COURSE DATA

DATA SUBJECT

Code: 46794
Name: Real-Time PDS Hardware Systems
Cycle: Doctorate / Master's Degree
ECTS Credits: 4.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2269 - Master's Degree in Electronic Engineering	Escola Tècnica Superior d'Enginyeria	1	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2269 - Master's Degree in Electronic Engineering	Tratamiento Digital de Señales	COMPULSORY

COORDINATION

BATALLER MOMPEAN MANUEL

FRANCES VILLORA JOSE VICENTE

SUMMARY

The Real-Time PDS Hardware Systems subject focuses on the physical implementation of Digital Signal Processing (PDS) algorithms, with a special emphasis on their real-time execution.

In a later subject, Signal and Data Processing, advanced digital signal processing (DSP) techniques will be described, among which we can mention spectral estimation, prediction, time-frequency techniques, design and analysis of linear and non-linear filters, linear adaptive filters, etc.

In this subject, the different alternatives for real-time hardware implementation of Digital Signal Processing techniques and algorithms are presented.

To this end, the techniques and aspects of the architecture that optimize the performance of real-time execution are initially described.

In the first part, the approach to hardware processing using digital signal processors (DSP), microprocessors with DSP extensions and native processing is described. In this sense, the main architectures, both scalar and superscalar, are described; the main development tools; profiling techniques; and the different levels of performance optimization, using this approach.

In this part of the subject, practices will be carried out on DSP processors (or with DSP extensions in their architecture) for the realization of real-time applications with special emphasis on real-time implementation and performance measurement.

In a second part of the subject, the calculation and memory needs of digital processing algorithms will be analyzed and design techniques for specific digital systems, such as FPGA and System on Chip (SoC), will be described. Attention will also be paid to high-level hardware synthesis, including the most used software tools (such as VHDL, Verilog, System Generator, HDL-Coder or high-level synthesis, HLS) and will be studied the integration of functional modules in FPGAs .

In this part of the subject, practice will be carried out on FPGA-type programmable logic devices, describing digital signal processing algorithms in VHDL or other hardware description languages. Finally, the synthesis and physical implementation will be carried out on different Xilinx development boards.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

Relationship with other subjects of the same degree

No enrollment restrictions have been specified with other subjects in the curriculum.

Other types of requirements

To successfully approach the subject, it is recommended that the student know the basic theory of digital signal processing and have basic knowledge of processor architecture and programming.

The basic knowledge required for digital design includes: number systems, Boolean algebra, minterms and maxiterms of a logical function, simplification of logical functions (Karnaugh and Quine-McCluskey methods), and combinational and sequential subsystems.

COMPETENCES / LEARNING OUTCOMES

2269 - Master's Degree in Electronic Engineering

Conduct a critical analysis, evaluation and synthesis of new ideas to solve problems in complex or unfamiliar environments within broader contexts in the field of electronic engineering and related multidisciplinary fields.

Create mathematical models and simulations in the field of electronic engineering and related multidisciplinary fields.

Demonstrate a systematic knowledge and a mastery of technical, personal, social and methodological skills in the field of electronic engineering and related multidisciplinary fields.

Design systems and processes that meet electronic, regulatory, economic, social, ethical and environmental specifications.

Gain the professional skills and cooperation abilities that are suitable for practising in the field of electronic engineering and related multidisciplinary fields.

Handle specialised software and hardware, as well as design, simulation and programming environments in the field of electronic engineering and related multidisciplinary fields.

Identify, formulate and solve problems in the field of electronic engineering and related multidisciplinary fields.

Interpret technical documentation and regulatory standards for equipment and systems in the field of electronic engineering and related multidisciplinary fields.

Know advanced techniques of digital signal and data processing systems, from conception to implementation in real-time hardware systems.

Project, calculate and design products, processes and installations in the field of electronic engineering and related multidisciplinary fields.

DESCRIPTION OF CONTENTS

1. Introduction

1.1 Introduction.
1.2 Applications and market.

2. Basic elements of DSP architecture

2.1 Basic hardware elements of the architecture.
2.2 Different alternatives for real-time hardware implementation.

3. Advanced DSP Processor Architectures

3.1 Concepts on superscalar organization.
3.2 Superscalar DSP processors.
3.3 Multiprocessor systems.
3.4 Description of the TI C6000 family.

