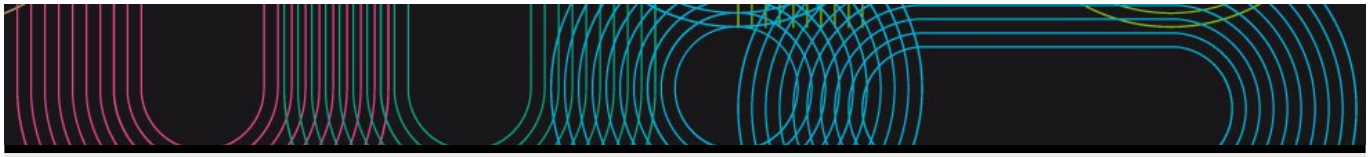

IDENTIFYING DATA				
Digital processing in real time				
Subject	Digital processing in real time			
Code	V05G301V01413			
Study programme	Grado en Ingeniería de Tecnologías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Cardenal López, Antonio José			
Lecturers	Cardenal López, Antonio José			
E-mail	cardenal@gts.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	This course is designed to provide the student with basic knowledge about the design and implementation of real-time digital signal processing (DSP) algorithms. The main objective for the student is to obtain knowledge about the different platforms available for this purpose in scenarios with real-time restrictions, and to learn the practical issues related with the implementation of DSP algorithms in such platforms. Knowledge acquired on lectures will be reinforced by laboratory practices. For this purpose a Digital Signal Processor development board, will be employed. The course will be taught in Spanish, but all teaching materials will be in English. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
B3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
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.
C69	(CE69/OP12) The ability to implement digital signals processing schemes in programming devices.
C70	(CE70/OP13) The ability to interact digitally with radio signals.
D2	CT2 Understanding Engineering within a framework of sustainable development.
D3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.

Expected results from this subject	Training and Learning Results		
Know the architectures for applications in real time	B3	C69	D2
Develop applications in real time on selected architectures.	B3 B4	C69	D2
Adapt the knowledges of digital signal processing to real time tasks.	B3 B4	C69 C70	D3
Propose digital solutions for its integration in radio transceptors.	B4	C70	D3

Contents
Topic

Topic 1 Elementary concepts	Definition of real-time processing. Real-time restrictions for digital signal processing. Overview of hardware platforms for real time digital signal processing.
Topic 2 Time-domain algorithms.	Signal generation. Advanced structures for IIR filters. Finite-precision effects.
Topic 3 Frequency-domain Algorithms	Fast Fourier Transform (FFT). Discrete Cosine Transform. Goertzel algorithm
Topic 4 Introduction to Digital Signal Processors.	DSP architecture. Arithmetic-logic unit. Address-Generation Unit. Program flow control. Performance measures.
Topic 5 High level programming for DSP	Development systems structure. Fixed point programming techniques. Optimising high level code.
Practice 1: Introduction to the development system	Compiling, runing and debugging programs on the DSP development system. Signal generation using lool¡k-up tables
Practice 2: Signal generation	Signal generation using polynomials.
Practice 3: FIR filters	Fixed point FIR filter programming.
Practice 4: IIR filters (I)	IIR filters: coefficient quantization and scaling.
Practice 5: IIR filters (II)	IIR filters: overflow.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	21	42	63
Mentored work	7	35	42
Laboratory practical	3	6	9
Laboratory practical	3	6	9
Laboratory practical	2	4	6
Laboratory practical	2	4	6
Laboratory practical	2	4	6
Essay questions exam	2	7	9

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Presentation of main topics in class. Multimedia material will be made available in faitic before classes take place. Personal study. Support from the instructors through tutorial help. Individual activity. Through this methodology the competencies B3, C69, D2 and D3 are developed.
Mentored work	Group work on a project centered in a practical application using the DSP development board employed in the laboratory.Group activity. Through this methodology the competencies B3, B4, C69, C70, D2 and D3 are developed.
Laboratory practical	Practical exercises on a DSP development board. Matlab will be used for designing filters, and for simulation purpose if necessary. Individual activity. Through this methodology the competencies B4, C69, C70, D2 and D3 are developed.
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Laboratory practical	Practical exercises on a DSP development board. Matlab will be used for designing filters, and for simulation purpose if necessary. Individual activity. Through this methodology the competencies B4, C69, C70, D2 and D3 are developed.

