INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Digital Signal Processing			Field of study	Telecommunications and Signal Processing								
Bachelor in	Electrical and Computers Engineering			School	School of Technology and Management								
Academic Year	2023/2024	Year of study	2	Level	1-2	ECTS credits	6.0						
Type	Semestral	Semester	2	Code	9112-742-2204-00-23								
Workload (hours)	162	Contact hours	T 15	TP 15	PL 30	TC -	S -	E -	OT -	O -			

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): João Paulo Ramos Teixeira

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. express himself in the oral and written form about problems of PDS using a language and terminology of Signal Processing;
2. create and represent, under Matlab environment, digital signal in original and transformed domains using the FFT;
3. interpret the spectral representation of signals;
4. interpret and represent the transfer function / frequency response of a system;
5. specify, project and implement digital filters.

Prerequisites

Before the course unit the learner is expected to be able to:
1. the competences of the Signals and Systems (1st semester);
2. implement basic operations over signal;
3. understand the dual representation in time and frequency domains of the signals;
4. work with complex numbers and complex functions;
5. work in Matlab.

Course contents

Discrete-time signals and systems; Fourier transform of discrete-time signals; sampling; The z transform; Discrete Fourier transform; FFT algorithms; Specification, project and implementation of FIR and IIR digital filters; project and implementation of FIR and IIR digital filters under Matlab.

Course contents (extended version)

1. Introduction to Digital Signal Processing
2. Discrete-Time Signals and Systems
   - Discrete-time signals
   - Discrete-time systems
   - Frequency response of a discrete-time system
   - Discrete-time Fourier Transform: properties
   - Differences equation to transfer function
3. Sampling of Continuous-Time Signals
   - Introduction
   - Nyquist sampling theorem
   - Aliasing
   - Reconstruction of a signal from its samples
   - Interpolation
   - Decimation
4. The z-Transform
   - Definition
   - Region of convergence
   - Relation with Fourier transform
   - Z-transform properties
   - Inversion of z-transform
5. The Discrete Fourier Transform - DFT
   - Definition
   - Properties of DFT
   - Relation with z-transform
   - Linear convolution using the DFT
   - Fast Fourier transform algorithms - FFT
   - Inverse discrete Fourier transform
6. Digital Filters
   - Filters characteristics specification
   - FIR digital filters project
   - IIR digital filters project
   - Frequency transformations
   - Digital filter implementation under Matlab

Recommended reading

1. A. V. Oppenheim, R. W. Schafer e J. R. Buck, “Discrete-Time Signal Processing”, 3nd edition, Prentice-Hall, 2010.
2. Paulo Sérgio Diniz, Eduardo Silva e Sérgio Netto, “Processamento Digital de Sinais – Projecto e Análise de Sistemas”, Bookman Editora, 2002.
3. https: //www. mathworks. com/academia/educators/teaching-quick-start-guide. html#
4. James H. McClellan, C. Sidney Burrus, Alan V. Oppenheim, Thomas W. Parks, Schafer/ Schuessler, “Computer-Based Exercises for Signal Processing Using MATLAB 5”, Prentice-Hall, 1998.
5. Texeira, J. P. , Caderno de Exercícios para PDS + Conjunto de transparências para PDS 2024.

Teaching and learning methods

In T/TP classes, the subject will be exposed and example exercises will be carried out on each topic. In laboratorial classes, the exercises on paper and in Matlab proposed will be carried out. In the 4 non-face-to-face hours, students must study and do a set of HNP exercises. Two mini-projects will be carried out that will develop communication and programming skills with signals and systems.

Assessment methods

- Unique - (Regular, Student Worker) (Final, Supplementary, Special)
  - Final Written Exam - 75%
  - Projects - 25% (Two projects in Matlab.)

Language of instruction

1. Portuguese
2. Portuguese, with additional English support for foreign students.

Electronic validation

João Paulo Ramos Teixeira	José Augusto de Almeida Pinheiro Carvalho	José Luís Sousa de Magalhaes Lima	José Carlos Rufino Amaro
21-02-2024	26-02-2024	27-02-2024	02-03-2024