Course guide
330224 - DP - Programmable Devices

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Unit in charge: Manresa School of Engineering
Teaching unit: 750 - EMIT - Department of Mining, Industrial and ICT Engineering.

Degree: BACHELOR'S DEGREE IN ICT SYSTEMS ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2026 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: FRANCISCO DEL AGUILA LOPEZ

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge and understanding of the architecture of programmable devices, including the identification of the elements that make it up and their interaction, with emphasis on the most common architectures of embedded systems.
2. Develop the ability to abstract procedures and generic data in the face of a real small and medium-sized industrial problem.
3. (ENG) La capacitat d'especificar, analitzar, dissenyar, avaluar i documentar circuits digitals, tant seqüencials com combinacionals, així com les seves alternatives d'implementació.
4. The ability to use the tools and languages of specification, synthesis and verification of electronic circuits.
5. The knowledge and ability to use existing tools and instrumentation for the analysis, design, development and verification of electronic, computer and communications systems.
6. Develop their ability to solve real problems through the development of small and medium-sized programs at the industrial level.

Transversal:
7. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
8. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

TEACHING METHODOLOGY

The course consists of face-to-face activities comprising 2 weekly hours of lectures and 2 hours of laboratory practicals.
Students carry out their learning through various mechanisms. In the lectures and participatory classes, the course contents are presented and interaction between students and the professor is facilitated. Individual / group personal work activities are also proposed, which should contribute to the understanding of the subject.
In the laboratory classes, students carry out prior work that helps to put into context the work to be developed in the laboratory. The laboratory activity itself is carried out in groups of students and allows them to experiment with certain aspects developed in the course. Writing the report and interacting with the professor in the laboratory allows students to work on their oral and written communication skills.
Occasionally, the professor will teach a class in English, where a summary of the contents previously introduced in the course will be presented. In the event that a student has any questions, the question must also be formulated in English.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of this course the student will get the following objectives:
- Understand the basic architecture of a microcontroller, identifying the CPU, registers, memory, buses, input/output ports, and instruction cycle.
- Interpret and apply a microcontroller's instruction set, correctly using operations, data formats, flags, and addressing modes.
- Program AVR microcontrollers in assembly language, using procedures, the stack, tables, macros, and control structures.
- Design programs that interact with peripherals, such as input/output ports, timers, analog-to-digital converters, and serial communication.
- Manage events through polling and interrupts, developing applications that respond efficiently to internal or external signals.
- Design, implement, and debug simple microcontroller-based systems, integrating hardware, software, and technical documentation to solve specific problems.

STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	20.00
Self study	90,0	60.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

1. Introducction to programmable devices

Description:
In this topic, the history of computers and microcontrollers is introduced. The different levels of hierarchy in computers are presented. Mechanisms for measuring performance are introduced. Simple architectures are shown, and an overview of Microchip AVR microcontrollers is provided.

Related activities:
All of them

Full-or-part-time: 15h
Theory classes: 3h
Practical classes: 4h
Self study : 8h

2. Design and architecture of the instruction set

Description:
- Memory locations and operations
- Number of operands and instruction length
- Addressing modes: immediate, direct, indexed, etc.
- Types of instructions: data movement, comparisons, conditionals, procedure calls, and input/output
- Data formats: Big Endian, Little Endian, ASCII, and two's complement

Related activities:
All of them

Full-or-part-time: 34h
Theory classes: 8h
Practical classes: 6h
Self study : 20h

3. Assembly language

Description:
- Concept and use of assembly language
- Directives and macros
- Assembly process: source code, object code, linker, and programmer
- Translation of high-level instructions into assembly language
- Parameter passing
- Use of the stack and recursion
- Working with tables

Related activities:
All of them

Full-or-part-time: 34h
Theory classes: 6h
Practical classes: 8h
Self study : 20h

4. Modules and peripherals of AVR microcontrollers

Description:
- Input/output ports
- Timers
- Analog-to-digital converters
- Other microcontroller peripherals
- Peripheral control by polling
- Peripheral control by interrupt

Related activities:
All of them

Full-or-part-time: 52h
Theory classes: 8h
Practical classes: 10h
Self study : 34h

Processor unit design

Description:
- CPU organization
- Register set
- Buses
- Datapath
- Inputs and outputs
- CPU timing
- Clocks
- Instruction cycles and pipeline
- Opcode design

Related activities:
All of them

Full-or-part-time: 15h
Theory classes: 3h
Practical classes: 4h
Self study : 8h

ACTIVITIES

1. Lectures and participatory classes

Description:
The theoretical aspects of the course will be covered in class. These sessions will allow interaction between students and the lecturer.