Personalized assistance

Methodologies	**Description**
Laboratory practical	In practical sessions, each student must solve his/her own tasks. The teacher will be available during the session to solve any problem/question or doubt the student may have.
Lecturing	Lectures are develop within a continuous interaction framework, where students can answer questions delivered by the teacher. They could also solve their particular doubts during the sessions. Tutoring hours will be available at https://www.uvigo.gal/universidade/administracion-persoal/pdi/antonio-jose-cardenal-lopez.

Mentored work	Tutored works are developed in small working groups. The works are followed during meetings between the groups and the teacher. In those meetings the students can interact and ask their questions to the teacher.
Laboratory practical	In practical sessions, each student must solve his/her own tasks. The teacher will be available during the session to solve any problem/question or doubt the student may have.
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Assessment

	Description	Qualification	Training and Learning Results		
Mentored work	Group work centred in a practical application of real-time signal processing, using the DSP development board.	20	B3 B4	C69	D3
Laboratory practical	Evaluation of practical exercices using the DSP development board. Introduction: signal generation using look-up tables.	10	B3 B4	C69 C70	D2
Laboratory practical	Evaluation of practical exercices using the DSP development board. Signal generation using polynomials .	15	B3 B4	C69 C70	D2
Laboratory practical	Evaluation of practical exercices using the DSP development board. FIR filter programming.	15	B3 B4	C69 C70	D2
Laboratory practical	Evaluation of practical exercices using the DSP development board. IIR filter programming (I).	15	B3 B4	C69 C70	D2
Laboratory practical	Evaluation of practical exercices using the DSP development board. IIR filter programming (II).	15	B3 B4	C69 C70	D2
Essay questions exam	Written exam encompassing all the material exposed in the classroom and laboratory. The teacher will provide the students support to solve any questions related to the exam.	10	B3 B4	C69	D3

Other comments on the Evaluation

The course will be taught in Spanish, but all teaching materials will be in English.

Evaluation

Students shall be offered two evaluation systems: continuous assessment or evaluation at the end of the semester.

Continuous assessment

The continuous assessment of the course will consist in:

- 5 individual practices developed on the DSP development board. These practices will account for 70% of the final grade.
- 1 project to be carried out in group that will account for 20% of the final grade.
- A written exam encompassing all the material exposed in the classroom and in the laboratory. It will take place in the dates scheduled by the school. It will account for 10% of the final grade.

The final qualification of the student will be computed as a weighted sum (70%, 20% and 10%,respectively) of the qualifications of laboratory, group project and final exam.

The contents and the weight of each continuous assessment exercise are the following:

- Introduction: signal generation using look-up tables (10%)
- Signal generation using polynomials (15%)
- FIR filter programming (15%)
- IIR filter programming (I) (15%)
- IIR filter programming (II) (15%)
- Project: (20%)

The laboratory and group project will be considered mandatory for all students who chose continuos assessment.

It will be considered that the student has chosen continuous assessment upon submision of the first three practices. The choice of continuous assessment means that the student can not have a final grade of "Not presented".

Global assessment

1. **Ordinary exam**. Should a student decide not to be graded through continuous assessment,he will have a written examination opportunity that will take place thesame day of the final exam for all the students. The exam will cover all the material mastered in the classroom and the laboratory. Students should communicate their intention to renounce to be graded through continuous assessment at least a week before the date of the final exam.
2. **Extraordinary exam**. Students who do not pass the course at the end of the semester have an opportunity to retest on the end of the academic year. Previously to the exam, students will be asked to choose to be evaluated by continuous assessment system or only by the final exam. In the former case, they will have the opportunity to improve the continuous assessment grade by means of redoing and improving selected practices.
3. **End-of-program exam.** The student will have a written examination covering all the material mastered in the classroom and the laboratory.

Ethical code

Plagiarism is regardedas serious dishonest behavior. If any form of plagiarism is detected in any of the tests, the final grade will be FAIL (0), and the incident willbe reported to the corresponding academic authorities for prosecution.

Sources of information

Basic Bibliography

Sanjit K. Mitra, **Digital Signal Processing: A Computer Based Approach**, McGraw-Hill,

Complementary Bibliography

Sen M. Kuo, Bob H. Lee, **Real-Time Digital Signal Processing,: Implementations, Application and Experiments with the TMS320C55X**, John Wiley & Sons,

Alan V. Oppenheim, Ronald W. Schafer, **Discrete-Time Signal Processing**, Prentice Hall,

Recommendations

Subjects that it is recommended to have taken before

Multimedia Signal Processing/V05G301V01321