4. Code optimization

4.1 Types of code optimization.
4.2 Comparison of the performances of the different optimization techniques.

5. Laboratory Practices: Development of applications on DSP processors

5.1 Development tools.
5.2 Language and programming.
5.3 Application development.

6. Digital programmable systems

6.1 Description of FPGA devices. Introduction to systems on chip (SoC).

7. Design of algorithmic state machines

7.1 ASM chart design methodology.
7.2 VHDL description of the control unit.
7.3 VHDL description of the calculation unit.

8. VHDL Hardware Description Language

8.1 Introduction and justification of high-level languages: VHDL.
8.2 Components.
8.3 Sequential and concurrent instructions.
8.4 Test benches.
8.5 Examples.
8.6 Synthesis-oriented VHDL: methodology and synthesis of combinational and sequential logic.

9. Synthesis-oriented VHDL hardware description language

9.1 Introduction to synthesis
9.2 Methodology and synthesis of combinational logic
9.3 Methodology and synthesis of sequential logic.
9.4 Examples

10.1 Introduction to High Level hardware design environments: System Generator and HDL-Coder.
10.1 Introduction to HDL-Coder. Examples.

10. High-level description tools

10.1 Introduction to High Level hardware design environments: System Generator and HDL-Coder.
10.2 Elements of the Xilinx System Generator. Examples.

11. Laboratory practices.

11.1 VHDL description of signal processing systems.
11.2 High-level description tools.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	20,00
Laboratory	25,00
Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	10,00
Preparation of lessons	45,00
Preparation for assessment activities	12,50
Resolution of case studies	0,00
Total hours	**67,50**

TEACHING METHODOLOGY

The development of the subject is structured around theory classes, tutorials and laboratory practices.

The teaching methodologies to be used in the development of the subject are the following:

a) Theoretical activities.

In the theoretical sessions, the master lesson model will be used to present the fundamental contents of the subject, using various audiovisual media (presentations, transparencies, blackboard).

The practical problem classes will be developed following two models. In some of the classes, the teacher will be the one who solves a series of standard problems so that students learn to identify the essential elements of the approach and resolution of the problem. In other types of problems, students will have to solve analogous problems under the supervision of the teacher.

b) Practical activities.

The practical activity sessions are closely related to the theory sessions.

In the first part of the subject, the practical sessions are organized around the design and implementation of real-time processing applications using DSP processors, while in the second part the laboratory practical sessions are organized around the design, simulation and implementation on a physical device of certain digital systems. The students will have the practice scripts in advance and the realization will be carried out entirely by them under the supervision of the teacher.

c) Tutorials

Students have a tutoring schedule whose purpose is to resolve problems, doubts, guidance on work, etc. They will also have the opportunity to clarify more specific doubts through email or discussion forums, using the "Virtual Classroom" tool.

d) Personal work of the student

Outside the classroom, the student will prepare for classes, exams and activities.

It is possible that some work will be carried out during the course that complements what was explained during it. The work would consist of the complete resolution of a real project or other types of proposals that the teacher deems appropriate.

On the other hand, e-learning platforms (Virtual Classroom) will be used to support communication with students. Through it you will have access to the teaching material used in class, as well as the problems and exercises to solve.

EVALUATION

The learning of the theory and laboratory parts will be evaluated.

To average the theory and laboratory grades, it will be necessary for the grade for each of them separately to be equal to or greater than 4.

Thus, the evaluation of the subject will be carried out by:

- (**SE1**) A knowledge test that will be carried out in the form of an individual exam on the theoretical contents of the subject. This test will take the form of an exam of short theoretical-practical questions. All questions will be related to the contents of the syllabus, and with difficulty similar to the concepts and problems asked in class.

- (**SE2**) An individual practical test, which will have two very different parts, corresponding to each of the parts of the subject. In this test, both the development of a real-time application and the development of a hardware design will be carried out. Demonstrated skill, mastery in the use of laboratory equipment, and design development will be evaluated.

The weight of each grade in obtaining the final grade will be:

50% theory exam
50% laboratory exam

In the optional case that the teacher proposes one or more assignments (**SE3**), the weights in obtaining the final grade would be:

40% theory exam
35% laboratory exam
25% work

Copying or plagiarism of any activity that is part of the evaluation will result in the impossibility of passing the course, and the student will then be subject to the appropriate disciplinary procedures indicated in the ACTION PROTOCOL FOR FRAUDULENT PRACTICES AT THE UNIVERSITY OF VALENCIA (ACGUV 123/2020).

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).

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