

Academic Year: ( 2024 / 2025 )

Review date: 17-04-2024

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 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.- To know the different types of electronic and optoelectronic sensors and transducers, their applications, their metrological and instrumental characteristics, and the most used conditioning circuits.
- 4.- To specify, design and evaluate instrumentation systems, through the study of real and specific examples.
- 5.- To get the fundamental notions about data acquisition systems, their architectures and the different standards (IEEE, VXI, PXI), as well as use the most common tools in these environments (LabVIEW).
- 6.- To get basic knowledge about the integration of instrumentation systems in complex environments such as the industrial and aeronautical fields.
- 7.- To acquire a global vision of the growing instrumentation field in areas such as Medicine, Bioengineering, Aerospace Engineering, smart sensors and sensor networks.

## DESCRIPTION OF CONTENTS: PROGRAMME

- 1.- Introduction to instrumentation system
  - 1.1 Instrumentation system architecture, 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 low noise techniques
  - 3.4 Interference, 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 magnitudes
- 5.- Optical sensors and optoelectronic instrumentation

- 5.1 Optical sensors of intensity
- 5.2 Interferometry, polarimetry and spectroscopy
- 5.3 Examples of measurement optoelectronic sensors and instrumentation
- 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 of industry and aerospace
  - 8.2 Examples of 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

<b>% end-of-term-examination:</b>	35
<b>% of continuous assessment (assignments, laboratory, practicals...):</b>	65

The assesment includes continuous evaluation of the students' work (assignments, laboratory reports, class participation and activities to evaluate skills and knowledge) and final evaluation through a written exam in which the knowledge, skills and abilities acquired throughout the course will be evaluated globally.

Ordinary call:

Continuous assessment based on a first individual assignment of theoretical and practical content (15%), a second individual assignment of practical content (15%) and work made in team, that includes laboratory practice sessions and is evaluated through reporting, self-evaluation and presentation (35%).  
Final exam (35%).

Extraordinary call:

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

## BASIC BIBLIOGRAPHY

- Robert B. Northrop Introduction to Instrumentation and Measurements (Third Edition), CRC Press, 2014

## ADDITIONAL BIBLIOGRAPHY

- Jacob Fraden Handbook of Modern Sensors. Physics, Designs, and Applications (Third Edition), Springer, 2004
- James A. Blackburn Modern Instrumentation for Scientists and Engineers, Springer, 2001

## 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>