Probability Theory and Stochastic Process

Course Code	**23BS1304**	**Year**	II	**Semester**	I
Course Category	BS	**Branch**	ECE	**Course Type**	Theory
Credits	3	**L-T-P**	3-0-0	**Pre requisites**	Mathematics
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes		
Upon successful completion of the course, the student will be able to		BL
CO1	Apply the knowledge of probability to solve engineering problems	L3
CO2	Determine the probability distribution and density functions of various types of Random variables.	L3
CO3	Estimate the nature of probability distributions with the help of moments	L4
CO4	Analyze the temporal and spectral characteristics of random processes	L4
CO5	Illustrate the concepts of Noise sources and their properties	L3

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of Correlations (3:High, 2:Medium, 1:Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3										2	2	
CO2	3										2	2	
CO3	3	3									2	2	
CO4	3	3									2	2	
CO5	3										2	2	
Avg.	3	3									2	2	

Syllabus		
Unit No.	**Contents**	**Mapped CO**
1	**Probability & Random Variable:** Probability introduced through Sets and Relative Frequency: Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Probability Definitions and Axioms,Joint Probability, Conditional Probability, Total Probability, Bay's Theorem, Independent Events. **Random Variable**-Definition, Conditions for a Function to be a Random Variable, Discrete, Continuous and Mixed Random Variable, Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh Methods of defining Conditioning Event, Conditional Distribution, Conditional Density and their Properties.	CO1, CO2
2	**Operations on Single Random Variable:** 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 and Non-Monotonic Transformations of Continuous Random Variable, Transformation of a Discrete Random Variable.	CO2,CO3

3	**Operations on Multiple Random Variables:** Vector Random Variables.Joint Distribution Function and its Properties, 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, (Proof not expected). Unequal Distribution, Equal Distributions. Expected Value of a Function of Random Variables: Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two Random Variables case, N Random Variable case, Properties, Transformations of Multiple Random Variables, Linear Transformations of Gaussian Random Variables	CO2,CO3
4	**Random Processes Temporal Characteristics:** The Random Process Concept, Classification of Processes, Deterministic and Nondeterministic Processes, Distribution and Density Functions, concept of Stationarity 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. 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.	CO1,CO4
5	**Random Processes Spectral Characteristics:** The 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. **Noise Sources:** Resistive/Thermal Noise Source, Arbitrary Noise Sources, Effective Noise Temperature, Noise equivalent bandwidth, Average Noise Figures, Average Noise Figure of cascaded networks, Narrow Band noise, Quadrature representation of narrow band noise & its properties	CO1,CO4, CO5

Learning Resources
Text Books
1. Peyton Z. Peebles, Probability, Random Variables & Random Signal Principles, TMH, 4th Ed., 2001.
2. A. Papoulis and S. Unnikrishna Pillai, Probability, Random Variables and Stochastic Processes , PHI, 4th Ed., 2002.
Reference Books
1.S.P. Eugene Xavier, Statistical Theory of Communication, New Age Publications, 2003.
2. George R. Cooper, Clave D. MC Gillem, Probability Methods of Signal and System Analysis. Oxford, 3rd Ed., 1999
3. B.P. Lathi, Signals, Systems & Communications, B.S. Publications, 2003.
4. R.P. Singh and S.D. Sapre, Communication Systems: Analog & Digital, TMH, 1995

e-Resources & other Digital Material
1. http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Signals20and %20System/TOC-M1.htm 2. http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Signals%20and %20System/Course%20Objective.htm 3. http://www.stanford.edu/~boyd.ee102 4. http://www.ece.gatech.edu/users/bonnie/book 5. http://ocw.mit.edu