PROBABILITY THEORY AND STOCHASTIC PROCESS (EC305ES)

COURSE PLANNER

I. COURSE OVERVIEW:

The course introduces the basic concepts of probability. It then introduces the concept of Stochastic Processes. A discussion is made about the temporal and Spectral Characteristic of Random processes viz the concept of Stationary, Auto and Cross correlation, Concept of Power Spectrum density. The course also deals the response of Linear Systems for a Random process input. Finally it covers the concept of Noise and its modeling

II. PREREQUISITE:

NIL

III. COURSE OBJECTIVES

1.	This gives basic understanding of random signals and processing
2.	Utilization of Random signals and systems in Communications and Signal Processing areas.
3.	To known the Spectral and temporal characteristics of Random Process.
4.	To Learn the Basic concepts of Noise sources

IV. COURSE OUTCOMES Upon completing this course, the student will be able to

S.No.	Description	Bloom's Taxonomy Level
1.	**Understand** the concepts of Random Process and its Characteristics.	Understand(Level2)
2.	**Understand** the response of linear time Invariant system for a Random Processes.	Understand(Level2)
3.	**Determine** the Spectral and temporal characteristics of Random Signals	Understand (Level2), Apply(Level3)
4.	**Understand** the concepts of Noise in Communication systems.	Understand (Level2)

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (PO)		Level	Proficiency assessed by
PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems related to Electronics & Communication and Engineering.	2	Lectures, Assignments, Exercises
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems related to Electronics & Communication Engineering and reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Hands on Practice Sessions
PO3	**Design/development of solutions:** Design solutions for complex engineering problems related to Electronics & Communication Engineering and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	Design Exercises , Projects
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Lab sessions, Exams
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	Design Exercises, Oral discussions
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Electronics & Communication Engineering professional engineering practice.	-	-
PO7	**Environment and sustainability:** Understand the impact of the Electronics & Communication Engineering professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	-	-

Program Outcomes (PO)		Level	Proficiency assessed by
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	-	-
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	Seminars Discussions
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	-	-
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	-	-
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Development of Mini Projects

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO 1	**Professional Skills:** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.	3	Lectures and Assignmen ts
PSO 2	**Problem-Solving Skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	3	Tutorials
PSO 3	**Successful Career and Entrepreneurship:** An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and	2	Seminars and

	zeal for real-world applications using optimal resources as an Entrepreneur.		Projects

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

VII. COURSE SYLLABUS:

UNIT – I

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.

UNIT – II

Operations On Single & Multiple Random Variables – Expectations: 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. 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.

UNIT – III

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, SecondOrder 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.

UNIT – IV

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.

UNIT – V

Noise Sources & Information Theory: 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. Entropy, Information rate, Source coding: Huffman coding, Shannon Fano coding, Mutual information, Channel capacity of discrete channel, Shannon-Hartley law; Trade - off between bandwidth and SNR.

TEXT BOOKS:

1. Probability, Random Variables & Random Signal Principles - Peyton Z. Peebles, TMH, 4th Edition, 2001.
2. Principles of Communication systems by Taub and Schilling (TMH), 2008

REFERENCE BOOKS:

1. Random Processes for Engineers-Bruce Hajck, Cambridge unipress,2015.

1. Probability, Random Variables and Stochastic Processes – Athanasios Papoulis and S. Unnikrishna Pillai, PHI, 4th Edition, 2002.
2. Probability, Statistics & Random Processes-K. Murugesan, P. Guruswamy, Anuradha Agencies, 3rd Edition, 2003.
3. Signals, Systems & Communications - B.P. Lathi, B.S. Publications, 2003.
4. Statistical Theory of Communication – S.P Eugene Xavier, New Age Publications, 2003

IES SYLLABUS & GATE SYLLABUS: Not Applicable

CASE STUDIES:

1. Study Of STOCHASTIC PROCESS – TEMPORAL CHARACTERISTICS
2. Study Of STOCHASTIC PROCESS – SPECTRAL CHARACTERISTICS
3. Study of Noise.

VIII. COURSE PLAN (WEEK-WISE)

The course will proceed as follows for all sections. Please note that the week and the classes in each week are relative to each section.

