Instituto Politécnico de Bragança

Course Unit	Signals and Systems	Field of study	Telecommunications and Signal Processing
Bachelor in	Electrical and Computers Engineering	School	School of Technology and Management
Academic Year	2025/2026	Year of study	2	Level	1-2	ECTS credits	6.0
Type	Semestral	Semester	1	Code	9112-852-2105-00-25

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 - 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. differentiate between continuous and discrete signal and systems;
2. identify the properties of signal and of systems;
3. implement basic operations over signal;
4. understand the dual representation in time and frequency domains of the signals;
5. determine and understand the Fourier and Laplace transforms;
6. work in Matlab with signals and systems.

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

Signals. Operations with signals. Characterisation of systems. LTI Systems. Signal processing mathematical tools under Matlab environment. Concepts of continuous signal processing, namely about Fourier Series, Fourier transform and Laplace transform. Signal representation in time and frequency domains. Relation between those representations.

Course contents (extended version)

1. Introduction to Matlab
   - Variables
   - Operations
   - Functions
   - Scripts
   - Read and write files
   - Some functions of the SP toolbox
2. Characterization of Signals
   - Introduction
   - Definition of continuous-time signals and of discrete-time signals
   - Properties of the signals: even signals; odd signals; periodicity
   - Elementary signals: exponential; sinusoidal; complex exponential; step function; impulse function
   - Basic operations with signals
   - Determination of the average and root mean square value
3. Systems
   - Introduction
   - Model of a system
   - Properties of systems
4. Analysis of Linear Time Invariant Systems (LTI)
   - Introduction
   - Discrete LTI systems: impulse response; convolution.
   - Continuous LTI systems: impulse response; convolution.
   - Properties of convolution: commutative; distributive; associative.
5. The Fourier Series
   - Introduction
   - Approximation of periodic functions
   - Representations of Fourier series: exponential; combined trigonometric; trigonometric.
   - Fourier's coefficients
   - Spectral representation: magnitude spectra; phase spectra
   - Properties of Fourier series
   - Dirichlet conditions
6. Continuous Time Fourier Transform
   - Introduction
   - Definition of Fourier transform
   - Definition of inverse Fourier transform
   - Properties of Fourier transform
   - Basic Fourier transform pairs: constant signal; step function; sinusoidal; exponential
7. Laplace Transform
   - Introduction
   - Definition of Laplace transform
   - Region of convergence
   - Inversion of the Laplace transform
   - Properties of Laplace transform
   - Initial and final value theorem
   - Basic Laplace transforms

Recommended reading

1. Sinais e Sistemas, Simon Haykin, Barry Van Veen, Bookman, Porto Alegre 2001.
2. Signals and Systems, Simon Haykin, Barry Van Veen, John Wiley & Sons, 1999.

Recommended reading

3. Sinais e Sistemas, Alan V. Oppenheim e Alan S. Willsky, 2ª edição, 2010. Pearson Education.
4. Sinais e Sistemas, 570 problemas totalmente resolvidos. Hwei Hsu, 2011, Bookman.
5. Caderno de Exercícios para Sinais e Sistemas + Conjunto de transparências para Sinais e Sistemas, 2026, J. P. Teixeira

Teaching and learning methods

Sessions for presentation of the basic mathematical concepts on signals and on systems, accompanied by practical exercises in “paper and pencil” and in Matlab. The non-presence 4 weekly hours must be used for study, for realization of a set of exercises and for the development of works in Matlab.

Assessment methods

- Unique - (Regular, Student Worker) (Final, Supplementary, Special)
  - Final Written Exam - 75%
  - Projects - 25% (2 short projects.)

Language of instruction

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

Electronic validation

João Paulo Ramos Teixeira	Orlando Manuel de Castro Ferreira Soares	José Luís Sousa de Magalhaes Lima	José Carlos Rufino Amaro
10-10-2025	14-10-2025	15-10-2025	01-11-2025