Università degli Studi di L'Aquila - Dipartimento di Ingegneria e Scienze dell'Informazione e Matematica

Course catalogue

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Programme of Course "Analisi Ed Elaborazione Dei Segnali"

- Code: I0646
- Type of course unit: Compulsory (Laurea in Ingegneria dell'Informazione curriculum Automatica), Compulsory (Laurea in Ingegneria dell'Informazione curriculum Telecomunicazioni), Compulsory (Laurea in Ingegneria dell'Informazione curriculum Elettronica), Compulsory (Laurea in Ingegneria dell'Informazione curriculum Comune), Compulsory (Laurea in Ingegneria dell'Informazione curriculum Informatica)
- Level of course unit: Undergraduate Degrees
- Semester: 2

Number of ects credits: (Laurea in Ingegneria dell'Informazione) 9 (workload 225 hours)

Teachers: Fortunato Santucci

1	**Course objectives**	The goal of this module is to provide the fundamental set of concepts and techniques that relate to the analysis of signals in the broad area of information engineering. On successful completion of this module, the student should understand i) the fundamental concepts of representation of signals in both the time and the frequency domain and their relation, ii) how signals get processed by both linear and non-linear systems, iii) the characterization of random signals in both time and frequency domain. The student is finally introduced to digital representation and processing of signals, and becomes confident with practical operations through specific computer-assisted tools. The module is tightly connected with the modules in System Theory, Electronics, Object programming, that are thaugth in the same semester, and to the module of Communication Systems that is thaught in the 3rd year.
2	**Course content and learning outcomes (dublin descriptors)**	Topics of the module include: • Definition and classification of signals: continuous and analogic signals, discrete time signals, digital signals, energy and power of signals, the space of signals. • Representation of signals in the frequency domain: The Fourier series and the Series Fourier Transform for periodic signals; the Fourier integral and the Continuous Fourier Transform; convergence, computation and transformations from time to frequency and vice-versa; properties of Fourier transforms, Parseval's equality, and their applications to relevant examples; main parameters in time and frequency domains. • Systems in time and frequency domains: mail properties of systems; LTI systems, impulse response and frequency response, filters and their applications; characterization of non-linear systems and examples related to amplifiers, clippers and clampers. • Correlation and detection: auto- and cross-correlation of signals, energy and power spectra and the Wiener Theorem; applications to the matched filter and communication chains. • Random signals: remind of probability theory and its application to information and communication theory: the binary channel and relevant models for random variates (uniform, Poisson, Gaussian, one-sided exponential, geometrical); definition and characterization of stochastic processes, auto- and cross-correlation, Wide Sense Stationary (WSS) processes and their power spectral density, filtering of WSS processes; the thermal (white) noise and narrowband noise. • Sampling of signals and discrete-time processing: from continuous signals to discrete time signals and vice-versa, the Nyquist frequency and the Sampling Theorem; sampling and interpolation under realistic constraints, aliasing and anti-aliasing filtering, sample-and-hold devices; A/D conversion and quantization noise; discrete-time signals and sequences, Discrete Fourier Series and Transforms and related properties, Fast Fourier Trasform (FFT); linear and circular convolution, applications of FFT in circular convolution, spectral analysis, sampling frequency conversion (up-sampling and decimation); applications of digital signal processing in the audio domain. On successful completion of this module, the student should : • To have solid knowledge of basic theory and techniques for signal analysis in time

		and frequency, along with their transformations. • To understand the fundamental concepts and applications of Fourier Transforms and their properties, linear and non-linear systems in time and frequency, A/D conversions and signal processing in the digital domain, representation of random signals; • To understand and carry out the complete (analytical) path from description of a relevant engineering system, development of a theoretical framework and application of related techniques to provide quantitative description of the problem and to support a first attempt to solve a design problem. • To demonstrate skill in abstract and mathematical reasoning, ability to derive a framework, and solve a problem also through the use of HW/SW tools. • Demonstrate capacity for reading and understand other texts on related topics, exploiting the set of knowledge and abilities to solve problems in a larger variety of contexts.
3	**Course prerequisites**	The student must know the notions of mathematical analysis, algebra and probability contained in the programs of Mathematical Analysis I and II, Geometry and Theory of Probability
4	**Teaching methodsand language**	Lectures, exercises and practical sessions. Language: Italian **Language**: Italian **Reference textbooks** • A. Papoulis, ***Probability, Random Variables and Stochastic Processes***. McGraw-Hill. • A. W. Oppenheim, A. S. Willsky (with S. H. Nawab), ***Signals and Systems***. Prentice Hall. • M. Luise, G. M. Vitetta, ***Teoria dei Segnali***. McGraw-Hill.
5	**Assessment methods**	Written and oral exam. Preparation of a small project work is required for the section on digital signal processing.