Electronic Instrumentation I

Academic Year: (2023 / 2024) **Review date: 28-04-2023**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: ZUMEL VAQUERO, PABLO

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Electronics Engineering Fundamentals
- Electrical Engineering Fundamentals

SKILLS AND LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
ECRT7. Applied knowledge of electronic instrumentation.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.

OBJECTIVES

- Acquiring knowledge and understanding of physical and mathematical principles, and of the operation of electronic instrumentation systems from an engineering point of view.
- Acquiring the ability to apply knowledge and understanding of electronic instrumentation to identify, formulate and solve engineering problems within the industrial environment, and recognize specifications using established methods of analysis of circuit design and electronic instrumentation systems.
- Acquiring the ability to use appropriate methods to conduct research and make innovative contributions in the field of Industrial Engineering, and specifically in the field of electronic instrumentation.
-Acquiring e the ability to apply the knowledge and understanding of electronic instrumentation to solve problems and to design devices or processes in the field of industrial engineering according to criteria of cost, quality, safety, efficiency and respect for the environment.
- Acquiring basic technical and laboratory skills, handling of electronic laboratory equipment and interpretation of results.
- Acquiring the ability to perform bibliographic searches, use databases and other sources of information to apply them to the design of basic electronic instrumentation systems.
- Acquiring the ability to combine theory and practice to solve engineering problems by applying electronic instrumentation technologies.
- Knowing the reference model of an electronic instrumentation system, the main electronic

components used in instrumentation systems, the main sensors of physical magnitude and the basic structure of industrial instrumentation systems.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to Electronic Instrumentation
1.1. Basic structure of an electronic instrumentation system
1.2. Characteristic of an electronic instrumentation system
1.3. Errors and uncertainty
1.4. Calibration curve
2. Analog signal processing
2.1. Amplification: circuits based on operational amplifiers (OA)
2.2. Frequency response in electronics systems
2.3. Filtering: active filters based on OAs
2.4. Other applications of OAs (linear and non linear)
3. Sensor and conditioning circuits
3.1. Resistive sensors and transducers
3.2. Capacitive sensors and transducers
3.3. Inductive sensors and transducers
3.4. Thermocouples
3.5. Optoelectronics and fiber optic based sensors and transducers
3.6. Other sensors: piezoelectrics, pyroelectrics, Hall effect and biosensors.
3.7. 555 timer: sensors based on the measurement of time and frequency
4. A/D and D/A conversion
4.1. Introduction: AD and DA conversion in instrumentation
4.2. A/D conversion: fundamentals
4.3. A/D converters: static and dynamic characteristics and errors.
4.4. A/D converters: architectures, comparison and selection criteria.
4.5. D/A conversion: fundamentals
4.6. D/A converters: characteristics, architectures and selection criteria
5. Digital signal processing (DSP)
5.1. Introduction to DSP systems
5.2. Basic architectures of a microprocessor
5.3. Digital signal processors and advanced microcontrollers
5.4. Instrumentation with FPGA
5.5. Data acquisition systems
6. Introduction to the design
6.1. Real components: datasheet and interpretation
6.2. Simulation of electronic circuits applied to instrumentation systems
7. Remote sensing
7.1. Introductions to remote sensing: basic elements
7.2. Voltage and current loops: basic concepts about noise and interferences
7.3. Introduction to the modulation and demodulation of signals
7.4. Introduction to the industrial communications systems: field buses
7.5. Introduction to instrumentation systems

Finally, students will carry out a practical design project in 4 lab sessions. Students will be grouped in teams of two or three. A written report and a practical examination will be evaluation elements of the project.

LEARNING ACTIVITIES AND METHODOLOGY

- Theory classes, problem resolutions classes, individual tutorials and student personal homework oriented to theoretical knowledge acquisition.

- Laboratory sessions and student personal homework; oriented to practical knowledge related to the fields of the course.

- Development of a design project related to the contents of the course.

ASSESSMENT SYSTEM

The assessment is based on the following criteria:
a) Design Project, consisting of the design, assembly and characterization of a basic instrumentation electronic system. The mark will be assigned considering a Project report and a practical exam showing the operation of the system. The design Project has a 20% weight in the final score of the student if it follows the ongoing evaluation.
b) Midterm exam, which comprises a first thematic block. This midterm exam has a 20% weight in the

final score of the student if it follows the ongoing evaluation
c) Final Exam: The student¿s ability to analyze and/or design electronic instrumentation circuits. This exam has a weight of 60% in the final score. A minimum qualification of 4.0 in this final exam and a weighted average equal to 5.0 are required to pass the subject.
Percentage of Final Exam: 60%
Percentage of Evaluation of Other Activities: 40%

Extraordinary Call: Assessment can be fitted to continuous assessment process (with the same percentages as in the ordinary exam) or with a final exam with the 100% of qualification

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

BASIC BIBLIOGRAPHY

- Miguel A. Pérez García et al INSTRUMENTACIÓN ELECTRÓNICA, Thomson, 2003 o posterior
- Miguel Ángel Pérez García Instrumentación Electrónica. 230 problemas resueltos, Garceta grupo editorial, 2012

ADDITIONAL BIBLIOGRAPHY

- Fiore, James M. Amplificadores operacionales y circuitos integrados lineales : teoría y aplicación, Thomson-Paraninfo, 2002
- RAMÓN PALLÁS ARENY SENSORES Y ACONDICIONADORES DE SEÑAL, MARCOMBO, S.A., 2005 o posterior

BASIC ELECTRONIC RESOURCES

- Carmen Vázquez, Ernesto García Ares . OCW-UC3M Instrumentación electrónica I: http://ocw.uc3m.es/tecnologia-electronica/instrumentacion-electronica-i