PROBABILITY THEORY AND STOCHASTIC PROCESSES

III Semester: ECE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AECC04	Foundation	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 60		
Prerequisites: There are no prerequisites to take this course.								

I. COURSE OVERVIEW:

Stochastic processes are mathematical objects defined on probability space. The study of these processes is of primary importance in all science and engineering specializations. This course comprises two parts. The first part introduces the fundamental principles of probability theory and random variables necessary to understand the stochastic processes. The second part introduces the basic concepts of random processes, random signals, and their interaction 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 data science.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental concepts of the 1-dimensional and 2-dimensional random variables and their characterization in probability space.
II. The stationary random process, its framework and application for analysing random signals and noises.
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 random signals useful for subsequent design and analysis of communication systems.

III. COURSE OUTCOMES:

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

CO 1	**Infer** the concepts of the random experiment and probability for proving the Bayes theorem, computing complex event probabilitiesand independence of multiple events.	Understand
CO 2	**Interpret** the concept of random variable, the probability distribution function, probability density function and operations on single random variable to derive the moments.	Understand
CO 3	**Utilize** the joint distribution and density function for operations on multiple random variables.	Apply
CO 4	**Extend** the random variable concept to random process and its sample functions for demonstrating the time domain and frequencydomain characteristics.	Understand
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.	Apply
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.	Analyze

IV. SYLLABUS:

MODULE – I: PROBABILITY, RANDOM VARIABLES AND OPERATIONS ON RANDOM VARIABLES (09)

Random Experiments, Sample Spaces, Events, Probability, Axioms, Joint, Conditional and Total Probabilities, Bay‟s Theorem, Independent Events. Random Variables: Definition, Conditions for mapping function of a Random Variable, 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, Variance and Skew, Chebychev‟s Inequality

MODULE – II: SINGLE RANDOM VARIABLE TRANSFORMATIONS - MULTIPLE RANDOM VARIABLES (09)

Characteristic Function, Moment Generating Function, Monotonic and Non-monotonic Transformations of Single Random Variables (Continuous and Discrete), Vector Random Variables, Joint Distribution Function and its Properties, Marginal Distribution Functions, Joint Density Function and its Properties, Marginal Density Functions, Conditional Distribution and Density – Point Conditioning, Conditional Distribution and Density – Interval conditioning, Statistical Independence, Sum of Two and more Random Variables, Central Limit Theorem: Equal and Unequal Distribution.

MODULE – III: OPERATIONS ON MULTIPLE RANDOM VARIABLES – EXPECTATIONS (09)

Expected value of a function of multiple random variables, Correlation and Covariance, Correlation Coefficient, Joint Moments about the origin, Joint Central moments, Joint characteristic function, Joint moment generating function.

Jointly Gaussian random variables: Two random variables case and N random variable case, Properties, Transformations of Multiple Random Variables, Jacobian Matrix, Linear Transformations of Gaussian Random Variables

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 (09)

Power Density Spectrum: Definition and Properties, Relationship between Power Density Spectrum and Autocorrelation Function, Cross Power Spectral Density: Definition and Properties, Relationship between Cross Power Spectrum and Cross-Correlation Function, System Evaluation using Random Noise, Spectral Characteristics of System Response: Power Density Spectrum of Response, Cross-Power Density Spectra of Input and Output, Noise Bandwidth, White and Colored Noises

V. TEXT BOOKS:

1. Peyton Z. Peebles, “Probability, Random Variables & Random Signal Principles”, TMH, 4th Edition, 2001.

VI. REFERENCE BOOKS:

1. Bruce Hajck, “Random Processes for Engineers”, Cambridge Unipress, 2015.
2. Athanasios Papoulis and S. Unnikrishna Pillai, “Probability, Random Variables and Stochastic Processes”, PHI, 4th Edition,2002.
3. K.Murugesan, P. Guruswamy, “Probability, Statistics & Random Processes”, Anuradha Agencies, 3rd Edition, 2003.
4. B.P. Lathi, “Signals, Systems & Communications” B.S. Publications, 2003.

VII. WEB REFERENCES:

1. www.britannica.com/topic/probability-theory
2. www.math.uiuc.edu/~r-ash/BPT.html
3. https://www.ma.utexas.edu/users/gordanz/.../introduction_to_stochastic_processes.pdf
4. nptel.ac.in/courses/111102014/
5. http://vceece2k10.blogspot.in/p/semester-2-1.html