UAB
Universitat Autònoma de Barcelona

# Digitization and Microcontrollers

Code: 106936
ECTS Credits: 6

2025/2026

| Degree | Type | Year |
|---|---|---|
| Management of Smart and Sustainable Cities | OB | 2 |

## Contact

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## Teachers

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## Teaching groups languages

You can view this information at the end of this document.

## Prerequisites

For the full understanding of the contents of the course, it is convenient to have a basic ability in programming and a good knowledge of how programs execute in computers. For this, you should have completed Computer science and Internet applications' programming courses. As programs interact with external devices directly, you should also have taken Fundamentals of electronics and Sensors and instrumentation courses.

## Objectives and Contextualisation

This course is the second at the sequence of courses within the subject of Sensors and Digitalization, after Sensors and instrumentation course. The subject deals with the acquisition of data and the development of systems that work with these. As part of this subject, students that take Digitalization and microcontrollers course will acquire the following.

- Have a global vision of the digitalization of data, understanding its utility and necessity.
- Know about the principal types of sensors and the signals that provide.
- Understand the basic architectures of microcontrollers.
- Have notions of the technological alternatives for prototyping microcontroller-based systems.
- Have the capability to develop a basic microcontroller system.
- Understand the basic concepts of real time processing and of the use of real-time operating systems (RTOS).
- Be capable of assessing the features of a microcontroller-based system.

## Learning Outcomes

1. CM17 (Competence) Distinguish the economic and environmental costs of the use of information and communication technologies.
2. KM22 (Knowledge) Describe the technologies of data capture and transmission, as well as actuators and robotic systems and the problems associated with their integration into the urban fabric.
3. SM21 (Skill) Use data acquisition systems (e.g. sensors and RFID tags) and their processing as a tool for control (e.g. of instrumentation and robots) and decision-making.

## Content

1. Introduction to the design of microcontroller-based systems
2. Basic architectures of microcontrollers
3. Digitalization
    1. Analog/digital input/output
    2. Microcontroller and sensors interfaces
    3. Communication protocols for sensors
5. Microcontroller-based development platforms
6. Programming of microcontrollers
    1. Signal processing
    2. State-based controllers

## Activities and Methodology

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Laboratory | 12 | 0.48 | |
| Theory classes | 20 | 0.8 | |
| Type: Supervised | | | |
| Evaluation | 5 | 0.2 | |
| Problem-solving: Reporting solutions to proposed problems | 12 | 0.48 | |
| Type: Autonomous | | | |
| Reading and studying material | 14 | 0.56 | |
| Writing reports | 8 | 0.32 | |

Teaching structures around the following activities:

Theory classes: They are publications of series of "knowledge pills" that either disseminate the necessary knowledge for the analysis and the design of embedded systems or put in context the knowledge and the abilities that are acquired during the course (for example, how a digital signal is read) or state the problems that will be dealt with in the corresponding seminars.
At the class time, the corresponding pills will be published. Note that they can have different formats and will be available since. There will be a section for each class in the classroom discussion forum.

Problem-solving seminars: Discussion of small case studies (for example, control of the water level of a tank) to consolidate theoretical knowledge regarding the analysis and design of embedded systems.

Practical sessions: Follow up of several small-project developments.

TRANSVERSAL COMPETENCES

By taking this course, it is expected that students acquire autonomy and capacity of organization of the assigned tasks, feel comfortable working in English and have a basic competence at teamwork. Assessment will focus on the latter:

T01. Work cooperatively in complex or uncertain environments and with limited resources, within a multidisciplinary context, assuming and respecting the roles of the rest of team members. The laboratory projects will be done in teams, and the corresponding reports will have to include, necessarily, the escription of what each person has done.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

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## Assessment

## Continous Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|---|---|---|---|---|
| Continuous assessment tests (3 blocks) | 75% | 29 | 1.16 | CM17, KM22, SM21 |
| Laboratory | 25% | 50 | 2 | CM17, KM22, SM21 |

a) Continuous Assessment

Thi subject does not include a single assessment system.

There will be two continuous assessment tests covering all five topics: Topics 1 and 2 in the first block; Topics 3 and 4 in the second bloc and Topic 5 in the threeth block.

The continuous assesment tests has doing individual.

a.1 Continuous Assessment Tests

| Continuous Assessment Tests | Weight in Continuous Assessment Grade | Minimum Grade to Be Averaged |
|---|---|---|
| Topics 1, 2 | 25% | 4.0 |
| Topics 3, 4 | 35% | 4.0 |
| Topic 5 | 40% | 4.0 |

Final Grade for Continuous Assessment

| Grade Component | Weight in Final Grade |
|---|---|

| | |
|---|---|
| Continuous Assessment | 75% |
| Practical Work | 25% |

a.2 Practical Work

A total of 5 practical assignments will be completed and the final grade is the weighhed average.

