# Instrumentation and measurements

**Academic Year: ( 2024 / 2025 )** **Review date: 10-05-2024**

**Department assigned to the subject: Electronic Technology Department**

**Coordinating teacher: MARTIN MATEOS, PEDRO**

**Type: Compulsory ECTS Credits : 6.0**

**Year : 3 Semester : 2**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Signals, Systems and Circuits. Electronic 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.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Analyze and synthesize basic problems related to physics and engineering, solve them and communicate them efficiently.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CE14. Specify and use electronic instrumentation, measurement systems, sensors, techniques and experimental procedures usual and advanced in physics, engineering and biology, including electromechanical and microfluidic microdevices, and design experiments using the scientific method.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

## OBJECTIVES

Provide basic skills for the development and use of electronic instruments and equipment to measure, monitor and/or record physical phenomena.
(1) theory, methodology, and practice of measurement;
(2) design, development and evaluation of instrumentation and measurement systems and components used in generating, acquiring, conditioning and processing signals;
(3) hands on electronic instrumentation projects

## DESCRIPTION OF CONTENTS: PROGRAMME

1.-Fundamentals concepts: Instrumentation and Measurements
1.1.- Metrological characterization of instruments and measurement systems. Precision, accuracy, resolution and sensitivity.
1.2.- Measurement errors and measurement uncertainty. Error propagation.

2.-Sensors.
2.1.- Sensor characterization
2.2.- Types of Sensors and classification
2.3.- Sensor examples

3.-Electronic Instrumentation systems.
3.1.- Block diagram of an electronic instrumentation system.
3.2.- Introduction to signal conditioning circuits and modulation techniques.
3.3.- Filters.
3.4.- Noise and interference in instrumentation systems.

4.-Sampling and signal acquisition.
4.1.- Analog signal sampling: Nyquist theorem and applications.
4.2.- Analog to digital converters. Working principles, characteristics and types.
4.3.- Digital to analog converters.

5.-Digital signal processing in instrumentation systems

## LEARNING ACTIVITIES AND METHODOLOGY

AF1. THEORETICAL-PRACTICAL CLASSES. Knowledge and concepts students mustacquire. Receive course notes and will have basic reference texts.Students partake in exercises to resolve practical problems
AF2. TUTORING SESSIONS. Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.Subjects with 6 credits have 4 hours of tutoring/ 100% on- site attendance.
AF3. STUDENT INDIVIDUAL WORK OR GROUP WORK.Subjects with 6 credits have 98 hours/0% on-site.
AF8. WORKSHOPS AND LABORATORY SESSIONS. Subjects with 3 credits have 4 hours with 100% on-site instruction. Subjects with 6 credits have 8 hours/100% on-site instruction.
AF9. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course. It entails 4 hours/100% on-site
MD1. THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject`s main concepts are developed, while providing material and bibliography to complement student learning
MD2. PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group
MD3. TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with teacher as tutor. Subjects with 6 credits have 4 hours of tutoring/100% on-site.
MD6. LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

## ASSESSMENT SYSTEM

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

The evaluation will consist of a final exam (with a weighting of 40% of the final grade) and a continuous evaluation (60%).It is necessary to obtain a minimum score of 4 out of 10 in the final exam to weight the continuous evaluation. In addition, the completion of the laboratory practices (project) are mandatory.

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

The continuous evaluation will consist of the following parts:
(i) Partial exam. 20%.
(ii) Deliverable exercises: 20%.
(iii) Practices: Development of a project in the electronics laboratory in small groups, compulsory attendance. 20%.

## BASIC BIBLIOGRAPHY

- Cataldo, Andrea, Giaquinto, Nicola, De Benedetto, Egidio, Masciullo, Antonio, Cannazza, Giuseppe, Lorenzo, Ilaria, Nicolazzo, Jacopo, Meo, Maria Teresa, De Monte, Alessando, & Parisi, Gianluca. Basic Theory and Laboratory Experiments in Measurement and Instrumentation, Springer International Publishing AG, 2020

- Northrop, R.B. Introduction to Instrumentation and Measurements , CRC Press, 2014

## ADDITIONAL BIBLIOGRAPHY

- Domenique Placko (editor). Fundamentals of Instrumentation and Measurement, Wiley, 2007

- Peter H. Sydenham, Richard Thorn (Editors) Handbok of Measuring System Design. Volume 1 (Part 3), Volume 2 (Part 5 - section 3, Part 7, Part 8 ¿ sections 1,2), Volume 3 (Parts 9, 11, 12), Wiley, 2005