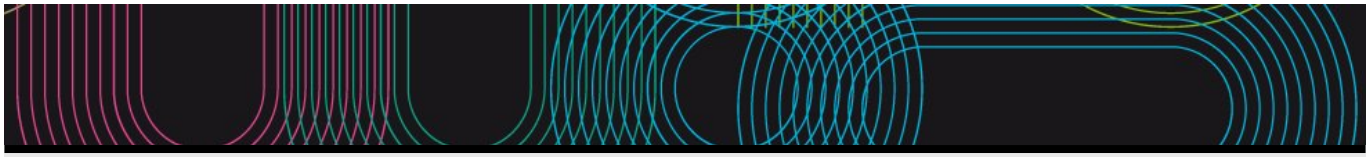

IDENTIFYING DATA				
Digital Signal Processing				
Subject	Digital Signal Processing			
Code	V05G300V01304			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish Galician			
Department	Signal Theory and Communications			
Coordinator	Alonso Alonso, Ignacio			
Lecturers	Alonso Alonso, Ignacio Docampo Amoedo, Domingo Docio Fernández, Laura Márquez Flórez, Óscar Willian			
E-mail	ignacio.alonso@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Digital signal processing is nowadays a feature of most everyday communications and entertainment devices. The aim of this course is to equip students with a mathematical grounding in general signal and systems analysis. In subsequent course subjects, this knowledge will be applied to specific applications of signals and systems, including audio, image, video and voice signals. Objectives cover the following areas: - Managing signals and systems mathematically and visually, including learning and applying their properties. - Studying the different domains for signal and systems analysis: time domain, frequency domain and Z domain. - Learning how to transfer a problem in one domain to a domain in which it is easier to solve. - Mastering the concept of filter frequency response and learning to interpret the system function. - Understanding the relationship between the poles and zeros of the system function and the frequency response. - Acquiring basic notions of filter design in the Z domain. - Managing specific digital signal processing software. - Applying the above knowledge to simple and practical laboratory examples.			

Competencies	
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.
C48	(CE48/T16) The knowledge of the appropriate techniques to develop and exploit signal processing subsystems .
C49	(CE49/T17) The ability to analyze digital signal processing schemes.
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.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Managing specific software for digital signal processing	B3	C48	D3
Applying mathematical knowledge for signal filtering	B4	C49	D2

Mastering filtering operations in frequency domain.	B4	C49	D2
Learning mathematical issues for understanding the processes of sampling and windowing of analog signals.	B3	C48	D3
Analysis of simple processing systems.	B4	C49	D2

Contents	
Topic	
Subject 1. Introduction	Concept of signal and system. Mathematical representation
Subject 2. Sinusoids	Sinusoidal signals: Frequency, amplitude and phase. Complex exponentials and phasors. Phasor addition rule.
Subject 3. Spectrum representation	Spectrum of a sum of sinusoids. Mathematical expression and graphical plot. Fourier Series analysis of periodic signals.
Subject 4. Introduction to Sampling and Aliasing	Sampling and digital frequency. Analog frequency vs discrete frequency. Aliasing. The sampling theorem.
Subject 5. FIR Filters	Introduction to discrete-time systems. Difference equation. Filter Coefficients. Block Diagrams. Causality, linearity and time-invariance. LTI systems and convolution. FIR frequency response. Cascaded LTI systems.
Subject 6. Frequency response of FIR filters	Sinusoidal response of FIR systems. Frequency response. Properties. Graphical representation.
Subject 7. Z Transform	Definition and properties. Linear-phase filters.
Subject 8. IIR Filters	Difference equation. Filter Coefficients. Block Diagrams. Impulse response. Relation between the position of poles and zeros of the system function and the frequency response.
Subject 9. Continuous-Time Signals and Systems	Introduction to continuous-time systems. The unit impulse. The unit step. Time delaying. Linearity and time-invariance. Convolution
Subject 10. Continuous-Time Fourier Transform	Definition. Basic pairs. Properties
Subject 11. Sampling and Reconstruction in the Frequency Domain	The sampling theorem in the frequency domain
Project 1. A/D and D/A Conversion	Digitalisation of Continuous-Time Signals. Aliasing.
Project 2. Digital Filters	Digital filters in the time and frequency domains.

