Course guide
330237 - SEN - Embedded Systems

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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: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Bonet Dalmau, Jordi

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. The ability to design interface devices, data capture and storage devices, and terminals.
2. Knowledge and ability to use existing tools and instrumentation for the analysis, design, development and verification of electronic, computer and communications systems.
3. The ability to perform the typical activities of the degree, taking into account the corresponding standards, rules and regulations.
4. The ability to analyze, design and implement, select and use real-time data processing, control and automation systems, especially in embedded systems.
5. The ability to define, program, and use embedded devices with global connectivity.
6. The ability to define, analyze, design, develop, evaluate, document and launch systems that include electronic, computer and communications subsystems.
7. The ability to design, understand and use systems made to perform a specific task based on the stimuli captured in their environment, including robotic systems. An understanding of the basic concepts of complementary technology in the field of ICT with the aim of acquiring a broad perspective of the technology applied to engineering.

Transversal:
8. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 3. Taking social, economic and environmental factors into account in the application of solutions. Undertaking projects that tie in with human development and sustainability.
9. 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.
10. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
11. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

TEACHING METHODOLOGY

The subject consists of face-to-face activities consisting of 2 hours per week in the classroom (large group) and 2 hours per week in the laboratory (small group).
The student body carries out learning through various mechanisms. In the lectures and participative classes in the classroom, the contents of the subject are presented and the interaction between students and teachers is facilitated. Individual / group personal work activities are also proposed that should contribute to the understanding of the subject.
In the classes in the laboratory, the students carry out preliminary work that helps to put in context the work that is intended to be carried out in the laboratory. The laboratory activity itself is developed in groups of two students and allows experimentation with certain aspects developed in the subject. The writing of the memory and the interaction with the teachers in the laboratory allows working on the oral and written communication skills.
From time to time, it introduces nomenclature in English to progressively start the student body in learning this language.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student:
· Understand what embedded systems are and their architecture.
· Decide between an embedded system with or without an operating system.
· Understand the issue of real-time work.
· Make embedded systems interact with their environment.
·Understand the connectivity of embedded systems.
· Implement embedded systems in microcontrollers or microprocessors and FPGAs.

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

Content Title 1: Embedded Systems

Description:
1. Definition
2. Classification
3. Relationship with other subjects

Related activities:
A1, A2, A3, A4 and A5

Full-or-part-time: 8h
Theory classes: 2h
Self study : 6h

Content Title 2: Architecture

Description:
1. FPGA
2. Microcontroller without OS
3. Microcontroller with OS
4. Comparison

Related activities:
A1, A2, A3, A4 and A5

Full-or-part-time: 52h
Theory classes: 10h
Laboratory classes: 12h
Self study : 30h

Content Title 3: Real-Time Computing

Description:
1. Real-time computing constrains
2. Soft and hard real-time systems
3. Schedulers

Related activities:
A1, A2, A3, A4 and A5

Full-or-part-time: 50h
Theory classes: 10h
Laboratory classes: 10h
Self study : 30h

Content Title 4: Programming embedded systems.

Description:
Programming embedded systems using C.
Fixed-point arithmetic.
State machines.
Examples of serial port access on single-processor computers using C and Python.

Related activities:
A1, A2, A3, A4 and A5

Full-or-part-time: 40h
Theory classes: 8h
Laboratory classes: 8h
Self study : 24h

ACTIVITIES

TITLE OF ACTIVITY 1: LECTURES WITH EXERCISES

Description:
Face-to-face sessions focused on understanding the subject content, completing exercises and assigning new exercises that will lead to new content.

Specific objectives:
At the end of the course the student:
· Know the description and architecture of embedded systems.
· You will have criteria to decide between an embedded system with or without an operating system.
· You will know the problems of work in real time.
· You will be able to interact with the embedded systems with their surroundings.
· Will have notions about embedded systems connectivity.

Material:
Recommended bibliography
Published teaching material

Full-or-part-time: 27h
Theory classes: 27h

TITLE OF ACTIVITY 2: INDEPENDENT STUDY

Description:
Independent study consists of studying to understand and solidify knowledge, vocabulary and techniques either individually or in a group.

Specific objectives:
At the end of the course the student:
· Know the description and architecture of embedded systems.
· You will have criteria to decide between an embedded system with or without an operating system.
· You will know the problems of work in real time.
· You will be able to interact with the embedded systems with their surroundings.
· Will have notions about embedded systems connectivity.

