study : 10h

Description:
- General principles of measurement systems.
- Measurements and their uncertainty: precision, accuracy, resolution and sensitivity. Error sources. Evaluation of uncertainty.
- Theory of errors. Propagation.
- Processing and data representation. Fitting and linearization. Calibration.

Basic electronic instrumentation

Learning time: 18h
Theory classes: 7h
Self study : 11h

Description:
- Equipment for measuring electrical parameters. Analog and digital measurements. Multimeter.
- A/D converter: quantization error and aliasing.
- Equipment for measurements in the time domain: oscilloscope.
- Measuring equipment in the frequency domain: lock-in amplifier and spectrum analyser.
- Impedance measurement. Impedance analyzer.
- Interference and noise. Introduction to passive filters.

Physical principles of measurements. Sensors

Learning time: 35h
Theory classes: 13h
Self study : 22h

Description:
- Structure and characteristics of a sensor based measurement system. Sensors classification.
- Variable resistance sensors: potentiometric sensors, piezoresistive sensors, resistance temperature detectors (RTD), thermistors, photoresistances, and magnetoresistances.
- Variable reactance sensors: variable and differenctial capacitor, variable reluctance sensors, variable transformers, linear variable differencial transformer (LVDT), electret based sensors.
- Electromagnetic and Hall effect-based sensors. Magnetoelastic sensors.
- Sensors generators: thermoelectrics, piezoelectrics, piroelectrics and fotovoltaics.
- Other types of sensors.

Introduction to advanced experimental techniques	Learning time: 43h Theory classes: 13h Guided activities: 3h Self study : 27h
Description: - Vacuum technology, cryogenic and high temperature. - Light microscopy: optics, fluorescence, and confocal. - Scanning probe microscopy: STM, AFM, and variants. - Electron microscopy: SEM, TEM, and complementary techniques. - Spectroscopies: UV-VIS, FTIR, Raman and XPS / UPS. - Diffraction: X-ray and neutron.	

Virtual instrumentation laboratory using Labview	Learning time: 38h Laboratory classes: 12h Self study : 26h
Description: It will made six sessions of two-hour lab oriented to use Labview as a tool for virtual instrumentation and remote control of instruments.	

Qualification system

The assessment comprises a final exam (EF), a mid term exam (EP), a group work (TG), and practices (PL).
Final mark = 20% PL + 5% TG + max{30% EP + 45% EF , 75%EF}

230476 - INSTR - Instrumentation

Bibliography

Basic:

Pallás Areny, R. Instruments electrònics bàsics. Barcelona: Marcombo, 2008. ISBN 84-267-1484-6.

Pallás Areny, R. Sensores y acondicionadores de señal. 4a ed. Barcelona [etc.]: Marcombo Boixareu, 2003. ISBN 8426713440.

Pérez García, M.A. Instrumentación electrónica. 2ª ed. Madrid: Thomson, 2004. ISBN 8497321669.

Lyman, C.E. [et al.]. Scanning electron microscopy, X-ray microanalysis, and analytical electron microscopy: a laboratory workbook. New York: Plenum Press, 1990. ISBN 0306435918.

Manuel Lázaro, A.; Río Fernández, J. del. LabVIEW 7.1: programación gráfica para el control de instrumentación. Madrid: International Thomson Paraninfo, 2005. ISBN 84-973-2391-2.

Wolf, S.; Smith, R.F.M. Student reference manual for electronic instrumentation laboratories. 2nd ed. Upper Saddle River: Pearson Education, 2004. ISBN 0130421820.

Complementary:

Williams, D.B.; Carter, C.B. Transmission electron microscopy: a textbook for materials science. 2nd ed. New York ; London: Springer, 2009. ISBN 0387765026.

Cohen, S.H.; Lightbody, M.L. (eds.). Atomic force microscopy/scanning tunneling microscopy 3 [on line]. New York: Kluwer Academic Publishers, 2002 [Consultation: 29/07/2013]. Available on: <http://link.springer.com/book/10.1007/b118422/page/1>. ISBN 0306470950.

Woodruff, D.P.; Delchar, T.A. Modern techniques of surface science. 2nd ed. Cambridge ; New York: Cambridge University Press, 1994. ISBN 0521424984.