PROBABILITY THEORY AND STOCHASTIC PROCESSES

III Semester: ECE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AEC003	Foundation	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

I. COURSE OVERVIEW:

Stochastic or random 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 elec- tronic systems. The course forms the basis for the next level courses of an electronics engineer such as analog communication, digital communication and digital signal processing, radar systems and digi- tal image processing. It is also useful for a data science engineer in designing the machine learning algorithms.

II. OBJECTIVES:

The course should enable the students to:

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 analyzing random signals and noises.
III	The characteristics of 1-dimensional stationary random signals in time andfrequency 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 ofcommunication systems.

III. COURSE OUTCOMES:

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

CO 1	**Infer** the concepts of the random experiment, event probability, jointevent probability, and conditional event probability for proving the Bayes theorem and for computing complex event probabilities and independence of multiple events.	Understand
CO 2	**Explain** the concept of random variable, the probability distribution function, probability density function and operations on single random variable to analytically derive the moments.	Understand
CO 3	**Develop** joint distribution, density function, expectation operator and transformations for multiple random variables using the concept of single random variable.	Apply
CO 4	**Extend** the random variable concept to random process and its sample functions for demonstrating the time domain and frequency domain characteristics.	Understand
CO 5	**Develop** analytically 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 bystationary random processes using the time domain and frequency domain description of random processes.	Analyze

IV. SYLLABUS:

UNIT-I	PROBABILITY AND RANDOM VARIABLE	Classes:08

Introduction to probability through sets and probability: Relative frequency; Experiments and sample spaces, discrete and continuous sample spaces; Events; Probability definitions and axioms; Mathematical model of experiments; Probability as a relative frequency; Joint probability; Conditional probability, total probability; Baye's theorem and independent events. Random variable: Definition of random variable, conditions for a function to be a random variable, discrete ,continuous and mixed random variable.

UNIT-II	DISTRIBUTION AND DENSITY FUNCTIONS	Classes:10

Distribution and density functions: Distribution and density functions definitions and properties; Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Conditional distribution, methods of defining conditioning on an event, conditional density, properties. 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	Classes: 08

Multiple random variables: Vector random variables, joint distribution function, properties of joint distribution; Marginal distribution functions, conditional distribution and density: Point conditioning, conditional distribution and density: Interval conditioning, statistical independence, sum of two random variables, sum of several random variables; Central limit theorem.

Operations on multiple random variables: Expected value of functions of random variables: Joint moments about the origin, joint central moments, joint characteristic functions and jointly Gaussian random variables: Two random variables case and N random variable case, properties; Transformations of multiple random variables; Linear transformations of Gaussian random variables.

UNIT-IV	STOCHASTIC PROCESSES: TEMPORALCHARACTERISTICS	Classes: 10

The random process concept, classification of processes, deterministic and non deterministic processes, distribution and density functions, concept of stationary and statistical independence; First order stationary processes; Second order and wide sense stationarity, N Order and strict sense stationarity, time averages and ergodicity, mean ergodic processes, correlation ergodic processes; Autocorrelation function and its properties; Cross correlation function and its properties; Covariance functions; Gaussian random processes; Poisson random process.

UNIT-V	STOCHASTIC PROCESSES: SPECTRAL CHARACTERISTICS	Classes: 09

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 of a linear system. Introduction to white Gaussian noise process and its properties.

Text Books:

1. Peyton Z. Peebles, "Probability, Random Variables & Random Signal Principles", Tata McGraw-Hill, 4th Edition, 2001.
2. Scott Miler, Donald Childers, "Probability and random process", Elsevier, 2nd Edition, 2012.
3. S.P. Eugene Xavier, "Statistical Theory of Communication", New Age Publications, 1st Edition, 2003.

Reference Books:

1. Athanasius Papoulis, S. Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", PHI, 4th Edition, 2002.
2. Henry Stark, John W. Woods, "Probability and Random Processes with Application to Signal Processing", Pearson Education, 3rd Edition, 2014.
3. George R. Cooper, Clave D. MC Gillem, "Probability Methods of Signal and System Analysis", Oxford, 3rd Edition, 1999.

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

E-Text Books:

1. http://freecomputerbooks.com/mathProbabilityBooks.html
2. http://www.springer.com/in/book/9780387878584
3. http://www.e-booksdirectory.com/listing.php?category=15

Course Home Page: