UNICUSANO ROME

Code: ING-INF/03 **Credits: 9**
Matter: Fundamentals of Signal Processing
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
Prof. Fabio Mangini

Introduction

1. *Objective of the course :*
   The course is aimed at providing the student with the main analytical tools related to the analysis of deterministic as well as stochastic signals. This analysis is carried out in both time and frequency domains and focuses on discrete-time signals (sequences) and waveforms. Finally, a brief overview of sampling theory is encompassed.

Objectives

2. *Course Structure:*
   a. *General features of a signal;*
   b. *Introduction to the most common continuous and discrete time signals;*
   c. *The linear systems and their properties; the impulse response;*
   d. *Fourier series and its properties; Fourier transform and its properties;*
   e. *Sampling Theory;*
   f. *Introduction to probability theory and random processes.*

Competencies:

1. Knowledge and understanding.
   The students will acquire analytical capabilities concerning the signal processing. In particular, they will be able to master the fundamental techniques to handle random as well as deterministic signals in the time and frequency domains.
2. Applying knowledge and understanding.

Through the comprehension of the most common signal processing techniques, the course intends to develop the ability to identify and assess the solutions to widespread problems in the field of electronic engineering.

3. Making judgements.
   The student will be able to fully understand and motivate the observed processing in order to select the right actions leading to the expected objectives.
4. Communication skills.
   The student will acquire the technical-scientific language required to interact with other experts in the field of signal processing.
5. Learning skills.
   The course will provide knowledge and methodological tools which might be exploited in subsequent education and professional paths concerning signal processing and, more generally electronic, engineering.

Syllabus

3. *Programme of the course:*

Subject 1. Introduction

Signal definition; deterministic signal; energy of a signal; time average; elementary operations on signals.

Subject 2. Deterministic signals in the time domain

Elementary signals; signal vector space; correlation coefficient; correlation functions.

Subject 3. Frequency domain analysis

Periodic signals; Fourier series; Dirichlet Criterion; Gibbs phenomenon; discrete-time Fourier series; Fourier transform; discrete-time Fourier transform; linear time-invariant systems; Paley-Wiener criterion; power spectral densities; Wiener-Khintchine Theorem.

Subject 4. Sampling theory

Sampling of real signals; analog-to-digital conversion; quantization; sampling frequency variations; bandpass sampling.

Subject 5. Probability Theory

Random experiment; definition of event; probability axioms; conditional probability; random variables; cumulative distribution function; probability distribution function;

statistical expectation and high-order moments; joint statistical characterization of several random variables; statistical independence; introduction to estimation theory.

Subject 6. Random Processes
Random processes; statistical and synthetic characterization of random signals; stationary random processes; Gaussian random processes; ergodicity; joint statistical characterization; power spectral densities and their transformations through linear time-invariant systems.

Evaluation system and criteria

The examination consists in solving three problems with a maximum score of 10 for each of them. The maximum final score is 30.

Bibliography and resources

4. *Materials to consult:*
    a. *M. Luise e G. M. Vitetta, Teoria dei Segnali, McGraw-Hill, II ed., 2002.*
    b. *Notes by the instructor*
    c. *A. Papoulis, S. U. Pillai, Probability, Random Variables, and Stochastic Processes, McGraw-Hill, 2002.*

5. *Recommended bibliography:*
    a. *E. Conte, Lezioni di Teoria dei Segnali, Liguori Editore, 1996.*
    b. *E. Conte e C. Galdi, Fenomeni Aleatori, Aracne Editore, 2006.*