INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	**PROBABILTY THOERY AND STOCHASTIC PROCESS**				
Course Code	**AECB08**				
Programme	B.Tech				
Semester	THIRD				
Course Type	CORE				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Course Faculty	Dr. M V Krishna Rao, Professor				

I. COURSE OVERVIEW:

The course addresses the principles of probability theory and random variables. The course also introduces the concepts of random processes and sample functions, which are nothing but the noise signals that appear in a communication channel. The course also introduces the concepts such as Information, entropy of random sources and various coding techniques based on information theory. This course (along with the Signals and Systems course) forms the basis for the next level courses: Analog communication (AC), Digital communication (DC) and Digital Signal Processing (DSP), Radar Systems (RS) and Digital Image Processing (DIP). Students will learn the basics of probability functions (PDF and CDF), Moments, Random Variable Transformations, Temporal and Spectral properties of Random processes, Types of Random Processes, LTI system driven by Random Process, Input and output correlations, and Input and output Power spectral densities.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHSB11	II	Mathematical Transform Techniques	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Probability Theory and Stochastic Process	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✘	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two subdivisions in a question. The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table 1.

Table 1. The expected percentage of cognitive level of questions in SEE.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
50 %	Understand
25 %	Apply
15 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 2), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 2: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours / classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table 3**.**

Table 3: Assessment pattern for AAT

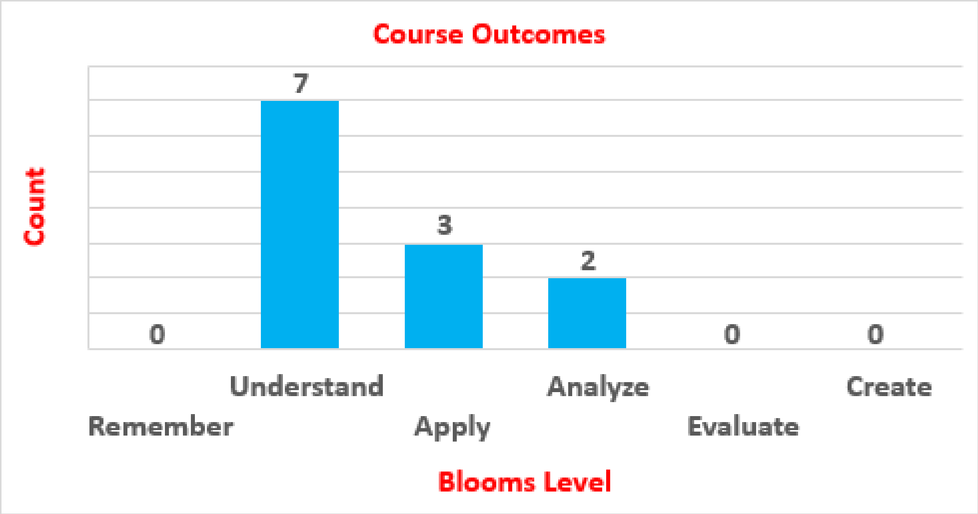
5 Minutes Video	Assignment	Tech-talk	Seminar	Open Ended Experiment
20%	30%	30%	10%	10%

VI. 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.

VII. COURSE OUTCOMES:

After successful completion of the course, students will be able to:		
	Course Outcomes	**Knowledge Level (Bloom's Taxonomy)**
CO 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
CO 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
CO 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
CO 4	**Interpret** the vector random variables as the extension of scalar random variables to characterize their joint, marginal, and conditional density/ distribution functions.	Understand
CO 5	**Derive** the density function of sum of random variables for demonstrating the central limit theorem and its physical significance.	Apply
CO 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
CO 7	**Develop** the framework for linear transformation of vector gaussian random variables using the properties of jointly gaussian variables.	Apply
CO 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
CO 9	**Relate** the correlation and covariance functions and their properties for the time domain classification of random processes.	Understand
CO 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
CO 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
CO 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



VIII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIA/Quiz/ AAT
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	3	SEE/CIA/Quiz/ AAT

3 = High; 2 = Medium; 1 = Low

IX. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	Formulate and Evaluate the applications in the field of Intelligent Embedded and Semiconductor technologies	-	-
PSO 2	Focus on the practical experience of ASIC prototype designs, Virtual Instrumentation and SOC designs	-	-
PSO 3	Build the Embedded hardware design and software programming skills for entry level job positions to meet the requirements of employers	-	-

