Signals theory B

Finalità
The aim of this course is to introduce the students to Analog Signals and to the transformations that they undergo when processed by (Analog) Linear Systems. Signals and Systems constitute the basic building blocks for the analysis and design of telecommunication systems and, more generally, of electronic systems for information processing. To this aim, most of the course is dedicated to studying the methods for representing signals and systems “in the frequency domain”, which is an engineering tool of primary importance.

Programma
SIGNALS AND SYSTEMS IN THE TIME DOMAIN
Classification of signals. Periodic and symmetric signals. Some remarkable signals. Duration, area, mean value, energy and power of a signal. Elementary transformations on signals. The Dirac delta pulse.
Classification of systems. Linear and stationary systems. The impulse response. Properties of convolution: cascaded and parallel systems. Graphical method for convolution. System properties expressed through the impulse response. Identification in frequency: the transfer function.
SIGNALS AND SYSTEMS IN THE FREQUENCY DOMAIN
The Fourier series. The Fourier transform. Mathematical issues regarding the Fourier transform. Filtering of impulsive signals. Amplitude, phase and energy spectra: the Rayleigh theorem. Symmetries in the Fourier transform. Basic properties of the Fourier transform: linearity, change of scale, time shift. Frequency shift property (complex modulation). Review of amplitude modulation (AM). Differentiation and integration properties. Systems defined by integral-differential equations. Review of frequency modulation (FM). Differentiation in the frequency domain. Other properties: convolution and product. Analysis of block diagrams in the frequency domain. Final properties: conjugation and correlation. Wiener-Kintchine theorem for deterministic signals.
Transform of a Dirac pulse and of a constant. Non distorting channel, linear distortions and equalization. Transform of a phasor and a sinusoid. Transform of the unit step. The Dirac impulse train. Spectrum of periodic signals. Filtering of periodic signals. Power spectral density of periodic signals: the Parseval theorem. The sampling theorem. Non ideal sampling.
RANDOM SIGNALS
Examples of stochastic processes. Statistics of a process. Markov and Gaussian processes. Expectations of a process: statistical mean and power, autocorrelation, autocovariance. Stationarity. Properties of the autocorrelation for WSS processes. Ergodicity. Ergodicity with respect to the mean value and to the autocorrelation. Filtering of random signals: the power spectral density. White noise. Amplitude modulation and sampling of a random signal.

Propedeuticità
Teoria dei segnali A

Testi consigliati
A. Vannucci, "Segnali Analogici e Sistemi Lineari: un corso di Teoria dei Segnali per le lauree triennali in ingegneria", Pitagora Editrice, Bologna, 2003.