II Year I Semester	**L**	**T**	**P**	**C**
Code: 17EC303	**3**	**1**	**0**	**3**

RANDOM VARIABLES & STOCHASTIC PROCESSES

Course Objectives:

1. To give students an introduction to elementary probability theory and to mathematically model the random phenomena with the help of probability theory concepts.
2. To discuss the concepts of discrete and continuous random variables and to calculate the parameters such as mean and variance.
3. To classify various types of probability distributions that occurs frequently in communication and signal processing.
4. To apply vector space concepts in random signal processing.
5. To illustrate the concept of random process in WSS and SSS with the importance of Ergodicity and its real time applications.
6. To estimate the power spectral density for a given random signal.
7. To analyze the LTI systems with stationary random process as input.
8. 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.

TEXT BOOKS:

1. Probability, Random Variables & Random Signal Principles, Peyton Z. Peebles, TMH, 4^{th} Edition, 2001.
2. Probability, Random Variables and Stochastic Processes, Athanasios Papoulis and S.Unnikrisha, PHI, 4^{th} 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, 3^{rd} 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, McGrawHill, 2015.
7. Probability Theory and Stochastic Processes,Y.Mallikarjuna Reddy,Universities Press,4^{th}Edition.

Course Outcomes:
After completion of the course, the student will be able to

- Mathematically model the random phenomena and solve simple probabilistic problems.
- Identify different types of random variables and compute statistical averages of these random variables.

- Interpret the concept of convergences in random signals from different applications.
- Characterize the random processes in the time and frequency domains.
- Describe the random signals in terms of its average properties such as average power in the random signal and its spectral distribution.
- Analyze the LTI systems with random inputs.
- Model and analyze the effect of noise in electronic circuits used in communication systems.