COURSE DATA

Data Subject	
Code	44283
Name	Embedded systems
Cycle	Master's degree
ECTS Credits	5.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2199 - Master's Degree in Electronic Engineering	School of Engineering	1	Second term
3131 - PhD in Electronic Engineering	Doctoral School	0	First term

Subject-matter

Degree	Subject-matter	Character
2199 - Master's Degree in Electronic Engineering	2 - Digital systems and communications	Obligatory

Coordination

Name	Department
TORRES PAIS, JOSE GABRIEL	242 - Electronic Engineering

SUMMARY

This subject teaches to the student all the stages of the codesign hardware / software for the development of embedded systems, focusing specially on the reconfigurable systems based on FPGAs with embedded software microprocessors.

The contents of the subject are the following ones:

- Programmable integrated systems.
- Architecture of the families of programmable systems.
- Embedded Microprocessors.
- Design tools.
- Integrated systems peripherals.
- Applications in information, audio and video.
- Design of commercial solutions.
- Applications in typical components of communications.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

It is convenient that the students have a basic knowledge of the language of hardware description VHDL.
It is necessary that the students have a basic knowledge of the language of programming C.
It is also necessary that the students have solid knowledge of digital programmable systems.

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

2199 - Master's Degree in Electronic Engineering

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Take into account the economic and social context in engineering solutions, be aware of diversity and multiculturalism and ensure sustainability and respect for human rights and equality between men and women.
- Diseñar un sistema, componente o proceso que cumpla unas especificaciones desde diferentes puntos de vista: electrónico, económico, social, ético y medioambiental.
- Demostrar una comprensión sistemática de un campo de estudio y el dominio de las habilidades.
- Realizar un análisis crítico, evaluación y síntesis de ideas nuevas y complejas.
- Ser capaz de fomentar, en contextos académicos y profesionales, el avance tecnológico, social o cultural dentro de una sociedad basada en el conocimiento.
- Capacidad para proyectar, calcular y diseñar productos, procesos e instalaciones en todos los ámbitos de la Ingeniería Electrónica y en particular los de tratamiento de la señal, sistemas digitales y de comunicaciones y electrónica industrial.
- Capacidad para el modelado matemático, cálculo y simulación en todos los ámbitos relacionados con la Ingeniería Electrónica y campos multidisciplinares afines. En especial los de tratamiento de la señal, sistemas digitales y de comunicaciones y electrónica industrial.

- Conocer las técnicas avanzadas para la propagación de señales y datos mediante soporte físico, haciendo especial hincapié en el estudio de casos prácticos y el diseño de circuitos de microondas mediante líneas de transmisión.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

The goal of this subject is to acquire the competences that allow the student to know the digital programable systems based on FPGAs which include embedded microprocessors in order to achieve Systems-on-Chip (SoC).

According to this goal, it will be explained the whole hardware/software codesign cycle, both regarding the use of hardware description languages for peripheral generation and their integration in the system, and also regarding the use of high-level languages, as C language, for the handling of these peripherals from the microprocessor.

It will also be explained the hardware design techniques for signal processing algorithms and the novel programable system families architectures that allow to develop these designs.

DESCRIPTION OF CONTENTS

1. Basic embedded systems design

1. Introduction to Embedded System Design using Zynq and Vivado
2. Lab 1: Simple Hardware Design
3. Zynq Architecture
4. Extending the Embedded System into PL
5. Lab 2: Adding IPs in Programmable Logic
6. Adding Your Own Peripheral
7. Lab 3: Creating and Adding Custom IP
8. Software Development Environment
9. Lab 4: Writing Basic Software Applications
10. Software Development and Debugging
11. Lab 5: Software Debugging Using SDK

2. Advanced embedded systems design

1. Review of Embedded System Design in Zynq using Vivado
2. Lab 1: Create a Complete Embedded System
3. Advanced Zynq Architecture
4. System Debugging using Vivado Logic Analyzer and SDK
5. Lab 2: Debugging using Vivado Logic Analyzer
6. Memory Interfacing
7. Lab 3: Extending Memory Space with BRAM
8. Interrupts
9. Low Latency High Bandwidth

10. Lab 4: Direct Memory Access using CDMA
11. Processor Configuration and Bootloader
12. Lab 5: Configuration and Booting
13. Profiling and Performance Improvement

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	25,00	100
Laboratory practices	25,00	100
Study and independent work	15,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	15,00	0
Preparing lectures	20,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**125,00**	

TEACHING METHODOLOGY

Training activities will be developed in accordance with the following distribution:

a) Theoretical activities.

Description: Subjects will be developed in theoretical classes by providing a comprehensive perspective, analyzing in greater detail the key aspects and of greater complexity, and encouraging, at all times, the participation of the student.

b) Practical activities.

Description: They will complement the theoretical activities with the objective to apply the basic concepts and extend them with the knowledge and experience that will be acquired during the implementation of the proposed work. In general, practical activities will take place in a group to foster the skills of team work of the students. They include the following type of activities:

- Laboratory work.
- Discussion and problem solving sessions of the students previous work.

c) Home work.

Description: Preparation of both theoretical and practical lessons, and also exams. This task will be individual, in order to improve the self-work capability.

d) Evaluation.

Description: The student performance in the practical sessions will be evaluated continuously, and there will be a final exam at the end of the curse.

e) Scheduled tutoring (Single or in group).

Description: The goal of this activity is to guide and to answer any doubt. The student will expose them, allowing a review of his/her work.

The E-learning platform (Aula Virtual) will be used as communication support tool for the students. Using this application the students will have access to the class materials, and also to the problems and exercises to solve.

EVALUATION

At the **first call for evaluation**, the subject will be evaluated continuously, according to the following instructions:

- SE3 - Continuous assessment of the activities done from the questions proposed in the theoretical/practical sessions (50%). This activity is not recoverable.
- SE1 - Exam that includes the realization of a Project based on the learning and development of the subject, and it also includes theoretical/practical questions to be answered (50%).
- In order to pass the subject, a minimum mark of 4 (over 10) is required in both, the activities and the exam.

At the **second call for evaluation**, it just be proposed another exam theoretical/practical, while the continuous activities mark will be kept from the first call.

In any case, the system of evaluation will be ruled by the established in the Regulation of Evaluation and Qualification of the University of Valencia for Degrees and Masters. (https://webges.uv.es/uvTaeWeb/MuestraInformacionEdictoPublicoFrontAction.do?accion=inicio&idEdictoSeleccionado=5639)".

REFERENCES

Basic

- Pong P. Chu, FPGA prototyping by VHDL Examples: Xilinx Spartan-3 version
- Dennis Silage, Embedded Design using Programmable Gate Arrays
- Uwe Meyer-Baese, Digital Signal Processing with Field Programmable Gate Arrays (Signals and Communication Technology)

Additional

- Uwe Meyer-Baese, DSP with FPGAs: VHDL Solution manual
- F. Vahid, T. Givargis, Embedded System Design: A unified HW/SW introduction
- K. Chapman, Creating embedded microcontrollers (Programmable state machines)