INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Digital Signal Processing			Field of study	Signal Processing		
Bachelor in	Informatics Engineering			School	School of Technology and Management		
Academic Year	2015/2016	Year of study	3	Level	1-3	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9119-606-3204-00-15		

Workload (hours)	162	Contact hours	T -	TP 60	PL -	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 - Tuturial; O - Other

Name(s) of lecturer(s): João Paulo Ramos Teixeira, Rui Vitor Pires Fernandes

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. perform basic operations with signals;
2. create and represent, under Matlab environment, signals in original and transformed domains, using the FFT;
   Program under Matlab.
3. sample a continuous time signal respecting the Nyquist theorem;
4. interpret the spectral representation of signals;
5. interpret and represent the transfer function / frequency response of a system;
6. project and implement digital filters.
7. understand the usefulness of Artificial Neural Networks (ANN) as artificial intelligence tool and the requirements for their use;
8. use ANN in specific applications.

Prerequisites

Before the course unit the learner is expected to be able to:
1. have knowledge about mathematical summation;
2. have knowledge about integral calculus;
3. work with complex numbers and complex functions.

Course contents

Matlab introduction. Artificial Neural Networks. Signals. Signal representation in time and frequency domains. Relation between those representations. Operations with signals. Discrete-time systems; discrete convolution. Fourier transform of discrete-time signals. Sampling. The z transform. Discrete Fourier transform. Project and implementation of FIR and IIR digital filters. Project and implementation of digital filters under Matlab.

Course contents (extended version)

1. Introduction to Matlab
2. Artificial Neural Networks (ANN)
   - Perceptron
   - Feedforward ANN
   - Back-propagation algorithm
   - Early stopping
   - Input/output matrices
   - ANN under Matlab
3. Signals
   - Continuous and discrete-time signals
   - Basic operations with signals
   - Properties of the signals: even signals; odd signals; periodicity
   - Elementary signals: exponential; sinusoidal; step function; impulse function
4. Discrete-time Systems
   - Model of a system
   - Impulsional response
   - Discrete convolution
   - Frequency response of a system
   - Fourier transform of a discrete-time signal
   - Properties of the Fourier transform
   - Differences equation to the transfer function
5. Sampling of continuous-time signals
   - Introduction
   - Nyquist sampling theorem
   - Aliasing
6. The z-Transform
   - Definition
   - Region of convergence
   - Relation with Fourier transform
   - Z-transform properties
   - Inversion of z-transform
7. The Discrete Fourier Transform - DFT
   - Definition
   - Properties of DFT
   - Relation with z-transform
   - Linear convolution using the DFT
8. Digital Filters
   - Filters characteristics specification
   - FIR digital filters project
   - IIR digital filters project
   - Digital filter implementation in Matlab

Recommended reading

1. A. V. Oppenheim, R. W. Schafer e J. R. Buck, “Discrete-Time Signal Processing”, 2nd edition, Prentice-Hall, 1999.
2. Oktay Alkin, "Signals and Systems: A MATLAB Integrated Approach", CRC Press, 2014.
3. Simon Haykin, Redes Neurais, Princípios e prática, 2ª edição, Bookman, 2003.
4. Howard Demuth and Mark Beale, Neural Network Toolbox, for use with Matlab, User's Guide - version 4, The MathWorks.
5. J. P. Teixeira, Sebenta e Caderno de Exercícios para PDS-LEI, edição de 2016.

Teaching and learning methods

The non-presence 4 weekly hours must be used for study, for realization of a set of exercises that will be valued in the final classification. Throughout the semester each student will develop two mini-projects on issues of the discipline. One will be presented to colleagues and teacher. In these mini-projects will be also developed communication and programming skills.

Assessment methods

1. A - (Regular, Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 63% (Minimum classification of 35%.)
   - Projects - 25% (2 short projects.)
   - Practical Work - 12% (Home work.)
2. B - (Regular) (Supplementary, Special)
   - Final Written Exam - 75% (Minimum classification of 35%.)
   - Projects - 25% (2 short projects.)
3. B - (Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 75% (Minimum classification of 35%.)
   - Projects - 25% (2 short projects.)

Language of instruction

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

Electronic validation

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12-02-2016	12-02-2016	12-02-2016	11-03-2016