SIGNALS & SYSTEMS

Course Code:22EC1105

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Course Outcomes: At the end of the course the student will be able to

CO1: Understand the terminology of signals and systems.(L2)

CO2: Demonstrate Fourier tools through the analogy between vectors and signals.(L3)

CO3: Apply the concept of sampling and reconstruction of signals.(L3)

CO4: Illustrate linear systems in time and frequency domains.(L3)

CO5: Outline Z-transform as a mathematical tool to analyze discrete-time signals and systems.(L4)

UNIT-I **10 Lectures**

Introduction

Definition of Signals and Systems, Classification of Signals, Classification of Systems, Basic operations on signals, Problems on classification and characteristics of Signals and Systems, Complex exponential and sinusoidal signals, Singularity functions and related functions: impulse function, step function, Signum 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.

Learning outcomes: At the end of this unit, the student will be able to

1. understand different types of signals and systems (L2)
2. describe continuous time signal and discrete time signal (L2)
3. explain the principles of vector spaces and concept of Orthogonality (L2)

UNIT-II **10 Lectures**

Fourier Series and Fourier Transform

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

Learning outcomes: At the end of this unit, the student will be able to

1. apply system properties based on impulse response and Fourier analysis (L3)
2. discuss the spectral characteristics of signals (L2)
3. understand the role of Hilbert transform (L2)

UNIT-III **8 Lectures**

Sampling Theorem

Introduction to Sampling Theorem, Graphical and analytical proof for Band Limited Signals, Effects of under-sampling – Aliasing, Nyquist criterion, Sampling techniques, sampling with zero order Hold, Reconstruction of signal from its samples, Introduction to Band Pass sampling.

Learning outcomes: At the end of this unit, the student will be able to

1. understand the fundamentals of sampling techniques and its applications (L2)
2. understand the reconstruction of signal (L2)
3. apply sampling theorem to convert continuous-time signals to discrete-time signal and reconstruction (L3)

UNIT-IV **12 Lectures**

Analysis of Linear Systems

Impulse response, Response of a linear system, Convolution: time domain, frequency domain and Graphical representation, Transfer function of a LTI system, Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics, Causality and Poly-Wiener criterion for physical realization, Relationship between bandwidth and rise time, Cross-correlation and auto-correlation of functions, properties of correlation function, Energy density spectrum, Power density spectrum, Relation between auto-correlation function and energy/power spectral density function, Relation between convolution and correlation.

Learning outcomes: At the end of this unit, the student will be able to

1. differentiate the systems in time and frequency domain (L2)
2. explain the relation between auto-correlation and Power density spectrum (L2)
3. demonstrate systems based on their properties and determine the response of LTI system using convolution (L3)

UNIT-V **10 Lectures**

Z-Transforms

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

Learning outcomes: At the end of this unit, the student will be able to

1. apply transform techniques to analyze discrete-time signals and systems (L3)
2. determine the response of linear systems to known inputs by using Z- transforms (L3)
3. analyze relationships among the various representations of LTI systems (L4)

Text Books:

1. B.P. Lathi, *Signals, Systems & Communications*, BS Publications, 2003.
2. A.V. Oppenheim, A.S. Willsky and S.H. Nawab, *Signals and Systems*, 2nd Edition, PHI, 2009.

References:

1. Simon Haykin and Van Veen, *Signals & Systems*, 2nd Edition, Wiley, 2007.
2. John G. Proakis, Dimitris G. Manolakis, *Digital Signal Processing, Principles, Algorithms, and Applications*, 4th Edition, PHI, 2007.
3. BP Lathi, *Principles of Linear Systems and Signals*, Oxford University Press, 2015.