PROBABILITY THEORY AND STOCHASTIC PROCESSES

III Semester: ECE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AECB08	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	1	0	4	30	70	100
Contact Classes: 45	**Tutorial Classes:15**	**Practical Classes: Nil**				**Total Classes: 60**		

OBJECTIVES:

The students will try to learn:

1. The fundamental concepts of the 1-dimensional and 2-dimensional random variables and their characterization in probability space.
2. The stationary random process, its framework and application for analysing random signals and noises.
3. The characteristics of 1-dimensional stationary random signals in time and frequency domains.
4. 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.

COURSE OUTCOMES:

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

1. **Infer** the concepts of the random experiment, event probability, joint event probability, and conditional event probability for proving the Bayes theorem and for computing complex event probabilities and independence of multiple events. (**Understand**)
2. **Explain** the concept of random variable, the probability distribution function (PDF), probability density function (pdf), joint and conditional probability density function (cpdf), and demonstrate the differences among various density functions such as Gaussian, Rayleigh, Poisson, Binomial etc. (**Understand**)
3. **Explain** the transformation of random variables, the Expectation operator on functions of random variables to formulate the definition of moments and demonstrate the use of the characteristic and moment generating functions to analytically derive the standard moments. (**Understand**)
4. **Interpret** the vector random variables as the extension of scalar random variables to characterize their joint, marginal, and conditional density/ distribution functions. (**Understand**)
5. **Derive** the density function of sum of random variables for demonstrating the central limit theorem and its physical significance. (**Apply**)
6. **Explain** the Expectation operator on functions of vector random variables to formulate the definition of joint moments (e.g. Correlation and Covariance) and demonstrate the use of the joint characteristic and joint moment generating functions to alternatively derive the joint standard moments. (**Understand**)
7. **Develop** the framework for linear transformation of vector gaussian random variables using the properties of jointly gaussian variables. (**Apply**)
8. **Extend** the random variable concept to random process and its sample functions for demonstrating the time domain characteristics such as stationarity, independence, and ergodicity of a random process. (**Understand**)

9. **Relate** the correlation and covariance functions and their properties for the time domain classification of random processes. (**Understand**)
10. **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**)
11. **Analyze** the response of a linear time invariant (LTI) system driven by stationary random processes using the time domain description of random processes. (**Analyze**)
12. **Discover** the frequency domain characteristics of of a linear time invariant (LTI) system response driven by stationary random processes using the relationship between correlation functions and power density spectra (**Analyze**)

MODULE - I	PROBABILITY, RANDOM VARIABLES AND OPERATIONS ON RANDOM VARIABLES	Classes: 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	Classes: 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	Classes: 09

PART:1

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.

PART:2

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	Classes: 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	Classes: 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

Text Books:

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

Reference Books:

1. Probability Theory and Stochastic Processes - Y. Mallikarjuna Reddy, University Press, 4th Edition,
2. 2013.Random Processes for Engineers-Bruce Hajck, Cambridge unipress, 2015
3. Probability, Random Variables and Stochastic Processes – Athanasios Papoulis and S. Unnikrishna Pillai, PHI, 4th Edition, 2002.
4. Probability, Statistics & Random Processes-K .Murugesan, P. Guruswamy, Anuradha Agencies, 3rd Edition, 2003.
5. Signals, Systems & Communications - B.P. Lathi, B.S. Publications, 2003.

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