Syllabus
2025 - 2026

GENERAL INFORMATION

Data of the subject	
Subject name	Electronic Systems
Subject code	DEA-IND-512
Mainprogram	Official Master´s Degree in Industrial Engineering
Involved programs	Grado en Administración y Dirección de Empresas y Máster Universitario en Ingeniería Industrial [Fifth year] Máster Universitario en Ingeniería Industrial + Máster en Medioambiente y Transición Energética [First year] Máster Universitario en Ingeniería Industrial + Máster in Motorsport, Mobility and Safety [First year] Máster Universitario en Ingeniería Industrial + Máster in Smart Grids [First year] Máster Universitario en Ingeniería Industrial y Máster Universitario en Administración de Empresas [First year] Máster Universitario en Ingeniería Industrial y Máster Universitario en Sector Eléctrico [First year] Máster Universitario en Ingeniería Industrial y Máster Universitario en Sistemas Ferroviarios [First year] Máster Universitario en Ingeniería Industrial [First year] Máster Univ. en Ingeniería Industrial + Máster en Tecnologías Financieras: Pagos y Banca Digital [First year] Máster Universitario en Ingeniería Industrial y Máster en Industria Inteligente [First year]
Level	Postgrado Oficial Master
Quarter	Semestral
Credits	7,5 ECTS
Type	Obligatoria
Department	Department of Electronics, Control and Communications
Coordinator	Jaime Boal Martín-Larrauri and José Daniel Muñoz Frías
Office hours	Arrange an appointment through e-mail.

Teacher Information	
Teacher	
Name	Jaime Boal Martín-Larrauri
Department	Department of Electronics, Control and Communications
Office	D-217 (Alberto Aguilera, 25)
EMail	Jaime.Boal@iit.comillas.edu
Teacher	
Name	Romano Giannetti
Department	Department of Electronics, Control and Communications
Office	D-221 (Alberto Aguilera, 25)
EMail	Romano.Giannetti@iit.comillas.edu
Teacher	
Name	Santiago Lizón Martínez

Department	Department of Electronics, Control and Communications
Office	Electronics, Control, and Communications Department Office (Alberto Aguilera, 25 - 2nd floor)
EMail	slizon@icai.comillas.edu
Teacher	
Name	José Daniel Muñoz Frías
Department	Department of Electronics, Control and Communications
Office	D-219 (Alberto Aguilera, 25)
EMail	daniel@icai.comillas.edu
Teacher	
Name	Fermín Zabalegui Sanz
Department	Instituto Universitario de la Familia
Office	Electronics, Control, and Communications Department Office (Alberto Aguilera, 25 - 2nd floor)
EMail	ferminzs@comillas.edu
Profesores de laboratorio	
Teacher	
Name	Álvaro Machón Benítez
Department	Department of Electronics, Control and Communications
EMail	amachon@icai.comillas.edu
Teacher	
Name	Antonio Alejandro Rodríguez Blasco
Department	Department of Electronics, Control and Communications
EMail	aarblasco@icai.comillas.edu
Teacher	
Name	Eduardo Alonso Rivas
Department	Department of Electronics, Control and Communications
EMail	Eduardo.Alonso@comillas.edu
Teacher	
Name	Esther de Juana López
Department	Department of Electronics, Control and Communications
EMail	edejuana@icai.comillas.edu
Teacher	
Name	Francisco Javier Burgoa Román
Department	Department of Electronics, Control and Communications
EMail	fjburgoa@icai.comillas.edu

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Teacher	
Name	Juan Pedro López Llorens
Department	Department of Electronics, Control and Communications
EMail	jplopez@icai.comillas.edu
Teacher	
Name	Pedro Casatejada Herrera
Department	Department of Electronics, Control and Communications
EMail	pcasatejada@comillas.edu

DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

Contribution to the professional profile of the degree

Within the professional profile of the industrial engineer, this course aims to provide advanced knowledge in the design of mixed analog/digital real-time embedded systems to control a plant. By the end of the course, students will be able to design systems composed of an analog signal capture and conditioning part, a digital processing module based on a dsPIC microcontroller programmed in C language using MPLAB X IDE, and several actuators.