3 = High; 2 = Medium; 1 = Low

X. MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 7	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 8	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 11	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 12	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-

XI. JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING – DIRECT

Course Outcomes	POs / PSOs	Justification for mapping (Students will be able to)	No. of key competencies
CO 1	PO 1	Make use of (*knowledge*) the concepts of the random experiment, sample space, and appreciate (*understand*) the meaning of event probability, joint event probability, and conditional event probability for (*apply*) proving the Bayes theorem and for demonstrating (*understanding*) the random variables using the **mathematical principles** and **scientific methodology** to **support** the study **of next-level courses** such as communications , digital signal processing, (**own engineering discipline**) etc.	3
CO 2	PO 1	Define (*knowledge*) a random variable using (*knowledge*) a real mapping function of outcomes of a random experiment into a random variable, define (*knowledge*) the probabilities and (*understand*) the continuous/discrete probability density function and distribution function for characterizing (*knowledge, understand*) various types of density functions such as Gaussian, Rayleigh, Poisson, etc. using the **mathematical principles** and **scientific methodology** to **support** (*understand*) their applications in **next-level courses** of the program. (**own engineering discipline**).	3

Course Outcomes	POs / PSOs	Justification for mapping (Students will be able to)	No. of key competencies
CO 3	**PO 1**	Define (*knowledge*) the transformation and/or the expectation operation on random variables and their functions, to formulate the definition of moments of a random variable using **mathematical principles** and demonstrate (*understand*) the use of the characteristic and moment generating functions (*knowledge*) to analytically derive the standard moments (by means of **scientific principles** and **methodology)** useful for identifying (*understand*) various noises encountered in communication systems and electronic circuits to **support** the other courses of the program(**own engineering discipline**).	3
	PO 2	Demonstrate (*understand*) the physical significance of the characteristic and moment generating functions and develop (apply) the Nth order standard and central moments using the above functions to **identify**, **formulate** and **state a problem,** and **develop solution** that uses moments as features and **interpret** and **document the results.**	6
CO 4	**PO 1**	Define *(knowledge)* the vector random variables as the extension (*understand*) of scalar random variables using **mathematical principles** and explain (*understand*) the meaning of joint, marginal and conditional distribution and density functions using **scientific principles and methodology** and interpret (*understand*) them for supporting the study of interdisciplinary courses such as digital image processing (**own engineering discipline**) and data sciences (**other engineering disciplines**).	3
CO 5	**PO 1**	Relate (*understand*) the density function (*knowledge)* of sum of random variables to the density functions of individual random variables using the **mathematical principles** and demonstrate (*understand*) the central limit theorem and its physical significance using **scientific methodology** and **integrate** these concepts into the study of communication systems (**own engineering discipline**) and (**complex**) signal processing systems.	3
CO 6	**PO 1**	Define (*knowledge*) the expectation operation on vector random variables and their functions, to formulate the definition of joint moments of a vector random variable using **mathematical principles** and demonstrate (*understand*) the use of the joint characteristic and joint moment generating functions (*knowledge*) to analytically derive the joint standard moments (by means of **scientific principles and methodology)** and for **supporting** (**own engineering discipline**) some image processing algorithms.	3
CO 7	**PO 1**	Develop (apply) the framework for linear transformation of vector gaussian random variables (*knowledge*) using the properties of jointly gaussian variables using **mathematical principles** and **scientific methodology** for appreciating (*understand*) the difference between correlated and uncorrelated noises and integrate (*knowledge*) to analyze the noisy communication signals (**own engineering discipline**).	3
CO 8	**PO 1**	Extend *(knowledge)* the random variable concept to define *(knowledge)* random process and its sample functions using **mathematical principles, scientific principles and**	3

