II B.Tech – I Semester
(17EC303) RANDOM VARIABLES & STOCHASTIC PROCESSES

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	1	-	3

Pre-Requisites: Mathematics

Course Objectives:

- To give students an introduction to elementary probability theory and to mathematically model the random phenomena with the help of probability theory concepts.
- To discuss the concepts of discrete and continuous random variables and to calculate the parameters such as mean and variance.
- To classify various types of probability distributions that occurs frequently in communication and signal processing.
- To apply vector space concepts in random signal processing.
- To illustrate the concept of random process in WSS and SSS with the importance of Ergodicity and its real time applications.
- To estimate the power spectral density for a given random signal.
- To analyze the LTI systems with stationary random process as input.
- To introduce the types of noise and modelling noise sources.

UNIT- I: THE RANDOM VARIABLE:
Introduction, Review of Probability Theory, Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete, Continuous and Mixed Random Variables, Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Conditional Distribution,Conditional Density, Properties.

UNIT-II: OPERATION ON ONE RANDOM VARIABLE–EXPECTATIONS :
Introduction, Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Chebychev's Inequality, Characteristic Function, Moment Generating Function, Transformations of a Random Variable: Monotonic Transformations for a Continuous Random Variable, Non-monotonic Transformations of Continuous Random Variable. Transformation of a discrete Random variable.

UNIT -III: MULTIPLE RANDOM VARIABLES AND OPERATIONS:
Multiple Random Variables, Joint Distribution Function, Properties of Joint Distribution, Joint probability Density Function, Properties of Joint Density Function, Marginal Distribution Functions, Conditional Distribution and Density, Statistical Independence, Sum of Two Random Variables, Sum of Several Random Variables, Central Limit Theorem: Unequal Distribution, Equal Distributions.
OPERATIONS ON MULTIPLE RANDOM VARIABLES: Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two Random Variables case, N Random Variables case, Properties, Transformations of Multiple Random Variables, Linear Transformations of Gaussian Random Variables.

UNIT -IV: RANDOM PROCESSES – TEMPORAL CHARACTERISTICS:
The Random Process Concept, Classification of Processes, Deterministic and Nondeterministic Processes, Distribution and Density Functions, Concept of Stationary and Statistical Independence. First-Order Stationary Processes, Second-order and Wide-Sense Stationary, N^{th} order and Strict-Sense Stationary, Time Averages and Periodicity, Autocorrelation Function and its Properties, Cross-Correlation Function and its Properties, Covariance Functions, Gaussian Random Processes, Poisson Random Process.

UNIT- V: RANDOM PROCESSES – SPECTRAL CHARACTERISTICS:
The Power Density Spectrum: Properties, Relationship between Power Density Spectrum and Autocorrelation Function, The Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Density Spectrum and Cross-Correlation Function.

UNIT VI: LINEAR SYSTEMS WITH RANDOM INPUTS:
Random Signal Response of Linear Systems: System Response – Convolution, Mean and Mean-squared Value of System Response, Autocorrelation Function of Response, Cross-Correlation Functions of Input and Output, Spectral Characteristics of System Response: Power Density Spectrum of Response, Cross-Power Density Spectra of Input and Output, Band pass, Band-Limited and Narrowband Processes, Properties, Modeling of Noise Sources: Resistive (Thermal) Noise Sources, Arbitrary Noise Sources, White Noise or White Gaussian Noise, Power spectrum of White Noise, Effective Noise Temperature, Average Noise Figure, Average Noise Figure of cascaded networks.

Course Outcomes:

After successful completion of the course, the students can be able to:

S. No	Course Outcome	BTL
1.	Mathematically model the random phenomena and identify different types of random variables.	L1,2
2.	Compute statistical averages of these random variables and Transform one random variable into another	L2,3
3.	Compute statistical averages of multiple random variables and transformation of multiple random variables	L2,3
4.	Characterize the random processes in the time and frequency domains	L2
5.	Compute power spectral densities and obtain the relationship between the power spectral densities and correlation functions	L2
6.	Analyze the LTI systems with random inputs and apply these techniques to analyze the systems in the presence of different types of noise	L2

Correlation of COs with POs & PSOs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	1	1	1	1	-	-	3	2	-	2	2	1
CO 2	3	3	1	1	1	1	-	-	3	2	-	2	2	1
CO 3	3	2	1	1	1	1	-	-	3	2	-	2	2	1
CO 4	3	3	1	1	1	1	-	-	3	2	-	2	2	1
CO 5	3	3	1	1	1	1	-	-	3	2	-	2	2	1
CO 6	2	2	1	1	1	1	-	-	3	2	-	2	2	1

Text Books:

1. Probability, Random Variables & Random Signal Principles, Peyton Z. Peebles, TMH, 4th Edition, 2001.
2. Probability, Random Variables and Stochastic Processes, Athanasios Papoulis and S.Unnikrisha, PHI, 4th Edition, 2002.

Reference Books:

1. Probability Theory and Stochastic Processes – B. Prabhakara Rao, BS Publications
2. Probability and Random Processes with Applications to Signal Processing, Henry Stark and John W. Woods, Pearson Education, 3rd Edition.
3. Schaum's Outline of Probability, Random Variables, and Random Processes.
4. An Introduction to Random Signals and Communication Theory, B.P. Lathi, International Textbook, 1968.
5. Random Process – Ludeman , John Wiley
6. Probability Theory and Random Processes, P. Ramesh Babu, McGraw Hill, 2015.
7. Probability Theory and Stochastic Processes, Y.Mallikarjuna Reddy, Universities Press, 4th Edition.