Material:
Recommended bibliography
Published teaching material

Full-or-part-time: 20h
Self study: 20h

TITLE OF ACTIVITY 3: LABORATORY SESSIONS

Description:
The sessions will be conducted at the university laboratories. They will be focused on a class project to implement an application using different platforms: a microcontroller, microprocessor and FPGA.

Specific objectives:
At the end of the course the student:
· Know the description and architecture of embedded systems.
· You will have criteria to decide between an embedded system with or without an operating system.
· You will know the problems of work in real time.
· You will be able to interact with the embedded systems with their surroundings.
· Will have notions about embedded systems connectivity.
· It will have implemented embedded systems on microcontrollers, microprocessors and FPGAs.

Material:
Practice Manual
Laboratory equipment
Recommended bibliography
Published teaching material

Delivery:
At the end of each practice, a report is given and / or a defense is made before the teaching staff of the subject. Laboratory evaluation consists of
the evaluation of the memory and / or the defense of each practice and the methodology of work in the laboratory. This evaluation will contribute 40% to the final evaluation.

Full-or-part-time: 58h
Laboratory classes: 28h
Self study: 30h

TITLE OF ACTIVITY 4: EXERCISES

Description:
Exercises that students must solve individually or in a group and which they must deliver and, eventually, defend individually before the professor in an interview.

Specific objectives:
At the end of the course the student:
· Know the description and architecture of embedded systems.
· You will have criteria to decide between an embedded system with or without an operating system.
· You will know the problems of work in real time.
· You will be able to interact with the embedded systems with their surroundings.
· Will have notions about embedded systems connectivity.

Material:
Recommended bibliography
Published teaching material

Delivery:
Solved exercises, which will contribute 10% to the final evaluation.

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

TITLE OF ACTIVITY 5: EXAM

Description:
Written exam and lab activity in which the knowledge acquired up to the time of the test is evaluated. There will be a midterm that students must take individually. At the end of the class, there will be a final exam on the overall knowledge acquired.

Specific objectives:
At the end of the student year:
· It will have synthesized and consolidated the concepts and techniques worked so far.

Material:
Statements of the tests of previous courses
The work of the entire course

Delivery:
Exercises of the tests, which will contribute 50% to the final evaluation.

Full-or-part-time: 15h
Theory classes: 3h
Laboratory classes: 2h
Self study: 10h

GRADING SYSTEM

The final grade for the course will be obtained as follows:
45% Laboratory class (A3)
10% Completion of exercises (A4)
45% Exam (A5)

The evaluation will be continuous.
Note 1. The grade in a part or in the whole of the final test will replace, if it is higher and there is a coincidence in the evaluated aspects, the results obtained in other evaluation acts carried out throughout the course.
Note 2. When the results of the evaluation acts corresponding to individual activities are substantially lower than those obtained in group activities, the individual execution of activities similar to those carried out in a group may be required. The last qualification will replace the original ones.

EXAMINATION RULES.

All activities are compulsory.
If any of the activities of the subject is not carried out, it will be considered a zero.
Carrying out the laboratory activities is a necessary condition to pass the subject.
In the case of laboratory activities for which a previous study has been established, it will be mandatory to submit it before accessing the laboratory.
Those activities that are explicitly declared as individual, whether in person or not, will be carried out without any collaboration from other people.
The dates, formats and other delivery conditions that are established will be mandatory.

BIBLIOGRAPHY

Basic:
- Noergaard, Tammy. Embedded systems architecture [on line]. 2nd ed. Amsterdam: Elsevier/Newnes, 2013 [Consultation: 10/06/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780750677929/embedded-systems-architecture. ISBN 9780123821966.

Complementary:
- Wescott, Tim. Applied control theory for embedded systems. Burlington, MA: Newnes, cop. 2006. ISBN 0750678399.
- Oshana, R. DSP for embedded and real-time systems [on line]. Waltham: Newnes, 2012 [Consultation: 10/06/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780750677592/dsp-software-development-techniques-for-embedded-and-real-time-systems. ISBN 9780123865359.
- Williams, Tim. The Circuit designer's companion. 2nd ed. Oxford: Elsevier, 2005. ISBN 0750663707.

RESOURCES

Other resources:
Documentation published in the OpenCourseWare (ocw.itic.cat), which includes statements of the practices, exercises, statements of exams from previous courses and other resources.