COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

Syllabus
2025 - 2026

GENERAL INFORMATION

Data of the subject	
Subject name	Digital Signal Processing
Subject code	DEA-GITT-324
Mainprogram	Bachelor's Degree in Engineering in Telecommunication Technologies
Involved programs	Grado en Ingeniería en Tecnologías de Telecomunicación [Third year] Grado en Ingeniería en Tecnologías de Telecom. y Grado en Análisis de Negocios/Business Analytics [Third year]
Level	Reglada Grado Europeo
Quarter	Semestral
Credits	6,0 ECTS
Type	Obligatoria (Grado)
Department	Department of Electronics, Control and Communications
Coordinator	Carlos García de la Cueva
Office hours	Send an e-mail to get an appointment

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DESCRIPTION OF THE SUBJECT

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Contextualization of the subject

Prerequisites

This course presumes a solid understanding of LTI (Linear Time Invariant) systems, continuous-time signals, sampling, and Fourier transforms for deterministic and stochastic processes. The student should feel confident working with complex variables and advanced single-variable derivatives and integrals.

Course contents

Contents

Continuous-time signals and systems

1.1 Fourier Transform. Properties.

1.2 Spectrum of deterministic and stochastic signals.

Sampling and Reconstruction

2.1 Ideal Sampling theorem.

2.2 Quantization.

2.3 Analog to digital conversion: Time-domain analysis.

2.5 Analog to digital conversion: Frequency-domain analysis.

2.6 Digital to analog conversion.

2.7 Sample-rate conversion: Interpolation and Decimation

Finite Impulse Response Filters

3.1 Discrete-Time signals and LTI systems.

3.2 Discrete-time stochastic processes.

3.3 Finite Impulse Response systems definition and properties.

3.5 FIR filter design techniques.

Z-Transform and Infinite Impulse Response Filters

4.1 Z-transform definition. The region of convergence.

4.2 Inverse Z-transform.

4.3 Z-transform properties.

4.4 LTI systems analysis through the Z-transform.

4.5 Infinite Impulse Response Filters.

4.6 Effects of round-off noise in IIR filters.

4.7 IIR filter design techniques.

Discrete-Time spectral analysis

5.1 Spectral analysis fundamentals.

5.2 Spectral analysis of periodic signals.

5.3 The Discrete Fourier Transform.

5.4 Linear Filtering with the DFT.

5.5 The Fast Fourier Transform.

Adaptive Filters

6.1 Introduction

6.2 Optimum filtering

6.3 Iterative solutions

6.4 The LMS algorithm

Applications

This final chapter introduces some signal processing algorithms and techniques applied to state-of-the-art systems.

Laboratory Projects

1.- Project 1: Sampling and Quantization.

2.- Project 2: Sample rate conversion.

3.- Project 3: Design and analysis of FIR filters.

4.- Project 4: Design and analysis of IIR filters.

5.- Project 5: Fixed-point analysis of IIR filters.

6.- Project 6: Filtering with the DFT.

7.- Project 7: Adaptive filters.

8.- Project 8: Advanced digital signal processing architectures.

EVALUATION AND CRITERIA

The use of AI to produce full assignments or substantial parts thereof, without proper citation of the source or tool used, or without explicit permission in the assignment instructions, will be considered plagiarism and therefore subject to the University's General Regulations.

Evaluation activities	Evaluation criteria	Weight
Final Exam	Correctness of the solutions, approach to the problem, and understanding of the theoretical basis. The rest of the items would not be graded if the student gets a mark lower than 4 in this part.	50
Mid-Term Exam	Correctness of the solutions, approach to the problem, understanding of the theoretical basis.	15
Laboratory Projects	Correctness of the methods, analysis, and results of the projects. The rest of the items would not be graded if the student gets a mark lower than 6 in this part.	30
Background Exam	Correctness of the solutions, approach to the problem, and understanding of the theoretical basis.	5

Grading

Ordinary Period

The final grade is obtained from the following items:

- Background exam (5%)
- Mid-Term exam (15%)
- Final Exam (50%): A mark greater than or equal to 4 is required in this part.
- Laboratory projects (30%): A mark greater than or equal to 6 is required in this part.

Extra-ordinary Period

The final grade is obtained from the following items:

- Extraordinary Exam (70%): A mark greater than or equal to 5 is required in this part.
- Laboratory Projects (20%)
- Mid-Term Exam (10%)

Attendance Rules

Class attendance is mandatory, according to the Academic Regulations of the Higher Technical School of Engineering (ICAI). the requirements of attendance will be applied independently for theory and laboratory sessions:

- In the case of theory sessions, failure to comply with this rule may prevent them from taking the exam in the ordinary period.
- In the case of laboratory sessions, failure to comply with this rule may prevent you from taking the exam both in the normal and re-sit period.
- In any case, unjustified absences from laboratory sessions will be penalized in the evaluation.

BIBLIOGRAPHY AND RESOURCES

Basic References

- Slides provided by the course instructors.
- Tratamiento Digital de la Señal: teoría y aplicaciones, A. Albiol, Editorial Universidad Politécnica de Valencia, 2ª edición, 2007; accesible en http://personales.upv.es/aalbiol/librotds/librotds07.pdf

Additional Resources

- *Discrete-Time Signal Processing (2nd Edition). Oppenheim, Schafer, Buck. Prentice-Hall.*