ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

615000968 - Digital Signal Processing

DEGREE PROGRAMME

61IW – Degree in Software Engineering

ACADEMIC YEAR & SEMESTER

2022/23 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	615000968 - Digital Signal Processing
No of credits	6 ECTS
Type	Elective
Academic year ot the programme	Fourth year
Semester of tuition	Semester 7/8
Tuition period	February - June
Tuition languages	English
Degree programme	61IW – Software Engineering Bachelor
Centre	61 - Escuela Tecnica Superior De Ingenieria De Sistemas Informaticos
Academic year	2022-23

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Luis Miguel Pozo Coronado (Coordinador/a)	2106	lm.pozo@upm.es	To be confirmed.

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Mathematical Analysis

- Algebra

- Probability and Statistics

3.2. Other recommended learning outcomes

.

4. Skills and learning outcomes *

4.1. Competences

CB2 - Ability to understand and master the physical and technological foundations of computer science: electromagnetism, waves, circuit theory, electronics, and photonics, and their application to solving engineering problems.

CT12 - Use of information and communication technologies: Utilize information and communication technologies in the field of engineering.

CT2 - Problem-solving: Identify, analyze, and define the significant elements that constitute a problem in order to solve it effectively and with sound judgment.

CT4 - Written communication: Effectively engage with others by expressing thoughts clearly through writing and graphical aids..

4.2. Learning outcomes

- RA307 - Handles the FFT algorithm for efficient calculation of discrete Fourier transforms and convolutions.
- RA308 - Applies Z-transforms for the analysis and control of discrete-time linear systems.
- RA433 - Represents and analyzes speech in the time and frequency domains.
- RA305 - Manages the basic elements of signal processing.
- RA434 - Designs and evaluates algorithms for voice processing.
- RA436 - Applies Data Science methods in the analysis of temporal patterns.
- RA36 - Properly utilizes mathematical software in problem-solving.
- RA306 - Properly utilizes the Fourier transform for the analysis and processing of signals..

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

This subject aims to provide the necessary mathematical foundations for digital signal processing. The mathematical tools studied also have applications in other fields such as system control or image processing. Matlab will be used as the software tool in all learning and assessment activities.
Classes will be conducted in English.
Optionally, students who deem it appropriate can carry out practical activities in Python environments.

Syllabus

1. Introduction to Digital Signal Processing
2. Signals in discrete time
3. Z transform
4. Fourier transform, discrete Fourier transform
5. Fast Fourier transform
6. Digital Filters
7. Adaptive filtering
8. Voice analysis

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Theoretical lesson** Lecture	**Practical lesson** Duration: 02:00		
2	**Theoretical lesson** Lecture	**Practical lesson** Duration: 02:00		
3	**Theoretical lesson**	**Practical lesson** Duration: 02:00		Practice Submission TG: Group Work Technique Continuous Evaluation Non-presential Duration: 06:00 Moodle Questionnaire ET: Online Test Technique Continuous Evaluation Non-presential Duration: 00:30
4	**Theoretical lesson**	**Practical lesson** Duration: 02:00		
5	**Theoretical lesson**	**Practical lesson** Duration: 02:00		
6	**Theoretical lesson**	**Practical lesson** Duration: 02:00		Practice Submission TG: Group Work Technique Continuous Evaluation Non-presential Duration: 06:00 Moodle Questionnaire ET: Online Test Technique Continuous Evaluation Non-presential Duration: 00:30
7	**Theoretical lesson**	**Practical lesson** Duration: 02:00		

8	**Theoretical lesson**	**Practical lesson** Duration: 02:00		Partial Exam EX: Written Exam Technique Continuous Evaluation Face to face Duration: 01:15 Practice Validation Test EP: Practice Exam Technique Continuous Evaluation Face to face Duration: 00:45
9	**Theoretical lesson**	**Practical lesson** Duration: 02:00		Practice Submission TG: Group Work Technique Continuous Evaluation Non-presential Duration: 06:00 Moodle Questionnaire ET: Online Test Technique Continuous Evaluation Non-presential Duration: 00:30
10	**Theoretical lesson**	**Practical lesson** Duration: 02:00		
11	**Theoretical lesson**	**Practical lesson** Duration: 02:00		
12	**Theoretical lesson**	**Practical lesson** Duration: 02:00		Practice Submission TG: Group Work Technique Continuous Evaluation Non-presential Duration: 06:00 Moodle Questionnaire ET: Online Test Technique Continuous Evaluation Non-presential Duration: 00:30
13	**Theoretical lesson**	**Practical lesson** Duration: 02:00		
14	**Theoretical lesson**	**Practical lesson** Duration: 02:00		
15	**Theoretical lesson**	**Practical lesson** Duration: 02:00		Practice submission TG: Group Work Technique Continuous Evaluation Non-presential Duration: 06:00 Moodle Quiz ET: Telematic Test Technique Continuous Evaluation Non-presential Duration: 00:30
16				
17				Partial Exam EX: Written Exam Technique Continuous Evaluation Face to face Duration: 01:15 Practice Validation Test EP: Practical Exam Technique Continuous Evaluation Face to face Duration: 00:45 Theoretical Exam EX: Written Exam Technique Evaluation only on the final exam v Duration: 01:30 Practice Validation Exam EP: Practical Exam Technique Evaluation only on the final exam Face to face Duration: 01:30