In the laboratory, in addition to the principles of design, assembly and testing of electronic circuits, students will also develop teamwork skills and improve their ability to present results, which are essential abilities for an industrial engineer.

Prerequisites

Fundamentals of analog and digital electronics.

Course contents

Contents

Theory

1. Introduction to electronic systems

Students receive a global vision of the subject and are motivated towards the final integration project they will develop during the last laboratory sessions.

2. Digital processing

Students learn how to provide "intelligence" to an electronic system using a dsPIC microcontroller programmed in C language. The architecture of the microcontroller is studied, as well as its main peripherals and the real-time programming methods that allow the development of programs that interact with the environment.

3. Perception and conditioning

The most used industrial sensors and the circuits necessary to amplify and condition the measured signal until it reaches the analog-to-digital (A/D) converter are studied. The concepts of sampling, quantization, and aliasing, so important in the A/D conversion process, are also introduced.

4. Actuation

The circuits that allow a digital system to act on a plant are presented. The circuits studied range from basic circuits such as transistors and relays, to more advanced circuits such as H-bridges controlled by PWM.

5. Complex electronic systems

Basic concepts to approach the design of complex projects: decomposition of the problem, top-down design, bottom-up implementation, documentation of an electronic system, electromagnetic compatibility...

Laboratory

1. Sensing and signal adaptation

Students test sensors similar to those they intend to use in the complex system that will be developed at the end of the semester. They will also have to solve the signal adaptation problems to interface with the microcontroller. Generally, it will be a non-linear sensor, which will have to be modeled, linearized, and amplified.

2. Quantization and digital processing

The objective is to process the measurements of a perception system by means of a dsPIC microcontroller to act on the environment. Emphasis will be placed on quantization problems, to which the student will have to propose solutions.

3. Actuation

Students test actuators that they will need to build their final project. In addition, they must solve signal adaptation problems to effectively excite the actuator.

4. Communication, synchronization and concurrency of processes

Students experience for themselves how to coordinate the different processes running on a microcontroller. The communication, concurrency, and synchronization among the processes involved play an important role.

5. Design of a complex electronic system

In the final part of the course, a comprehensive project that integrates all the modules previously developed in the laboratory is developed and tested. Each team will face a different problem in the field of home automation, industry, energy...

EVALUATION AND CRITERIA

The use of AI to produce full assignments or substantial parts thereof, without proper citation of the source or tool used, or without explicit permission in the assignment instructions, will be considered plagiarism and therefore subject to the University's General Regulations.

Evaluation activities	Evaluation criteria	Weight
	• Understanding of the theoretical concepts.	

• Intermediate tests • Final exam	• Application of these concepts to problem-solving. • Critical analysis of the numerical results. • Oral and written communication skills.	45
• Lab assignments • Lab exam • Final project presentation	• Understanding of the theoretical concepts. • Application of these concepts to problem-solving. • Critical analysis of the numerical results. • Oral and written communication skills. • Quality of the results obtained.	55

Grading

Regular assessment

The weighting of each of the evaluation activities will be as follows:

- Theory (45%)
  - Intermediate tests: 15%
  - Final exam: 30%
- Laboratory (55%). Depending on the previous knowledge of the students, two grading modalities exist.
  - If students have no prior knowledge of microprocessors:
    - Lab assignments: 15%
    - Lab exam: 15%
    - Project: 25%
  - Otherwise:
    - Lab assignments: 27.5%
    - Project (graded individually): 27.5%

The final grade will be computed according to these restrictions:

- The *examinations mark* will be the weighted average of the intermediate tests, the final exam, and the laboratory exam (if any), **provided that the final exam grade is greater than or equal to 4**. Otherwise, the examinations mark will be the minimum between the weighted average and the final exam grade.
- The *assignments mark* will be the weighted average of the lab assignments and the project.
- If the examinations mark is greater than or equal to 5 and the assignments mark is also greater than or equal to 5, the course grade will be obtained as indicated in the percentages above. Otherwise, the final grade will be the lower of the two marks.

