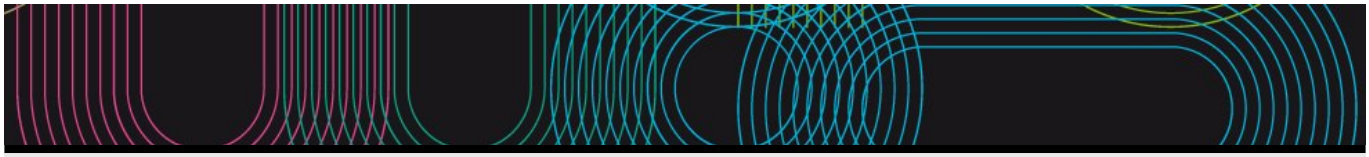

IDENTIFYING DATA				
Electronic Systems for Signal Processing				
Subject	Electronic Systems for Signal Processing			
Code	V05G300V01522			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Valdés Peña, María Dolores			
Lecturers	Valdés Peña, María Dolores			
E-mail	mvaldes@uvigo.es			
Web	http://www.faitic.uvigo.es			
General description	This subject introduces the basic concepts of digital signal processing systems from the point of view of its hardware implementation. Emphasis is put on FPGAs-based solutions, using professional software design tools and hardware supports. The nature of the course is mainly practical. It enhances the development of collaborative projects whose ultimate goal is the design of electronic signal processing systems.			

Competencies	
Code	
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
B6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
B9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.
B13	CG13 The ability to use software tools that support problem solving in engineering.
C39	(CE39/SE1): The ability to construct, exploit and manage the receiving, transporting, representation, processing, storage, manage and presentation multimedia information from the electronic systems point of view.
C45	(CE45/SE7): The ability to design interface, data capturing and storage devices, and terminals for services and telecommunication systems.
D2	CT2 Understanding Engineering within a framework of sustainable development.
D4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Understand the fundamental design principles of the signal processing hardware systems.	B6 B13	C39 C45	
Ability to decide different design strategies depending on the application.	B4	C39 C45	D2
Ability to choice the most suitable hardware architecture for each application.	B4 B6	C39 C45	
Ability to design basic circuits for audio and image processing.	B4 B6 B9 B13	C39 C45	D4

Acquire skills in the use of design, simulation and implementation tools of signal processing systems.	B13	C39 C45	
Acquire skills to verify the proper operation of complex hardware systems.	B6 B13	C39 C45	
Acquire skills to combine different software tools and hardware platforms.	B13	C39 C45	
Ability to document hardware design projects.	B4 B9		D4

Contents	
Topic	
Theory: Theme 1. Introduction	- Basic architecture of electronic signal processing systems: signal conditioning, sampling, conversion, and reconstruction.
Theory: Theme 2. Types of signal processing	-Different hardware and software solutions: DSP and FPGAs. -Processing forms: Serial/Parallel, Hardware/Software. -Hardware cost of regular signal processing circuits. Logical resources used. Processing rate.
Theory: Theme 3. Arithmetic in DSP	-Data types. -Data modification: quantification and overflow. -Arithmetic operations and associated circuits. -Associated concepts: critical path, pipeline and latency.
Theory: Theme 4. Siignal conditioning and sampling	- Example of a real system for signal conditioning and sampling using a FPGA-based development board.
Theory: Theme 5. Design and Implementation of Digital Filters	- Implementation of digital filters in FPGA. - Analysis of full parallel and semi-parallel solutions: hardware costs, operation rates.
Theory: Theme 6. Design of audio processing systems	- Examples of audio processing systems. - Analysis of required hardware resources. - Implementation and performance analysis.
Theory: Theme 7. Design of image processing systems	- Examples of basic image processing systems. - Analysis of hardware resources required. - Implementation and performance analysis.
Labs: Design of basic signal processing systems.	- Design, implementation and verification of basic signal processing systems described using VHDL: digital filters, communication applications, image processing, audio processing. - Using the ISE design tool from Xilinx and MATLAB from MathWorks.