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment for progressive attendance

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
3	Submission of practical project	Workteam	Non-presential	10:00	10%	/10	CT12 CB2
3	Moodle test	Online test	Non-presential	00:30	2%	/10	CB2
6	Submission of practical project	Written exam	Face to face	02:00	10%	4/10	CE4 CT2 CE2
6	Moodle test	Online test	Non-presential	00:30	2%	/10	CB2
8	Exam	Written exam	Face to face	01:15	15%	/ 10	CT2 CB2 CT4
8	Practical test	Practical test	Face to face	00:45	5%	/ 10	CT12 CT2 CB2 CT4
9	Submission of practical project	Workteam	Non-presential	06:00	10%	/ 10	CT12 CB2
9	Moodle test	Online test	Non-presential	00:30	2%	/10	CB2
12	Submission of practical project	Workteam	Non-presential	06:00	10%	/ 10	CT12 CB2
12	Moodle test	Online test	Non-presential	00:30	2%	/10	CB2
15	Submission of practical project	Workteam	Non-presential	06:00	10%	/ 10	CT12 CB2
15	Moodle test	Online test	Non-presential	01:15	2%	/10	CT2 CB2 CT4
17	Exam	Written exam	Face to face	01:15	15%	/ 10	CT2 CB2 CT4
17	Practical exam	Practical exam	Face to face	00:45	5%	/ 10	CT12 CT2 CB2 CT4

7.1.2. Global examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
"Final theoretical exam"	Written exam	Face to face	01:30	40%	/ 10	CT2 CB2 CT4
Practical Exam	Practical exam	Face to face	01:30	60%	/ 10	CB2 CT4 CT12 CT2

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
"Final theoretical exam"	Written exam	Face to face	01:30	40%	/ 10	CT2 CB2 CT4
Practical Exam	Practical exam	Face to face	01:30	60%	/ 10	CB2 CT4 CT12 CT2

7.2. Assessment criteria

1. ASSESSMENT CRITERIA

The progressive evaluation consists of theoretical exams (40% of the weight) and practical exams (60% of the weight). The theoretical exams consist of five online quizzes on the Moodle platform, which account for 10% of the overall grade, and two written partial exams, each carrying a 15% weight. The first partial exam and the online quizzes can be retaken on the date of the second partial exam by taking a comprehensive theoretical exam, which would contribute 40% to the final grade. The Moodle quizzes assess the following learning outcomes: Quiz 1 - LO RA305; Quiz 2 - LO RA308; Quiz 3 - LO RA306 and RA307; Quiz 4 - LO RA433; Quiz 5 - LO RA434. The first partial exam assesses the learning outcomes RA305, RA306, RA307, and RA308. The second partial exam assesses the learning outcomes RA433, RA434, and RA436.

The practical exams consist of the submission of five laboratory assignments (which can be done in pairs), each carrying a weight of 10%, and two individual practice validation exams, each carrying a weight of 5%. The submissions and the first practice validation exam can be retaken on the date of the second practice validation exam by taking a comprehensive practical exam, which contributes 60% to the final grade. All practical exams assess the learning outcome RA36. Additionally, Practice 1 assesses RA305 and RA308, Practice 2 assesses RA306 and RA307, the first practice validation exam assesses RA305-308, Practice 3 assesses RA433, Practice 4 assesses RA434, Practice 5 assesses RA436, and the second practice validation exam assesses RA433, RA434, and RA436.

The extraordinary evaluation consists of a written theoretical exam, which carries a weight of 40% and assesses RA305-308 and RA433, RA434, and RA436, and a practical exam, which carries a weight of 60% and assesses RA36, RA305-308, and RA433, RA434, and RA436.

8. Teaching resources for the subject

Name	Type	Notes
Moodle UPM	Web resource	The whole pack of documentation and examples used in class by the teacher. It is documentation elaborated by the teacher
BRIGHAM, E.O.: The fast Fourier transform and its applications. Prentice-Hall, 1988.	Bibliography	Main book.
CARTWRIGHT, M.: Fourier methods for mathematicians, scientists and engineers. Ellis Horwood, 1990.	Bibliography	Main book
OPPENHEIN, A.V.; SCHAFER, R.W. Tratamiento de señales en tiempo discreto. Prentice-Hall, 2000	Bibliography	Main book
OPPENHEIN, A.V; WILLSKY, A.S.; HAMID, S. Signals and systems. Prentice-Hall, 1996.	Bibliography	Complementary book.
Digital Signal Processing. Markus Kuhn (U. of Cambridge) (2009)	Web resource	Course in: http://www.cl.cam.ac.uk/teaching/0910/DSP/
Laboratory	Equipment	Computers and software available for each student

9. Other information