2020/2021

Digitization and Microcontrollers

Code: 104534
ECTS Credits: 6

Degree	Type	Year	Semester
2503743 Management of Smart and Sustainable Cities	OB	2	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)

Some groups entirely in English: No

Some groups entirely in Catalan: Yes

Some groups entirely in Spanish: No

Teachers

Raimon Casanova

David Castells Rufas

Màrius Montón Macián

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.

Competences

- Design platforms of management, integration of public and government services applying technologies and systems of sensorization, acquisition, processing and communication of data.
- Integrate cyberphysical systems based on the interrelationship between information technology and physical processes in urban environments.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Work cooperatively in complex and uncertain environments and with limited resources in a multidisciplinary context, assuming and respecting the role of the different members of the group.

Learning Outcomes

1. Be aware of existing actuators and the use of control variables as a response tool.
2. Describe the process of the specification, selection and integration of digital sensors for the digitisation of data in smart and sustainable cities.
3. Distinguish the architecture of embedded systems for the integration of digital sensors.
4. Recognize the limitations and advantages of sensors based on their specifications for a particular purpose.
5. Recognize the requisite information to be obtained from an urban environment, and which sensors and electronic systems should be used.
6. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
7. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
8. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
9. Understand the integration of digital sensors and embedded systems in developing cyberphysical systems.
10. Understand the use of captured information, as well as the importance of presenting and communicating it.
11. Use data-acquisition and processing systems as a control and decision-making tool.
12. Use specific information captured for a concrete purpose and evaluate this use.
13. Work cooperatively in complex and uncertain environments and with limited resources in a multidisciplinary context, assuming and respecting the role of the different members of the group.

Content

1. Introduction to the design of microcontroller-based systems

2. Basic architectures of microcontrollers

3. Digitalization

3.1. Analog/digital input/output

3.2. Microcontroller and sensors interfaces

3.3. Communication protocols for sensors

4. Microcontroller-based development platforms

5. Programming of microcontrollers

5.1. Signal processing

5.2. State-based controllers

Methodology

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.

On problem-solving and practical sessions' time, there will be immediate assistance by the teachers through the means available at that moment or, at least, via the classroom communication forum in the Campus Virtual.

In case sessions are carried face-to-face, attendance to the laboratory will be constrained by hygienic norms and, possibly, imply that only one team member will be allowed to attend each session.

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 description of what each person has done.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory	12	0.48	10, 9, 4, 11, 12
Theory classes	20	0.8	1, 2, 3, 10, 9, 7, 5, 4, 11, 12
Type: Supervised			
Evaluation	5	0.2	2
Problem-solving: Reporting solutions to proposed problems	12	0.48	2, 10, 9, 8, 6, 7, 4, 13
Type: Autonomous			
Study	14	0.56	1, 3, 10, 8, 6, 7, 5, 4
Writing reports	8	0.32	6, 7, 13

Assessment

a) Procedure and assessment activities' plan

The assessment is continuous with specific activities (exams and assignments) throughout the course. These assessment activities generate a series of grades that determine the final grade.

The calculation of the final grade, *n*, follows the expression:

$$n = \max(x \cdot 50\% + c \cdot 25\% + p \cdot 25\%, x \cdot 75\% + p \cdot 25\%)$$

where *x*, *c*, and *p* are the grades of the exam, continuous assessment, and project parts, respectively.

The final grade will be, at most, a 4.5 if *x* or p <5. In other words, exam and project must be passed separately.

Note that, in case the continuous assessment does not improve the final grade, it is not taken into account, thus the final grade is the maximum of the grades with or without the continuous assessment.

The exam grade (*x*) is the grade obtained from the final exam, which is to be held on-site and which can be retaken.

Continuous assessment grade (*c*) is calculated from a weighted average of continuous assessment tests along the course. Typically, there will be three of these.

The grade awarded for the practical work (*p*) will be the result of a weighted average of the grades of the follow-up reports.

b) Assessment activities schedule

The dates of the continuous assessment tests and assignment submission deadlines will be published on the Campus Virtual (CV) and may change to adapt to eventual incidents: it will always be reported previously through the CV since it is understood that it is the usualcommunication platform between lecturers and students.

c) Re-assessment procedures

Late submissions,subject to prior notice, will be accepted and penalized with a lower grade. Late submissions without prior notice or justification of force majeure will not be accepted. A second submission period may be opened for reports that receive a negative evaluation. Unaccepted or unsubmitted assignment reports will be scored 0 and will not have the option of a second assessment.

In accordance with the coordination of the Degree and the deanship of the School of Engineering, the following activities cannot be re-assessed:

- Practice work, 25% of the final grade

The continuous assessment can be made up by the final examination.

There is a make-up exam for the final examination, too.

d) Assessment review procedure

Assessment activities can be reviewed any time after corresponding grades are published and before the deadline for the revision of the final exam.

Should the change of a grade be agreed upon, that grade may not be modified in a later review.

No reviews will be done after the closure of the reviews of the final exam, but for the make-up exam.

e) Grading

A "non-assessable" grade is assigned to students that have not participated in any assessment activity. In any other case, not participating in an assessment activity scores 0 in the weighted average computation.

Honours will be awarded to those who obtain grades greater than or equal to 9.0 in each part, up to 5% of those enrolled in descending order of final grade. They may also be granted in other cases, provided that they do not exceed 5% and the final grade is equal to or greater than 9.0.

f) Irregularities, copies and plagiarism

Copies are evidences that the work or the examination has been done in part or in full without the author's intellectual contribution. This definition also includes attempts of copying in exams and reports, and violations of the norms that ensure intellectual authorship. Plagiarisms refer to the works and texts of other authors that are passed on as their own. They are a crime against intellectual property. To avoid plagiarism, quote the sources you use when writing the corresponding work reports or examinations.

In accordance with the UAB regulations, copies or plagiarisms or any attempt to alter the assessment result, for oneself of for others, like e.g. letting other copy, imply a final grade for the corresponding part (exam, continuous assessment or project) of 0 in the computation of the final score and failing the course. This does not limit the right to take action against perpetrators, both in the academic field and in the criminal.

g) Assessment of repeaters

There is no differentiated treatment for repeaters but they can take advantage of their own material from the previous year provided it is informed in the corresponding reports.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Continuous assessment tests (3)	25%	25	1	1, 2, 3, 10, 9, 8, 6, 7, 5, 4, 12
Final exam	50%	2	0.08	1, 3, 10, 6, 7, 5, 4
Laboratory	25%	50	2	1, 3, 10, 9, 8, 6, 7, 13, 11
Make-up exam	50%	2	0.08	1, 3, 10, 6, 7, 5, 4

Bibliography

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

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

[3] 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

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

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