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	14	14	28
Laboratory practical	14	14	28
Project based learning	9	54	63
Problem and/or exercise solving	2	6	8
Project	2	6	8
Laboratory practice	0	14	14
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Introductory activities	The teacher will present the theoretical ad practical key topics of the subject, as well as the projects to be developed along the course. CG6, CE39 and CE45 competencies will be worked on. It is an individual activity.
Lecturing	The theoretical content of the course and the introductory activities of both the theoretical and practical contents will be presented. CG6, CE39 and CE45 competencies will be worked on. It is an individual activity.

Laboratory practical	The students will implement basic signal processing systems using FPGAs platforms. CG6, CG9, CE39, CE45 and CG13 competencies will be worked on. It is a group activity.
Project based learning	Working groups of two or more students will be established. Each group will develop one project along the course. This projects will address the design of a signal processing system of medium complexity. Additionally, small groups (Groups Type C) will be available allowing monitoring the project to be developed in the course. Activities to be developed in groups C: Activity 1. Description, analysis and discussion of the system designed in the project. Activity 2. Demonstration of the behavior of the designed system. Analysis and discussion of results. CG6, CG9, CE39, C345, CG13, CT2, CG4 and CT4 competencies will be worked on. It is a group activity.

Personalized assistance

Methodologies	Description
Lecturing	The teacher will personally attend student□s doubts and queries related to theoretical contents. Students will have the opportunity to attend to individual or group tutorials, which will be held at the teacher's office following the schedule to be established at the beginning of the course, and to be published at the School of Telecommunications Engineering website.
Laboratory practical	The teacher will personally attend student□s doubts and queries related to laboratory practices and projects. Students will have the opportunity to attend to individual or group tutorials, which will be held at the teacher's office following the schedule to be established at the beginning of the course, and to be published at the School of Telecommunications Engineering website.
Project based learning	The teacher will personally attend student□s doubts and queries related to laboratory practices and projects. Students will have the opportunity to attend to individual or group tutorials, which will be held at the teacher's office following the schedule to be established at the beginning of the course, and to be published at the School of Telecommunications Engineering website. In adition, the projects asigned will be monitoring during the small groups (Groups Type C) activities.

Assessment

	Description	Qualification	Training and Learning Results		
Problem and/or exercise solving	There will be a short-answer test on the theoretical issues of the course. More information is provided in the "Other Comments" section below. This test will assess competencies CE39 and CE45.	20		C39 C45	
Project	The students will develop a project focused on the design of a signal processing system of medium complexity. More information is provided in the "Other Comments" section that follows. This project will assess competencies CG4, CG6, CG9, CG13, CE39, CE45, CT2 and CT4.	45	B4 B6 B9 B13	C39 C45	D2 D4
Laboratory practice	Laboratory practices will be evaluated based on the continuously work carried out during the laboratory hours (Type B hours) and on a final report of practices. These practices will assess competencies CG4, CG6, CG13, CE39, CE45 y CT4.	35	B4 B6 B13	C39 C45	D4

Other comments on the Evaluation

According to the guidelines for the degree programme, two evaluation systems will be offered to students: continuous assessment and eventual assessment.

1.- Continuous assessment

The continuous assessment consists of one theoretical test, a set of laboratory practices and one theoretical-practical work

(project).

1.1 Theoretical examination (NExam):

The theoretical examination will include all the theoretical contents of the course and will take place at the end of the term. The weight of this examination will be 2 points out of 10.

1.2 Laboratory practices (NPra):

The laboratory practices will be performed in groups of two or more students. The evaluation of the labs will take in to account both, the work in the laboratory as well as a final report. The weight of this assessment is 3,5 point out of 10.

The work in the laboratory will be individually evaluated and represent the 60% of the score. The remaining 40% correspond to the final report and will be the same for all the members of a working group.

