II Year I Semester	**L**	**T**	**P**	**C**
Code: 17EC304	**3**	**1**	**0**	**3**

SIGNALS AND SYSTEMS

Course Objectives:

The main objectives of this course are given below

1. To introduce the terminology of signals and systems.
2. To introduce Fourier tools through the analogy between vectors and signals.
3. To introduce the concept of sampling and reconstruction of signals.
4. To analyze the linear systems in time and frequency domains.
5. To study Laplace transform to analyze continuous time signals.
6. To study z-transform as mathematical tool to analyze discrete-time signals and systems.

UNIT-I: Introduction

Definition of signals and systems, classification of signals, classification of systems, operation on signals: time shifting, time scaling, amplitude shifting, amplitude scaling, problems on classification and characteristics of signals and systems, complex exponential and sinusoidal signals, singularity functions, step function and ramp function. Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, Closed or complete set of orthogonal functions, orthogonality in complex functions.

UNIT-II: Fourier series representation of periodic signals and Fourier Transforms

Fourier series representation of continuous time periodic signals, Dirichlet's conditions, properties of Fourier series. Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum. Deriving Fourier transform from Fourier series. Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and signum function. Introduction of Hilbert transform.

UNIT-III: Sampling Theorem

Graphical and analytical proof of Band limited signals, impulse sampling, Natural and Flattop sampling, Reconstruction of signals from its samples, effect of under sampling-Aliasing, Introduction to band pass sampling.

UNIT-IV: Analysis of Linear Systems

Linear system, impulse response, Response of a linear system, Linear time invariant (LTI) system, Linear time variant (LTV) system, concept of convolution in time domain and frequency domain, Graphical representation of convolution, Transfer functions of a LTI system. Filter characteristics of linear systems. Distortion less transmission through a system, signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics, Causality and Paley-Wiener criterion for physical realization, relationship between bandwidth and rise time. Cross correlation and auto correlation of functions, properties of correlation functions, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between auto correlation function and energy/power spectral density function. Relation between convolution and

correlation, Detection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.

UNIT-V: Laplace transforms .

Review of Laplace transforms, Partial fraction expansion, Inverse Laplace transform, Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L. T's, Relation between L.T's, and F.T. of a signal. Laplace transform of certain signals using waveform synthesis.

UNIT-VI: Z transforms

Fundamental difference between continuous-time and discrete-time signals, discrete time signal representation using complex exponential and sinusoidal components, Periodicity of discrete time signals using complex exponential signals. Concept of Z transform of a discrete sequence, Distinction between Laplace, Fourier and Z transform, Region of convergence in Z transform, constraints on ROC for various classes of signals, Inverse Z-Transform, properties of Z-transform.

Text books:

1. Signals, Systems & Communications- B. P. Lathi, BS Publication, 2003
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn.
3. Signals and Systems- Narayan Iyer and K Satya Prasad, Cenage Pub.

Reference Books:

1. Signals & Systems- Simon Haykin and Van Veen, Wiley, 2nd Edition.
2. Principles of Linear Systems and Signals – BP Lathi, Oxford University press, 2015.
3. Signals and Systems- K. Raja Rajeswari, B. Visweswara Rao, PHI, 2009.
4. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, 2008.
5. Signals and Systems- T K Rawat, Oxford University press, 2011.

Course outcomes:

At the end of this course the student will able to:

1. Characterize the signals and systems and principles of vector spaces, concepts of orthogonality.
2. Analyze the continuous-time signals and continuous-time systems using Fourier series and Fourier transform.
3. Apply sampling theorem to convert continuous-time signals to discrete-time signals and reconstruct back.
4. Understand the relationship among the various representations of LTI systems.
5. Derive constrains on ROC for various classes of signals using Laplace transform.
6. Apply z-transform to analyze discrete-time signals and systems.