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Electronic instrumentation and optoelectronics

Academic Year: (2019 / 2020)   **Review date: 08-05-2020**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: GARCIA SOUTO, JOSE ANTONIO

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

No prerequisites.

OBJECTIVES

1.- To understand the basic principles behind the measurement of different physical magnitudes and the characterization of electronic and optoelectronic instrumentation systems
2.- To be able to design, document and characterize signal conditioning circuits for electronic and optoelectronic sensors, including the issues associated to noise and interference in instrumentation systems and associated techniques.
3.- Knowledge about the different types of optoelectronic and electronic sensors commonly used in industrial applications.
4.- To be able to specify, design and evaluate instrumentation systems..
5.- Knowledge about data acquisition systems and the different standards: IEEE, VXI, PXI, and the use of a common tool used for these tasks (Labview).
6.- Basic knowledge about the integration of instrumentation systems in complex environments as are the industrial and aeronautical fields.
7.- To acquire a global vision of the growing instrumentation field as is the biomedical industry.

DESCRIPTION OF CONTENTS: PROGRAMME

1.- Introduction to instrumentation system
  1.1 Instrumentation system concept, sensors and transducers
  1.2 Static and dynamic metrological characteristics
  1.3 Errors in instrumentation and treatment of errors
2.- Signal Conditioning
  2.1 Analog signal conditioning
  2.2 Conditioning of resistive, capacitive and inductive sensors
  2.3 Bridges (DC and AC null measurements)
  2.4 Instrumentation amplifiers, isolation and auto-zero
  2.5 Conformation of signal, conditioning of optoelectronic sensors
3.- Noise and interference in instrumentation systems
  3.1 Types, properties and characterization of noise in instrumentation
  3.2 Evaluation of the resolution of a measurement system
  3.3 Specific techniques for low noise: lock-in and Boxcar
  3.4 Interferences and EMC shielding and grounding
4.- Electronic sensors and measurements
  4.1 Measurement of position, displacement and associated magnitudes
  4.2 Extensometry
  4.3 Temperature measurement
  4.4 Ultrasonic sensors and applications
  4.5 Measurement of other mechanical quantities
5.- Optical sensors, optoelectronic sensors and measurements
  5.1 Optical sensors of intensity (amplitude)
  5.2 Interferometry, polarimetry and spectroscopy
  5.3 CCD sensors
  5.4 Examples of measurement of physical quantities with optoelectronic sensors
6.- Data acquisition and integration of instrumentation systems
  6.1 DAQ systems, most used buses (IEEE VXI, PXI, etc.) and modular instrumentation
  6.2 "Digital" sensors and "smart" sensors
7.- Virtual instrumentation: hardware and software
  7.1 LabVIEW as an example of instrumentation software

8.- Integration of instrumentation systems in complex environments
  8.1 Examples: industrial and aeronautical
9.- Introduction to biomedical instrumentation

LEARNING ACTIVITIES AND METHODOLOGY

The various training activities fall into three different embodiments:
1. Lecture: They students will present the fundamental concepts and contents of the subject. These classes will be complemented by support material (recommended reading) and specific material.
2. Practical classes: They students will be guided in examples, case studies and realizations of what is presented in the lectures.
3. Work in the laboratory. In the laboratory students will work on the one hand, with real instrumentation systems to evaluate them and, secondly, with the software tools most commonly used virtual instrumentation.
4. Work Group. Students form teams, each of which will develop a design work an instrumentation system. They will address various technical aspects (system, analog conditioning, acquisition, integration, processing, hardware and software), documentation (report), self-evaluation and presentation.

ASSESSMENT SYSTEM

The assesment includes the continuous evaluation of the students' work (Lab Reports, Evaluation Tests, Guided projects) and a final writen exam.

Ordinary call:
Continuous assessment based on a first individual partial test of theoretical and practical content (15%), work and reports of laboratory practices made a couple (20%), a second individual subtest practical content (15%) and work made in team evaluated through reporting, self-evaluation and presentation (10%).
Final exam (40%).

Extraordinary call:
Based on continuous assessment and final exam with the same weights of the ordinary call. Optionally it can only be based on a final exam (100%).

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

BASIC BIBLIOGRAPHY

- 1 Robert B. Northrop Introduction to Instrumentation and Measurements (Second Editioin), CRC Press (2005).

- 2 Jacob Fraden Handbook of Modern Sensors. Physics, Designs, and Applications (Third Edition), Springer (2004).

ADDITIONAL BIBLIOGRAPHY

- Anton FP Van Putten Electronic Measurement Systems (Second Edition), IOP Publishing (1996).

- James A. Blackburn Modern Instrumentation for Scientists and Engineers, Springer (2001).

- John G. Webster, Ed. Medical Instrumentation. Application and Design (Fourth Edition), Wiley (2010).

BASIC ELECTRONIC RESOURCES

- Pablo Acedo Gallardo, José A. García Souto . OpenCourseWare (OCW) - Electronic Instrumentation and Laboratory of Electronic Instrumentation (2009): http://ocw.uc3m.es/tecnologia-electronica/electronic-instrumentation-and-laboratory-of-electronic-instrumentation