Course Outcomes	POs / PSOs	Justification for mapping (Students will be able to)	No. of key competencies
		methodology for demonstrating (*understand*) the time domain characteristics such as (*knowledge)* stationarity, independence, and ergodicity of a random process and **integrate** them to the study stationary signals encountered in communications (**own engineering discipline**).	
CO 9	**PO 1**	Define (*knowledge)* the correlation and covariance functions of multiple random variables (*knowledge*) using **mathematical principles** and **scientific methodology** and utilize (apply) these functions for classifying (*understand)* the random processes to **support** the **complex problem** of signal estimation in **own engineering discipline.**	3
	PO 2	Demonstrate (*understand*) the physical significance of the correlation and covariance functions, and **identify**, **formulate,** *(apply)* and **state a (**complex**) problem,** to **develop** (*apply*) **solution** using inversion of correlation/ covariance matrices in certain areas of communication (**problems**) and **interpret and document the results.**	6
CO 10	**PO 1**	Develop analytically (apply) the auto-power and cross- power spectral densities of random processes using correlation functions (*knowledge)* and Fourier transform (*knowledge)* using the **mathematical principles** and **scientific methodology** to **support** and **integrate** them into the frequency domain analysis (*understand*) of signals and systems encountered in (**own engineering discipline)** communications, radar, etc.	3
CO 11	**PO 1**	Recall (*knowledge)* the convolution integral to find the output time response (*understand*) of a linear time invariant system and analytically compute (apply) the system response when driven by a random process using **mathematical principles** and **scientific methodology** and analyze the system response in terms of autocorrelation and cross-correlation functions to **support** and **integrate** the (*knowledge)* results into the time-domain analysis of electronic systems (**own engineering discipline)**.	3
	PO 2	Demonstrate (*understand*) the convolution integral as a filtering operation (*knowledge* , and **identify**, **formulate,** *(apply)* and **state a (**complex**) problem,** to **develop** (*apply*) **solution** using appropriate filters in certain areas of communication (**problems**) and **interpret and document the results.**	6
CO 12	**PO 1**	Recall (*knowledge)* the frequency domain description of convolution operation to find the output frequency response (*understand*) of a linear time invariant system and analytically compute (apply) the output frequency response when driven by a random process using **mathematical principles** and **scientific methodology** and analyze the output frequency response in terms of auto-power spectra and cross-power spectra and cross-correlation functions to **support** and **integrate** the (*knowledge)* results into the frequency -domain analysis of electronic systems (**own engineering discipline)**.	3

Course Outcomes	POs / PSOs	Justification for mapping (Students will be able to)	No. of key competencies
	PO 2	Demonstrate (*understand*) the filtering operation (*knowledge*, in frequency domain, discover the frequency domain characteristics of a linear time invariant system that can produce white and colored noises, and **identify**, **formulate,** *(apply)* and **state a (**complex**) problem, and develop** (*apply*) **solution** using the power spectra analysis of noisy signals in the areas of communication, radar, image restoration/enhancement, etc. (**complex problems**), **interpret and document the results.**	6

XII. TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING

Course Outcomes	Program Outcomes / No. of Key Competencies Matched												Program Specific Outcomes / No. of key competencies		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**-**	**-**	**-**
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 7	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	3	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 11	3	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 12	3	6	-	-	-	-	-	-	-	-	-	-	-	-	-

XIII. PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

Course Outcomes	Program Outcomes / No. of key competencies												Program Specific Outcomes/ No. of key competencies		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	8	-	-	-
CO 1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 4	100.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 5	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 6	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 7	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 8	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 9	100.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 10	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 11	100.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 12	100.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

XIV. COURSE ARTICULATION MATRIX (PO – PSO MAPPING)

COs and POs and COs and PSOs on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 – **0** $\leq \boldsymbol{C} \leq$ 5% – No correlation;
1 – 5 $< \boldsymbol{C} \leq$ 40%– Low / Slight;
2 − 40 % $< \boldsymbol{C} <$ 60% – Moderate.
3 – 60% $\leq \boldsymbol{C} <$ 100% – Substantial / High

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CO 6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 9	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 11	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CO 12	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	36	12	0	0	0	0	0	0	0	0	0	0	0	0	0
AVERAGE	**3.0**	**3.0**	0	0	0	0	0	0	0	0	0	0	0	0	0

XV. ASSESSMENT METHODOLOGY - DIRECT

CIE Exams	PO 1,PO 2	SEE Exams	PO 1,PO 2	Assignments	PO 1,PO 2	Seminars	-
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-	Five Minutes Video	PO 10	Tech Talk	PO 10	Open Ended Experiments	-

XVI. ASSESSMENT METHODOLOGY - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✗	Assessment of Mini Projects by Experts		