Lecture no.	Week no.	Topic covered	Link for ppt	Link for pdf	Link for small projects and numericals	Course learning outcomes	Teaching Methodology	References
1	1	**UNIT – I Probability & Random Variable**: **Probability**	https://drive.google.com/drive/folders/1	https://drive.google.com/drive/	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4f	Understanding about Probability & Random	Chalk and Board and ICT materials	Probability by Papoulis

		& Random Variable: Probability introduced through Sets and Relative Frequency, Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events	M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	H?usp=sharing	Variable:		
2	1	**UNIT – I Probability & Random Variable**: Probability Definitions and Axioms, Joint Probability	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis
3	1	**UNIT – I Probability & Random Variable**: Conditional Probability, Total Probability, Bay's Theorem, Independent Events,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis

4	2	**UNIT – I Probability & Random Variable**: *Random Variable*- Definition, Conditions for a Function to be a Random Variable,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis
5	2	**UNIT – I Probability & Random Variable**: Discrete, Continuous and Mixed Random Variable,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis
6	2	**UNIT – I Probability & Random Variable**: Distribution and Density functions, Properties,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis

7	3	**UNIT – I Probability & Random Variable**: Binomial, Poisson, Uniform,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis
8	3	**UNIT – I Probability & Random Variable**: Gaussian, Exponential, Rayleigh	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis
9	3	**UNIT – I Probability & Random Variable**: Methods of defining Conditioning Event,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis

10	4	**UNIT – I Probability & Random Variable**: Conditional Distribution,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis
11	4	**UNIT – I Probability & Random Variable**: Conditional Density and their Properties.	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Probability & Random Variable:	Chalk and Board and ICT materials	Probability by Papoulis
12	4	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Expected Value of a Random Variable, Function of a Random Variable	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis

13	5	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Moment about the origin, Central Moment, Variance and Skew	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQl1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
14	5	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Chebychev's Inequality,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQl1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
15	5	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Characteristic Function, Moment generating function	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQl1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis

16	6	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Transformations of a Random Variable:	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
17	6	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Monotonic and Nonmonotonic transformations of continuous random variables	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
18	6	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations: Transformation of Discrete Random Variables, Vector Random**	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharin	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis

		Variables,		g				
19	7	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations: Joint Distribution function and its properties,**	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
20	7	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Marginal Distribution Functions, Conditional Distribution and Density – Point Conditioning	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
21	7	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Conditional Distribution and Density – Interval	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?us	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis

		conditioning		p=sharing				
22	8	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Statistical Independence	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
23	8	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Sum of Two Random Variables, Sum of Several Random Variables	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
24	8	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Central Limit Theorem, (Proof not expected).	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?us	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis

				p=sharing				
25	9	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Unequal Distribution, Equal Distributions. Expected Value of a Function of Random Variables: Joint Moments about the Origin	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
26	9	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two random Variables case	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
27	9	**UNIT – II Operations On Single &**	https://drive.google.	https://drive.go	https://drive.google.com/drive/folders/	Understanding about	Chalk and Board and	Probability by Papoulis

		Multiple Random Varaibles – Expectations: N Random Variable case, Properties,	com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	ogle.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Operations On Single & Multiple Random Varaibles	ICT materials	
28	10	**UNIT – II Operations On Single & Multiple Random Varaibles – Expectations:** Transformations of Multiple Random Variables, Linear Transformations of Gaussian Random Variables	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Operations On Single & Multiple Random Varaibles	Chalk and Board and ICT materials	Probability by Papoulis
29	10	**Random Processes – Temporal Characteristics:** The Random Process Concept, Classification of Processes, Deterministic and	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?us	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Temporal Characteristics	Chalk and Board and ICT materials	Probability by Papoulis

		Nondeterministic Processes,		p=sharing				
30	10	**Random Processes – Temporal Characteristics:** Distribution and Density Functions, concept of Stationarity and Statistical Independence.	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Temporal Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
31	11	**Random Processes – Temporal Characteristics:** First-Order Stationary Processes, Second-Order and Wide-Sense Stationarity, (N-Order) and Strict-Sense Stationarity,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Temporal Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
32	11	**Random Processes – Temporal Characteristics:** Time Averages and Ergodicity, Mean-Ergodic	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=shar	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Temporal Characteristics	Chalk and Board and ICT materials	Probability by Papoulis

		Processes,	ing	P8fNDwVy4H?usp=sharing				
33	11	**Random Processes – Temporal Characteristics:** Correlation-Ergodic Processes, Autocorrelation Function and Its Properties, Cross-Correlation Function and Its Properties	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Temporal Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
34	12	**Random Processes – Temporal Characteristics:** Covariance Functions, Gaussian Random Processes, Poisson Random Process	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Temporal Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
35	12	**Random Processes – Temporal Characteristics:** Random Signal Response of Linear Systems:	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLD	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Temporal Characteristics	Chalk and Board and ICT materials	Probability by Papoulis