Practical Work has doing in group of two people

a.3 Pass Criteria

A student is considered to have passed if:

- They obtain a continuous assessment grade of 5 or higher, and
- They obtain a practical work grade of5 or higher, and
- They do not have any continuous assessment test score below the minimum (4.0) required to calculate the average.

a.4. Retake Exams

There will be a retake exam for each of the three theory blocks to recover any failed part of the continuous assessment.
These retake exams may also be used to improve the continuous assessment grade for each block if the student wishes.
Under no circumstances will the final grade from the retake exam be lower than the original continuous assessment grade.
The retake exams has doing individual.

| Retake Exam | Weight in Retake Grade | Minimum Grade to Be Averaged |
|---|---|---|
| Topics 1, 2 | 25% | 4.0 |
| Topics 3, 4 | 35% | 4.0 |
| Topic 5 | 40% | 4.0 |

Final Retake Grade

| Grade Component | Weight in Final Grade |
|---|---|
| Retake Exam | 75% |
| Practical Work | 25% |

## b) Scheduling of Assessment Activities

The dates of the continuous assessment tests and the deadlines forsubmitting practical work will be published on the Virtual Campus (VC) and may be subject to change due to unforeseen circumstances. Any changes will be communicated in advance via the VC, which is considered the standard method of communication between faculty and students.

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## c) Submission of Practical Work

Late submissions will be accepted only if there is prior notice and justification, but will be penalized with a lower grade.
Submissions without prior notice or valid justification will not be accepted under any circumstances.
Assignments that are not submitted will receive a grade of 0 and will not be eligible for resubmission or recovery.

Practical work accounts for 25% of the final grade.

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## d) Grade Review Procedure

Students may request a review within two weeks of the publication of grades and before the retake exam review deadline.
If a grade is changed following a review, the new grade is final and cannot be changed in any later review.
After the retake exam review period ends, no further grade changes will be allowed.

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## e) Final Grades

In the event of not passing the subject due to any of the assessment activities not reaching the minimum required grade, the numerical grade of the transcript will be the lower value between 4.5 and the weighted average of the grades as indicated in section a).

A grade of "not assessable" will only be given to students who do not complete ANY assessable activity (continuous assessment, final exam, or practical work).
Participation in even one assessable activity means all others not completed will be graded zero and included in the final grade calculation.

Honours distinctions (matrícula d'honor) will be awarded to students who achieve a grade of 9.0 or higher in each component, up to 5% of the total enrolled students, based on descending order of final grades.
At the discretion of the teaching staff, honours may also be awarded in other cases, provided that the limit of 5% is not exceeded and the final grade is at least 9.0.

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## f) Irregularities, Cheating, and Plagiarism

Cheating refers to evidence that a test or assignment has been completed in part or in full without the student's intellectual contribution.
This includes attempted cheating during exams or assignments and violations of academic integrity standards.
Plagiarism involves presenting other authors' work or texts as one's own,which constitutes an intellectual property offense.
To avoid plagiarism, all sources used in reports or assignments must be properly cited.

According to UAB regulations, cheating, plagiarism, or any attempt to manipulate assessment results-whether one's own or someone else's (e.g., by allowing others to copy)-will result in a grade of 0for the relevant component (exam, continuous assessment, or project) and a fail in the course.
This does not preclude the possibility of academic or legal action being taken against the student(s) involved.

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## g) Assessment for Repeating Students

Students retaking the course may retain the practical work grade from the IMMEDIATELY PREVIOUS ACADEMIC YEAR if they request it at the beginning of the course.
Otherwise, they will be required to complete the practical assignments again.

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### h) IA uses

In this subject, the use of Artificial Intelligence (AI) technologies is allowed as an integral part of the development of the work, provided that the final result reflects a significant contribution by the student in the analysis and personal reflection. The student must clearly identify which parts have been generated with this technology, specify the tools used, and include a critical reflection on how these have influenced the process and the final result of the activity.

Non-transparency in the use of AI will be considered a lack of academic honesty and may lead to a penalty in the grade of the activity, or greater sanctions in serious cases.

## Bibliography


[1] Cándido Bariáin , Carlos Ruiz y Jesús María Corres (2017). Programación de microcontroladores PIC en lenguaje C. Marcombo Universitaria..

[2] Ll. Ribas Xirgo. (2014). How to code finite state machines (FSMs) in C. A systematic approach. TR01.102791 Embedded Systems. Universitat Autònoma de Barcelona. [https://www.researchgate.net/publication/273636602_How_to_code_finite_state_machines_FSMs_in_C_A_syste

[3] David J. Russell (2010). Introduction to embedded Systems: Using ANSI C and the Arduino Development Environment. Morgan & Claypool Publishers.

[4] M. J. Pont. (2005). Embedded C. Pearson Education Ltd.: Essex, England.

[5] Oliver H. Bailey. (2005). Embedded Systems Desktop Integration. Wordware Publishing.

[6] Jon Wilson. (2004). Sensor Technology Handbook. Elsevier.


## Software

For the labs and problems parts we will use Arduino IDE.

## Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

| Name | Group | Language | Semester | Turn |
|---|---|---|---|---|
| (PAUL) Classroom practices | 611 | Catalan | first semester | afternoon |
| (PLAB) Practical laboratories | 611 | Catalan | first semester | afternoon |
| (PLAB) Practical laboratories | 612 | Catalan | first semester | afternoon |

| | | | | |
|---|---|---|---|---|
| (TE) Theory | 61 | Catalan | first semester | afternoon |