XVII. SYLLABUS

MODULE-I	**PROBABILITY, RANDOM VARIABLES AND OPERATIONS ON RANDOM VARIABLES**
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**
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**
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**
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**
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. Peyton Z. Peebles, “Probability, Random Variables & Random Signal Principles”, Tata McGraw Hill, 4th Edition, 2001.	
REFERENCE BOOKS:	
1. Probability Theory and Stochastic Processes - Y. Mallikarjuna Reddy, University Press, 4th Edition, 2013. 2. Probability, Random Variables and Stochastic Processes – Athanasios Papoulis and S. Unnikrishna Pillai, PHI, 4th Edition, 2002. 3. Probability, Statistics & Random Processes- K .Murugesan, P. Guruswamy, Anuradha Agencies, 3rd Edition, 2003. 4. Random Processes for Engineers-Bruce Hajck, Cambridge University Press, 2015 5. Signals, Systems & Communications - B.P. Lathi, B.S. Publications, 2003.	

XVIII. COURSE PLAN

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Outcomes	Reference
1-3	Define random experiments, sample spaces, events, probability, axioms, joint, conditional, and total probabilities, bay’s theorem, independent events	CO 1	T1:1.1-1.5
4	Random variables: definition, conditions for mapping function of a random variable, types of random variable,	CO 2	T1:2.0-2.1

Lecture No	Topics to be covered	Course Outcomes	Reference
5-9	Distribution and density functions: definition and properties, binomial, poisson, uniform, gaussian, exponential, and rayleigh random variables	CO 2	T1:2.2-2.5
10	Methods of defining conditioning event, conditional distribution, conditional density and their properties,	CO 2	T1:2.6
11-13	Expected value of a random variable, function of a random variable, standard and central moments, variance and skew, chebychev's inequality	CO 3	T1:3.0-3.2
14	Characteristic function, moment generating function	CO 3	T1:3.3
15-18	Monotonic and non-monotonic transformations of single random variables (continuous and discrete)	CO 3	T1:3.4
19-22	Vector random variables, joint distribution function and its properties, marginal distribution functions, joint density function and its properties, marginal density functions,	CO 4	T1:4.0-4.4
23-24	Joint Conditional distribution and density – point conditioning, Joint conditional distribution, and density – interval conditioning, statistical independence,	CO 4	T1:4.5
25-26	Sum of two and more random variables, central limit theorem: equal and unequal distribution.	CO 5	T1:4.6-4.7
27-28	Expected value of a function of multiple random variables, correlation and covariance , correlation coefficient,	CO 6	T1:5.0-5.1 R1: 5.2-5.5
29-31	Joint moments about the origin, joint central moments, joint characteristic function	CO 6	T1:5.2
32-33	Jointly gaussian random variables: two random variables case and n random variable case, properties	CO 7	T1:5.3
34-36	Transformations of multiple random variables, Jacobian matrix, linear transformations of gaussian random variables	CO 7	T1:5.4-5.5 R1: 5.6-5.8
37-40	Random process: definition and classification, distribution and density functions, stationarity and statistical independence.	CO 8	T1:5.4-5.6 R1: 6.7
41-43	First- order, second- order , wide-sense stationarities (n-order) and strict-sense stationarity, time averages and ergodicity, mean-ergodic and correlation-ergodic processes	CO 8	T1:6.1-6.2 R1: 6.7
42-44	Autocorrelation function and its properties, cross-correlation function and its properties, covariance functions, gaussian and poisson random processes.	CO 9	T1:6.3 R1: 6.8-6.9 R1: 6.12
45-49	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.	CO 11	T1:8.2
50-52	Power density spectrum: definition and properties, relationship between power density spectrum and autocorrelation function	CO 10	T1:7.1-7.2 R1: 7.2-7.5

Lecture No	Topics to be covered	Course Outcomes	Reference
53-54	Cross power spectral density: definition and properties, relationship between cross-power spectrum and cross-correlation function	CO 10	T1:7.3-7.4
55-57	System evaluation using random noise, spectral characteristics of system response: power density spectrum of response, cross-power density spectra of input and output.	CO 12	T1:8.3-8.4 R1: 8.3-8.4
58-60	Noise bandwidth, white and colored noises	CO 12	T1:8.5-8.7

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