Specific objectives:
- Understand how microcontrollers work.
- Be able to choose the most suitable device for each particular case.
- Design and program digital circuits.
- Know and understand what is needed to put a programmable device into practice.

Material:
Published teaching materials.
Recommended bibliography.

Delivery:
Occasionally, an assessable activity may be carried out, which will contribute to improving the final grade.

Full-or-part-time: 26h
Theory classes: 26h

2. Laboratory classes

Description:
Laboratory sessions will be carried out in groups and will last two hours per week. Students will have prior access to the assignment instructions for each practical session, which will be published on the digital campus.
The laboratory will be equipped with computers with the necessary software, as well as the hardware required to experiment with commercial digital devices.
During the sessions, the teaching staff will monitor each student's progress individually and provide support in the development of the activities. At the end of each practical session, each group must submit, through the digital campus, a report explaining the work carried out and the knowledge acquired.

Specific objectives:
- Implement microcontroller-based systems in the laboratory.
- Validate the operation of the designed systems.
- Write and present documents reflecting the design and validation process of the systems.

Material:
Electronic equipment, protoboard, digital devices, computer with suitable software. Microcontroller-based development board.
Practical assignment statement and supporting information for carrying out the work.

Delivery:
Before carrying out the practical session, students must individually submit the preliminary study corresponding to the activity to be performed. If the task includes software preparation, this preliminary study must be reflected in the materials published in the version control system made available to students.
At the end of the session, each working group will prepare a final report reflecting the main aspects of the work carried out.
During the sessions, or subsequently, the achievement of the objectives of each laboratory session will be assessed, taking into account the degree of understanding of the work demonstrated by each student.
The knowledge and skills acquired in the laboratory sessions will be graded through an oral or written defence of them. This defence makes up the LAB component.

Full-or-part-time: 60h
Laboratory classes: 30h
Self study: 30h

3. Individual / group personal work

Description:
Students must carry out certain activities individually and in groups in order to achieve the course objectives.

Specific objectives:
All those of the course.

Material:
Published teaching materials.
Recommended bibliography.

Delivery:
Individual and group work will be assessed throughout the course and will be reflected in the CON and LAB components.

Full-or-part-time: 30h
Self study: 30h

4. Exams

Description:
During the course, an individual assessment test will be carried out. At the end of the course, a comprehensive final exam will be held to assess the knowledge acquired.

Material:
Exam papers

Delivery:
The grade for the control test makes up the CON component.
The grade for the final exam makes up the FIN component.

Full-or-part-time: 34h
Theory classes: 4h
Self study: 30h

GRADING SYSTEM

The final grade for the course will be obtained as follows:

Final grade = 0.25 * CON + 0.35 * LAB + 0.4 * FIN

EXAMINATION RULES.

In the case of laboratory activities for which a prior study has been established, its submission will be mandatory before entering the laboratory. Those activities explicitly declared as individual, whether they are in-person or not, must be carried out without any collaboration from other people. The dates, formats, and other submission conditions established will be of mandatory compliance.

BIBLIOGRAPHY

Basic:
- Manual de referència i notes d'aplicació del fabricant.
- Gadre, Dhananjay V. Programming and customizing the AVR microcontroller. New York: McGraw-Hill, 2001. ISBN 007134666X.
- Tanenbaum, Andrew S. Structured computer organization [on line]. 5th ed. Upper Saddle River: Prentice Hall, 2010 [Consultation: 01/06/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=5173727. ISBN 0131485210.