		System Response – Convolution, Mean and Mean-squared Value of System Response	?usp=sharing	QeN-P8fNDwVy4H?usp=sharing				
36	12	**Random Processes – Temporal Characteristics:** autocorrelation Function of Response,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Temporal Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
37	13	**Random Processes – Temporal Characteristics:** Cross-Correlation Functions of Input and Output.	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Temporal Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
38	13	**UNIT – IV Random Processes – Spectral Characteristics:** The	https://drive.google.com/drive/folders/1M7Av5siA	https://drive.google.com/drive/folders/	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4f	Understanding about Random Processes – Spectral	Chalk and Board and ICT materials	Probability by Papoulis

		Power Spectrum: Properties, Relationship between Power Spectrum and Autocorrelation Function	R_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	H?usp=sharing	Characteristics		
39	13	**UNIT – IV Random Processes – Spectral Characteristics:** The Cross-Power Density Spectrum, Properties,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Spectral Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
40	14	**UNIT – IV Random Processes – Spectral Characteristics:** Relationship between Cross-Power Spectrum and Cross-Correlation Function	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Spectral Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
41	14	**UNIT – IV Random Processes – Spectral**	https://drive.google.com/drive	https://drive.google.co	https://drive.google.com/drive/folders/1VCEKwjBQiws49G	Understanding about Random Processes	Chalk and Board and ICT	Probability by Papoulis

		Characteristics: Spectral Characteristics of System Response: Power Density Spectrum of Response	/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	m/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	H_clNSZQvzpZOzj4fH?usp=sharing	– Spectral Characteristics	materials	
42	14	**UNIT – IV Random Processes – Spectral Characteristics:** Cross-Power Density Spectrums of Input and Output.	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Spectral Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
43	15	**UNIT – IV Random Processes – Spectral Characteristics:**	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Random Processes – Spectral Characteristics	Chalk and Board and ICT materials	Probability by Papoulis
44	15	**Noise Sources and Information**	https://drive.google.com/drive	https://drive.google.co	https://drive.google.com/drive/folders/1VCEKwjBQiws49G	Understanding about Noise	Chalk and Board and ICT	Probability by Papoulis

		Theory: Resistive/Thermal Noise Source, Arbitrary Noise Sources, Effective Noise Temperature,	/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	m/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	H_clNSZQvzpZOzj4fH?usp=sharing	Sources and Information Theory	materials	
45	15	**Noise Sources and Information Theory:** Noise equivalent bandwidth	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Noise Sources and Information Theory	Chalk and Board and ICT materials	Probability by Papoulis
46	16	**Noise Sources and Information Theory:** Average Noise Figures, Average Noise Figure of cascaded networks	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Noise Sources and Information Theory	Chalk and Board and ICT materials	Probability by Papoulis
47	16	**Noise Sources and Information**	https://drive.google.com/drive	https://drive.google.co	https://drive.google.com/drive/folders/1VCEKwjBQiws49G	Understanding about Noise	Chalk and Board and ICT	Probability by Papoulis

		Theory: Narrow Band noise	/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	m/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	H_clNSZQvzpZOzj4fH?usp=sharing	Sources and Information Theory	materials	
48	16	**Noise Sources and Information Theory:** Quadrature representation of narrow band noise & its properties.	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Noise Sources and Information Theory	Chalk and Board and ICT materials	Probability by Papoulis
49	17	**Noise Sources and Information Theory:** Entropy, Information rate,	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Noise Sources and Information Theory	Chalk and Board and ICT materials	Probability by Papoulis
50	17	**Noise Sources and Information**	https://drive.google.com/drive	https://drive.google.co	https://drive.google.com/drive/folders/1VCEKwjBQiws49G	Understanding about Noise	Chalk and Board and ICT	Probability by Papoulis

		Theory: Source coding: Huffman coding	/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	m/drive/folders/1tkQQl1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	H_clNSZQvzpZOzj4fH?usp=sharing	Sources and Information Theory	materials	
51	17	**Noise Sources and Information Theory:** Shannon Fano coding	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQl1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Noise Sources and Information Theory	Chalk and Board and ICT materials	Probability by Papoulis
52	18	**Noise Sources and Information Theory:** Mutual information, Channel capacity of discrete channel	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQl1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Noise Sources and Information Theory	Chalk and Board and ICT materials	Probability by Papoulis
53	18	**Noise Sources and Information**	https://drive.google.com/drive	https://drive.google.co	https://drive.google.com/drive/folders/1VCEKwjBQiws49G	Understanding about Noise	Chalk and Board and ICT	Probability by Papoulis

