INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

SIGNALS AND STOCHASTIC PROCESS								
III Semester: ECE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AECD02	**Core**	3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Electrical Circuits								

I. COURSE OVERVIEW:
This course introduces students to learn the fundamental concepts and techniques used in the analysis and processing of signals. The second part focus on the basic concepts of random processes, random signals, and theirinteraction with the electrical or electronic systems. The course forms the basis for the next level courses of an electronics engineer such as communications, digital signal processing, radar systems, machine learning and datascience.

II. COURSES OBJECTIVES:
The students will try to learn:

I. The Fourier transform, Laplace and their properties to analyze the signals and system
II. The temporal and spectral characteristics of Random process and the extraction of Signal from noise byfiltering
III. The characteristics of 1-dimensional stationary random signals in time and frequency domains.
IV. Analysis of the response of a linear time invariant (LTI) system driven by 1- dimensional stationary randomsignals useful for subsequent design and analysis of communication systems

III. COURSE OUTCOMES:
At the end of the course students should be able to:

CO 1 Utilize the concept of convolution and correlation to determine the response of an LTI system for different signals.
CO 2 Make use of Fourier series and Fourier transforms for calculating spectral characteristics of periodic and aperiodic signals.
CO 3 Apply the Laplace transform for analyzing the frequency domain representation of continuous time signals and systems respectively
CO 4 Extend the random variable concept to random process and its sample functions for demonstrating the time domain and frequency domain characteristics.
CO 5 Develop the auto-power and cross- power spectral densities to solve the related problems of random processes using correlation functions and the Fourier transform.
CO 6 Analyze the response of a linear time invariant (LTI) system driven by stationary random processes using the time domain and frequency domain description of random processes.

IV. COURSE CONTENT:
MODULE - I: SIGNAL ANALYSIS (09)
Signal Analysis: 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, Classification of Signals , Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signum function ,Operations on signals.

Signal Transmission through Linear Systems: Linear System, Impulse response, Response of a Linear System, Linear Time Invariant (LTI) System, Linear Time Variant (LTV) System, Causality, Transfer function of a LTI system, Filter characteristic of Linear System, Distortion less transmission through a system, Signal bandwidth, System Bandwidth, Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution.

MODULE –II: FOURIER SERIES, TRANSFORMS (10)

Fourier series: Representation of Fourier series, Continuous time periodic signals, Properties of Fourier Series,Dirichlet's conditions, Trigonometric Fourier Series and Exponential Fourier Series, Complex Fourier spectrum.

Fourier Transforms: Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function.

MODULE –III: LAPLACE TRANSFORMS AND RANDOM VARIABLES (10)

Laplace Transforms: Review of Laplace Transforms (L.T), 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, Relation between L.T and F.T of a signal, Laplace Transform of certain signals using waveform synthesis.

Random variables and operations on random variables: Random Variables: Definition, Types of Random Variable, Distribution and Density functions: Definition and Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, random variables, Methods of defining Conditioning Event, Conditional Distribution, Conditional Density and their Properties, Expected Value of a Random Variable, Function of a Random Variable, Standard and Central Moments.

MODULE –IV: RANDOM PROCESSES – TEMPORAL CHARACTERISTICS (09)

Random Process: Definition and Classification, Distribution and Density Functions, Stationarity and Statistical Independence., First- Order, Second- Order, Wide-Sense Stationarities (N-Order) and Strict-Sense Stationarity, Time Averages and Ergodicity, Mean-Ergodic and Correlation-Ergodic Processes, Autocorrelation Function and Its Properties, Cross-Correlation Function and Its Properties, Covariance Functions, Gaussian and Poisson Random Processes. Response of Linear Systems to Random Process input, Mean and MS value of System Response, Autocorrelation Function of Response, Cross- Correlation between Input and Output.

MODULE –V: Random Processes – Spectral Characteristics (10)

The Power Spectrum: Properties, Relationship between Power Spectrum and Autocorrelation Function, The Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function. Spectral Characteristics of System Response: Power Density Spectrum of Response, Cross-Power Density Spectrums of Input and Output, Noise Bandwidth.

V. TEXT BOOKS:

1. Signals, Systems & Communications - B.P. Lathi , 2013, BSP. Fundamentals of SemiconductorFabrication, Gary S May ad Simon M Sze, Wiley, 1st edition, 2003.
2. A.V. Oppenheim, A.S. Willsky and S.H. Nawabi, "Signals and Systems", 2nd edition 2010.

VI. REFERENCE BOOKS:

1. Electronic Devices and Circuit Theory, Robert L Boylestad and Louis Nashelsky, Pearson, 11th edition, 2018.
2. VLSI Technology, S M Sze, 2nd edition, 2003.
3. Microelectronic Circuit Design, Richard C Jaeger and Travis N Blalock, McGraw Hill, 5th edition, 2016.
4. Solid State Electronic Devices, Ben Streetman, Pearson, 7th edition, 2015.

VII. ELECTRONICS RESOURCES:

1. NPTEL :: Electrical , Electronics and Communication: Signals and Systems
2. NPTEL :: Electronics and Communication: Probability Theory and Stochastic Process
3. NPTEL :: Electrical , Electronics and Communication: Electrical circuits.

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Definition and terminology
4. Tech-talk topics
5. Assignments
6. Model question paper - I

7. Model question paper - II
8. Lecture notes
9. Early learning readiness videos (ELRV)
10. Power point presentations