Retake

A new final exam and another laboratory exam will be taken, the latter only if there was one in the regular assessment period and it does not have a passing grade. In case the assignments mark is lower than 5, the student will also carry out an individual project, which will be defended publicly at the latest on the day of the retake exam and whose grade will replace those of the lab assignments and the project. The marks of all those evaluation activities that do not have to be repeated will be preserved. The final grade will be computed as in the regular assessment period and according to the same restrictions.

Course rules

Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University and Article 6 of the Academic Rules (Normas Académicas) of the ICAI School of Engineering. Not complying with this requirement may have the following consequences:

- Students who fail to attend more than 15% of the lectures may be denied the right to take the final exam during the regular assessment period.
- Regarding laboratory, absence from more than 15% of the sessions can result in losing the right to take the final exam of the regular assessment period and the retake. Anyway, unjustified absences to laboratory sessions will be penalized in the evaluation.

According to Article 168, section 2.e) of the General Regulations of Universidad Pontificia Comillas, a serious offense is defined as *"any action aimed at falsifying or defrauding the systems used to assess academic performance."* If any irregularity is detected in an academic activity, the work will be graded with a zero (0.0), and disciplinary proceedings may be initiated. In laboratory assignments and the final project, the following will be considered irregularities: the total or partial copying of source code or answers from other students, whether from the current academic year or from previous years. The literal or paraphrased reproduction of content from external sources without proper citation will also be considered an attempt at plagiarism. This includes content generated using generative artificial intelligence models, which must comply with the guidelines outlined in the following section.

Guidelines for the use of generative artificial intelligence (AI)

- **Intermediate tests and theory and laboratory exams.** The use of generative artificial intelligence models or programming assistants is strictly prohibited during any assessment, whether conducted in person or remotely. These activities must reflect exclusively the student's own knowledge and individual work.
- **Laboratory assignments and project.** The use of AI-based programming assistants and generative language models is permitted under the following conditions:
  - These tools may be used as support for understanding technical concepts, obtaining suggestions on how to approach the proposed exercises, and generating code snippets or initial drafts of reports.
  - Their use must always be complementary and must not replace the student's individual work. Submitting automatically generated content as one's own, without proper understanding, review, and adaptation, is not allowed.
  - Any relevant content generated wholly or partially using these tools must be explicitly cited, clearly indicating which parts were generated with AI and which tools were used. The sequence of prompts must be included as an annex at the end of the report.
  - Instructors reserve the right to ask oral questions regarding content generated with AI assistance to assess the student's understanding. Failure to explain or justify such content may negatively impact the grade for the activity.
- The responsible use of these tools is encouraged as a means of supporting individual study —for example, to clarify concepts, generate additional exercises, or receive feedback. However, students should be aware that responses generated by AI models may contain errors, and it is their responsibility to critically assess and verify the information provided.

WORK PLAN AND SCHEDULE

Activities	Date of realization	Delivery date
Midterm	Week 7	
Final exam	Ordinary examination period	
Lab sessions	Weekly	

Self-study of the concepts covered in the lectures	After each lesson	
In-class problem solving	Weekly	
Submission of proposed problems		To be indicated in class
Lab report writing	After every session	One week after the end of each session
Midterm preparation	Week 6	
Final exam preparation	December	

BIBLIOGRAPHY AND RESOURCES

Basic References

- Slides and notes prepared by the instructors (available in Moodle).

Complementary bibliography

- D. E. Simon, An Embedded Software Primer, 1st Ed., Addison Wesley, 1999. ISBN-13: 978-0201-61569-2
- R. F. Coughlin and F. F. Driscoll, Operational Amplifiers and Linear Integrated Circuits, 6th Ed., Prentice Hall, 2000. ISBN-13: 978-0-13014991-6
- J. Fraden, Handbook of Modern Sensors, 5th Ed., Springer, 2016. ISBN-13: 978-3-319-19302-1
- Microchip Technology Inc., dsPIC33/PIC24 Family Reference Manual, [Online]. Available: https://www.microchip.com/doclisting/TechDoc.aspx?type=ReferenceManuals