EE-232 Signals & Systems - Course Contents

a. **Credit Hours:** 3+1

b. **Catalogue Description:**

Elementary Signals i.e. Unit Impulse, Unit Step, Exponential, Sinusoidal, Decaying/Rising Sinusoidal, their periodicity and difference in their properties in Continuous and Discrete time domain. LTI Systems, Important properties of LTI Systems. Representation of LTI System in terms of Impulse Response. Convolution Sum and Convolution Integral. LTI Systems described by Difference Equation in case of Discrete Time and by Differential Equation in case of Continuous time LTI Systems. Block Diagram representation of LTI Systems. Fourier Series for Discrete & Continuous time Signals, Magnitude & Phase Spectrum. Response of Discrete and Continuous LTI systems to periodic inputs. Continuous time Fourier Transform of periodic and non periodic Signals, Properties of CTFT, Characterization of Systems by linear constant coefficient difference equations. Sampling, Aliasing, Decimation & Interpolation, Signal Reconstruction from its samples. Laplace Transform, ROC, Inverse Laplace Transform, Properties of Laplace Transform, System Function.

c. **Text Book**: **Signals & Systems**, 2nd Edition by Allan V. Oppenheim, Alan S. Willsky & S. Hamid Nawab Prentice Hall Latest Issue.

d. **Reference Book**: **System and Signal Analysis,** 2nd Edition by C.T.Chen Oxford University Press 1994.

e. **Course Objectives**:

1. To introduce the fundamentals of Signals and Linear Systems.
2. To develop the skills to analyze different types of Systems and their responses.
3. To develop the concept of difference/differential equations, and how these equations help in physically realizing the systems.
4. To develop the ability to analyze Signals and Systems in different domains i.e. Fourier and Laplace.
5. To develop the skill to understand the problems and solutions related to Signals and Linear Systems.

6. To introduce the concepts related to frequency domain when a continuous signal is converted into a discrete signal.

f. **Course Outcomes:**

After completion of this course students should be able to:

1. Understand the fundamental signals, which are encountered in engineering fields.
2. Understand linear systems and their properties, and how these properties play important role in their response to any signal.
3. Understand concept of convolution and its effect in frequency domain.
4. Distinguish between FIR and IIR Systems.
5. Physically realize linear systems using difference/differential equations.
6. Understand the application of Fourier transform in signal analysis, where spectrum is of interest.
7. Understand the application of Laplace transform in system analysis, where stability is main issue.
8. Understand the basic concepts ADC and DAC

a. **Topics:**

1. Continuous-Time and Discrete-Time Signals, Transformations of Independent Variable
   Exponential and Sinusoidal Signals, Unit Impulse and Unit Step Functions

2. Continuous and Discrete time Systems. Basic System Properties: Memory/Memory less Systems, Causality, Stability, Time Invariance, Invertibility and Linearity

3. Discrete-time LTI systems – Convolution Sum

4. Continuous-time LTI systems – Convolution Integral
5. Properties of LTI Systems

6. Causal systems described by differential and difference equations

7. Response of LTI Systems to Complex Exponentials
8. Fourier Series Representation of Continuous-time periodic signals, Convergence of Fourier Series
9. Properties of Continuous-time Fourier Series

10. Fourier Series Representation of Discrete-time periodic signals
11. Properties of Discrete-time Fourier Series
12. Fourier Series and LTI Systems
13. Systems described by differential and difference equations

14. Representation of aperiodic signals – Continuous time Fourier transform, Continuous-time Fourier transform for periodic signals

15. Properties of Continuous-time Fourier transform
16. Systems characterized by linear constant coefficient differential equations
17. Representation of aperiodic signals – discrete time Fourier transform
18. Discrete-time Fourier transform for periodic signals

19. Properties of Discrete-time Fourier transform
20. Systems characterized by linear constant coefficient difference equations

21. Introduction to Laplace transform, Region of Convergence for Laplace transform, Pole-zero plots.
22. Inverse Laplace transform, Properties of Laplace transform.

23. Analysis and Characterization of LTI systems using Laplace transform.
24. System function , Unilateral Laplace transform

25. Magnitude-phase representation of Fourier transform
26. Time-frequency analysis of systems

27. Introduction to sampling, Sampling theorem Signal reconstruction, Aliasing