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	23	40	63
Laboratory practices	11	22	33
Problem solving	15	30	45
Discussion Forum	0	2	2
Objective questions exam	1.5	0	1.5
Problem solving	4.5	0	4.5
*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	Course presentation: programme, reading materials, teaching methodology and assessment system
Lecturing	Instructor presentation of the main concepts of each subject. During the 5 minutes before the lecture, a student will summarize the main concepts presented in the previous session. Students will participate by answering questions during the explanation and by doing exercises. Student will work alone afterwards on the concepts studied in class and on expanding this content using the guidelines provided for each subject. Identification of doubts that need to be resolved in personalized tutorials. Through this methodology the competencies CE48, CG3, and CT3 are developed.
Laboratory practices	Application of Matlab functions and commands for digital signal processing to solve practical exercises. Identification of doubts that need to be resolved in personalized tutorials. Through this methodology the competencies CE49, CG4 and CT2 are developed.

Problem solving	Problems and exercises formulated according to the content of the lectures and the guidelines for each subject. Students solve problems and exercises prior to the class in which one or several students explain the solution on the board. Identification of doubts that need to be resolved in personalized tutorials. Through this methodology the competencies CE49, CG4 and CT2 are developed.
Discussion Forum	The website for the course is included in the TEMA platform (http://faitic.uvigo.es). Subscription to this platform, including a photograph, is mandatory. The website provides all the information related to the course. It also publishes continuous assessment grades and runs forums for students to exchange ideas and discuss doubts. Through this methodology the competencies CE48, CE49, CG3, CG4 , CT2 and CT3 are developed.

Personalized attention

Methodologies	Description
Lecturing	Students will have the opportunity to attend personal tutorials in their lecturer□s office at times established by lecturers for this purpose at the beginning of the academic year and published on the course website. These tutorials are aimed at resolving student doubts and providing guidance regarding: □ The content of the lectures and approaches to study. □ Laboratory projects and the software used. □ Problems and exercises proposed and solved in the classroom as well as other problems and exercises arising during the course.
Laboratory practices	The same as in the previous section.
Problem solving	The same as in the previous section.

Assessment

	Description	Qualification	Training and Learning Results		
Objective questions exam	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	0	B3	C48 C49	D3
Problem solving	These tests are a requirement to pass the subject. See details in the "Other comments and second call" section.	100	B3 B4	C48 C49	D2 D3

Other comments on the Evaluation

ASSESSMENT PROCEDURE:

A. Overview

The acquired skills are assessed by a series of tests grouped into two parts, with different requirements:

1. **Lab assessment**.
2. **Problem assessment**.

To pass the course it is necessary to pass all two parts.

- For each part one or more tests are performed to obtain an independent grade on each.
- There are tests for each part both during the lecture period and final evaluation periods.
- A pass grade in any part is valid for the entire academic year.
- The final grade for Lab assessment is a numerical mark between 0 and 10. A student needs a grade equal or greater than 5 to pass the Lab. If the Lab grade is greater than 7, the Lab grade will increase the Course mark (see details below).
- The final grade for the Problem assessment is a numerical mark between 0 and 10.
- The **Course mark** is obtained as follows (for both continuous and unique assessment):
    - If you have passed all two parts and the Lab grade is not greater than 7:
        - Course mark=Problem assessment grade.
    - If you have passed all two parts and the Lab grade is greater than 7:
        - Course mark=minimum [10 , Problem assessment grade + [(Lab grade-7)/3]]
    - If you have not passed any of the two parts:

        - minimum [Problem assessment grade, Lab grade]
    - In case the student has more than one mark for any part, the highest one will be used.

It is also important to note that:

- The course can be passed with full marks from continuous assessment, with no need to attend a final exam.
- Students who have done continuous assessment and have failed any part, at the end of the term or at the end of the academic year, may need to perform only the failed parts.
- Students who attend any of the tests corresponding to Problem assessment will obtain a mark that will be listed in the academic records.

The following sections explain in detail how each part is graded.