1.3 Theoretical-practical work (NPro):

The theoretical-practical work will be conducted in type B and C hours, in groups of two or more students. As a result of the work a writing report and the implemented system must be delivered and the results will be oral discussed. The weight of this assessment is 4,5 points out of 10 (4 points correspond to the design and documentation tasks and 0,5 points to the discussion one).

To carry out the theoretical-practical work individual and cooperative tasks will be assigned to the students. The weight of the individual work will be the 60% of the maximum score of the project and the weight of the cooperative work will be the 40%. The 40% of the score corresponding the cooperative work will be the same for all the members of a working group.

1.4 Final grade (Final_grade):

The final grade for the continuous assessment correspond to:

Final_grade = (0,2*NExam + 0,35*NPrac + 0,45*NPro) if Nexam, NPrac and NPro are greater or equal to 4 and Final_grade is greater or equal to 5;

Final_grade = min[(0,2*NExam + 0,35*NPrac + 0,45*NPro), 4] in any other case.

The students who fail any of the partial assessments will have the possibility to repeat it/them in the second call. In this case the students would be evaluated only of the part they have not pass (theoretical exam, laboratory practices and/or project). The grade obtained in this evaluation will replace the previous one.

It is understood that the student chooses continuous assessment if he/she conducts the two first laboratory practices. In no case the final grade of a student who opts for continuous assessment may be "Not Submitted".

2.- Eventual assessment and extraordinary call

Students who opt for the eventual assessment or for the extraordinary call must pass two exams, a theoretical one covering all the contents of the subject and a practical exam.

2.1 Theoretical examination (NExam_U):

The theoretical examination would include short answer questions, problems, and/or system design exercises.

2.2 Practical examination (NPra_U):

The practical examination will consist in the final test of a previously designed and simulated system. One week before the date established for the exam the student must submit a writing report of the designed system as well as the simulation results. During the practical exam the student will validate the system designed in the hardware.

Both the theoretical and the practical exam will weigh 50% of the final grade.

2.3 Final grade (Final_grade_U):

The final grade of the eventual assessment and the extraordinary call will correspond to:

Final_grade_U = (0,5*NExam_U + 0,5*NPrac_U) if Nexam_U and NPrac_U are greater or equal to 4 and Final_grade_U is greater or equal to 5;

Final_grade_U = min[(0,5*NExam_U + 0,5*NPrac_U), 4] in any other case.

As in the case of continuous assessment, the students who opt for the eventual assessment will have two opportunities, first call and second call. Those students do not pass the course in the first call will be only evaluated of the part they have not

passed (theory and/or practice) in the second call.

3.- Other comments

- The students can use the Spanish, English or Galician to answer the exam and for the reports, works or presentations.
- The grades obtained from the continuous assessment, the eventual assessment or the extraordinary call are only valid for the current academic year.
- The use of books, notes or electronic devices such as phones or computers is not permitted in any classroom test or exam. Mobile phones must be turned off and be out of reach of the student.
- In case of plagiarism is detected in any of the reports/tasks/exams done/taken, the final score for the subject will be fail (0) and the teachers will inform the School authorities so that they take the actions that they consider appropriate.
- In case of plagiarism or abandonment of a member of a work group is detected, his/her score will be fail (0) and will not compute for the score of the rest of the group.

Sources of information

Basic Bibliography

U. Meyer-Baese, **Digital signal processing with Field Programmable Gate Arrays**, 3th ed., Springer-Verlag, 2007

James H. McClellan, Ronald W. Schafer, Mark A. Yoder, **Signal processing first**, 1st ed., Pearson Education International, 2003

XUP, University of Strathclyde and Steepest Ascent, **DSP for FPGA Primer**, 2011

Complementary Bibliography

John G. Proakis, Dimitris G. Manolakis, **Digital signal processing**, 4th ed., Pearson Education International, 2007

John G. Proakis, **Tratamiento digital de señales : principios, algoritmos y aplicaciones**, 4ª ed., Prentice Hall, 2007

Recommendations

Subjects that are recommended to be taken simultaneously

Programmable Electronic Circuits/V05G301V01302

Contingency plan