COURSE CONTENT

PROBABILITY THEORY AND STOCHASTIC PROCESSES								
III Semester: ECE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
25030403	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:45**		
Prerequisites: knowledge on probability								

Course Overview:

This course provides a rigorous foundation in probability theory, random variables, and random processes with applications in communications and signal processing. It covers statistical properties, temporal and spectral characteristics of random process and noise modeling. Students will gain analytical skills to model, analyze and interpret stochastic systems in Engineering.

Course Objectives:

The students will try to learn

- Fundamental concepts of probability and random variable models used in Engineering.
- Operations, transformations and properties of a single random variable, variances, and transformations of random variables.
- Joint distribution, independence, and operations on multiple random variables.
- Classification, ergodicity, and correlation properties of random process.
- Spectral properties of random process and noise models in communication systems.

Course Outcomes:

After successful completion of the course, students shall be able to

- Apply probability theorems and standard distributions to solve problems.
- Compute expected values, variances, and transformations of random variable.
- Analyse joint. Marginal and conditional distributions of multiple random variables.
- Evaluate temporal characteristics and correlation function of random process.
- Apply power spectral density and noise components in system analysis.

Module – I: Probability 9L

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, Bayes' Theorem, Independent Events. Random Variables: Definition, 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 Distributions. Conditional Distribution, Conditional Density and their Properties.

Module – II: Operations on Single Random Variable **9L**

Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skewness, Characteristic Function, Moment Generating Function, Monotonic and Non-monotonic Transformations of Continuous and Discrete Random Variables.

Module – III: Multiple Random Variables and Operations **9L**

Vector Random Variables, Joint Distribution Function and its Properties, Marginal Distribution Functions, Conditional Distribution and Density, Statistical Independence, Sum of Two Random Variables, Central Limit Theorem (Proof not expected). Expected Value of a Function of Random Variables, Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables.

Module – IV: Random Processes – Temporal Characteristics **9L**

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 Stationary Processes, (N-Order) and Strict-Sense Stationary Processes, Time Averages and Ergodicity, Mean-Ergodic Processes, Correlation-Ergodic Processes. Autocorrelation Function and its Properties, Cross-Correlation Function and its Properties. Random Signal Response of Linear Systems: System Response – Mean and Mean-Squared Value of System Response, Autocorrelation Function of Response, Cross-Correlation Functions of Input and Output.

Module – V: Random Processes – Spectral Characteristics **9L**

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. Power Density Spectrum of System 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, Narrow Band Noise, Quadrature Representation of Narrow Band Noise and its Properties.

TEXT BOOKS:

1. Peyton Z. Peebles - Probability, Random Variables & Random Signal Principles - TMH, 4th Edition
2. Murray R Spiegel, John Schiller, R Alu Srinivasan. – Probability and Statistics – Schaum's Outlines, 2nd Edition, TMH

REFERENCES:

1. P Ramesh Babu - Probability Theory and Random Processes – McGraw Hill Education
2. Athanasios Papoulis and S. Unnikrishnan Pillai - Probability, Random Variables and Stochastic Processes – McGraw Hill Education, 4th Edition
3. K. N. Hari Bhat, K. Anitha Sheela and Jayant Ganguly - Probability Theory and Stochastic Processes for Engineers - Pearson, 1st Edition, 2011.

REFERENCE LINK:

1. https://www.youtube.com/playlist?list=PLEAYkSg4uSQ2qu-goWslUkq2hiZYlEzFH
2. https://www.youtube.com/playlist?list=PLyqSpQzTE6M-wagCGk3pVpFuf0D_mZekp
3. https://www.youtube.com/playlist?list=PLyqSpQzTE6M-6uZtCcdhLS-HiXzQ43Bw2
4. https://www.youtube.com/watch?v=r1sLCDA-kNY
5. https://www.youtube.com/playlist?list=PLEAYkSg4uSQ2qu-goWslUkq2hiZYlEzF

MATERIALS ONLINE:

1. Course template.
2. Tutorial question bank.
3. Tech Talk and Concept Video topics.
4. Open-ended experiments.
5. Definitions and terminology.
6. Assignments.
7. Model question paper–I.
8. Model question paper–II.
9. Lecture notes.
10. Drshya Siksha Sangrah Videos(DSSV).