B. Details of the assessment procedure

B1. Lab assessments

- Their goal is to determine whether the student has acquired all the knowledge and/or skills corresponding to the laboratory practice, emphasizing the use of MatLab for digital signal processing.
- Content to be assessed: content of the lab manuals and related theory content.
- Type of test: The test consists of a combination of multiple-choice questions and short questions. Students may use MatLab, lab manuals with personal notes, and text book. Students may not use a calculator for this test.
- The final grade for Lab assessment is a numerical mark between 0 and 10. A student needs a grade equal or greater than 5 to pass the Lab. If the Lab grade is greater than 7, the Lab grade will increase the Course mark.
- Assessment method:
    - **First Opportunity**: The student will have two nonexclusive ways to pass the Practice part.
        1. Two tests in the lab room during the class period (continuous evaluation)
            - The test consists of a series of questions at the end of each Practice assignment
            - The tests will be graded between 0 and 10. The student will pass this part if he/she gets an average greater than or equal to 5. It is compulsory to attend the two tests.
            - Tests dates will be announced on the web site at the beginning of the lecture period.
        1. A final exam (unique assessment). The pass mark for this test is 5 out of 10.
    - **Second Opportunity and extraordinary call**: A final exam. The pass mark for this test is 5 out of 10.
- Remarks:
    - Once the Practice pass grade is obtained, this is valid for the entire academic year.

B2. Problem Assessment

- Their goal is to determine whether the student has acquired all the knowledge and/or skills corresponding to the course and knows how to apply them to solve problems.
- Content to be assessed: as specified in the guidelines for each topic in the section "Content to be assessed". MatLab knowledge is not assessed.
- Type of test: an exam of problems. Students may not use books or notes. The use of calculators may be granted on an exam basis.
- It will be graded between 0 and 10. The pass mark is 5.
- Assessment method:
    - **First Opportunity**: The student will have two nonexclusive ways to pass the Problems part.
        1. Three tests in the classroom during the class period (continuous evaluation). Each test will be graded between 0 and 10.
            - The mark will be obtained as : 0,25* Test1Mark+ 0,35*Test2Mark + 0,4*Test3Mark
            - Test1: Subjects 1 to 4. Test2: Subjects 1 to 8. Test3: Subjects 1 to 11.
            - Tests dates will be announced on the web site at the beginning of the lecture period.

2. A final exam (unique assessment). The pass mark for this test is 5 out of 10.

- **Second Opportunity and extraordinary call**: A final exam. The pass mark for this test is 5 out of 10.

- Remarks:
  - Once the pass mark is obtained, this is valid for the entire academic year.
  - A student who has passed the Problems part during the First Opportunity through the continuous evaluation is allowed to attend the final exam of the First Opportunity to try to get a better mark.
  - A student who has passed the Problems part during the First Opportunity, is NOT allowed to attend the Problems Part of the final exam of the Second Opportunity.

C. Other comments

- The grade obtained at the end of the term will be part of the academic record of the student. This grade will be final if the mark is above or equal to 5. Otherwise a provisional fail grade will be recorded on their academic record.
- The provisional mark will become definitive fails for students who do not sit at the end of the academic year exam period, or gets a lower mark. Otherwise the better mark will be part of the academic record and becomes final.
- Tests performed as continuous assessment may not be rescheduled.
- The grades obtained in the lab assessment or problem assessment 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 test or exam. Mobile phones must be turned off and out of reach of the student. If calculator use is permitted, the calculator must be a conventional scientific calculator. Under no circumstances may calculators be used that allow formulas to be saved or that have libraries that automatically perform operations with complex numbers, calculation of roots, etc.
- Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the tests or exams, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

Sources of information

Basic Bibliography

J.H. McClellan y R.W. Schafer, R, **Signal Processing First**, Pearson Prentice Hall,

Complementary Bibliography

A. Quarteroni y F. Saleri, **Cálculo científico con Matlab y Octave**, Springer,
M. J. Roberts, **Señales y Sistemas**, McGraw Hill,
A.V. Oppenheim y R.W. Schafer, **Tratamiento de señales en tiempo discreto**, Prentice Hall,

Recommendations

Subjects that continue the syllabus

Fundamentals of Sound and Image/V05G300V01405
Signal Transmission and Reception Techniques/V05G300V01404
Fundamentals of Image Processing/V05G300V01632
Sound Processing/V05G300V01634
Audio Systems/V05G300V01532
Imaging Systems/V05G300V01633
Electronic Systems for Signal Processing/V05G300V01522
Multimedia Signal Processing/V05G300V01513
Video and Television/V05G300V01533

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G300V01201
Mathematics: Linear algebra/V05G300V01104
Mathematics: Calculus 1/V05G300V01105
Mathematics: Calculus 2/V05G300V01203