		Theory: Shannon-Hartley law	/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	m/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	H_clNSZQvzpZOzj4fH?usp=sharing	Sources and Information Theory	materials	
54	18	**Noise Sources and Information Theory:** Trade -off between bandwidth and SNR	https://drive.google.com/drive/folders/1M7Av5siAR_vSZC_RC8L_AXFvSjtwDP9o?usp=sharing	https://drive.google.com/drive/folders/1tkQQI1WkLbRRBF1QLDQeN-P8fNDwVy4H?usp=sharing	https://drive.google.com/drive/folders/1VCEKwjBQiws49GH_clNSZQvzpZOzj4fH?usp=sharing	Understanding about Noise Sources and Information Theory	Chalk and Board and ICT materials	Probability by Papoulis

TEXT BOOKS:

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

2. Principles of Communication systems by Taub and Schilling (TMH),2008

REFERENCE BOOKS:

1. Random Processes for Engineers-Bruce Hajck, Cambridge unipress,2015
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. Signals, Systems & Communications - B.P. Lathi, B.S. Publications, 2003.
5. Statistical Theory of Communication – S.P Eugene Xavier, New Age Publications, 2003

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO2	P O3	PO 4	PO 5	P O6	PO 7	P O8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	1	2	1	-	-	-	3	-	-	2	3	2	3
CO2	3	3	3	1	2	-	-	-	3	-	-	1	3	1	3
CO3	1	2	3	1	1	-	-	-	3	-	-	2	3	2	3
CO4	1	1	3	1	1	-	-	-	3	-	-	1	3	1	3
Average	2	2.25	2.5	1.2 5	1.25	-	-	-	3	-	-	1.5	3	1.5	3
Rounded Average	2	2	3	1	1	-	-	-	3	-	-	2	3	2	3

1: Slight (Low) **2**: Moderate (Medium) **3**: Substantial (High) - : None

X. QUESTION BANK (JNTUH) :

S.No	QUESTION	BLOOMS TAXONOMY LEVEL	COURSE OUTCOME
UNIT-1 **Probability and Random Variable** **SHORT ANSWER TYPE QUESTIONS**			
1	Define probability?	Remember	1
2	Explain probability with axioms?	Understand	1
3	Define conditional probability?	Remember	1
4	Define joint probability?	Remember	1
5	Define total probability?	Remember	1
6	Define bayes theorem?	Remember	1
7	Explain how probability can be considered as relative frequency?	Understand	1
8	Define a random variable?	Remember	1

9	Define a sample space?	Remember	1
10	Define multiplication theorem ?	Remember	1
	LONG ANSWER QUESTIONS		
1	State and prove bayes theorm	Remembering	1
2	State and prove total probability theorem?	Remembering	1
3	A man wins in a gambling game if he gets two heads in in five flips of a biased coin. The probability of getting a head with the coin is 0.7. 1. Find the probability the man will win. Should he play this game? 2. What is the probability of winning if he wins by getting at least four heads in five flips? Should he play this new game?	Analysis	1
4	In the experiment of throwing two fair dice, let A be the event that the first die is odd, B be the event that the second die is odd, and C is the event that the sum is odd. Show that events A, B and C are pair wise independent, but A, B and C are not independent.	Analysis	1
5	A certain large city averages three murders per week and their occurrences follows a Poisson distribution 1. What is the probability that there will be five or more murders in a given week? 2. On the average, how many weeks a year can this city expect to have no murders? 3. How many weeks per year (average) can the city expect the number of murders per week to equal or exceed the average number per week?	Remembering	2
6	A man matches coin flips with a friend. He wins 2 Rs if coins match and loses 2 Rs if they do not match. Sketch a sample space showing possible outcomes for this experiment and illustrate how the points map onto the real line x that defines the values of the random variable X=”dollars won on a trial”. Show a second mapping for a random variable Y=”dollars won by the friend on a trial”	Understanding	1
7	Explain total probability and conditional probability theorems with properties?	Understanding	2
8	Explain total probability theorem and bayes theorem properties	Understanding	1

9	Spacecraft are expected to land in a prescribed recovery zone 80% of the time. Over a period of time, six spacecrafts land. 1. Find the probability that none lands in the prescribed zone 2. Find the probability that at least one will land in the prescribed zone	Understanding	2
10	Two cards are drawn from a 52 Cards 1. Given the first card is a queen, what is the probability that the second is also a queen? 2. Repeat part a) for the first card a queen and the second card a 7 3. What is the probability that both cards will be a queen?	Understanding	1
ANALYTICAL QUESTIONS			
1	If a box contains 75 good diodes and 25 defective diodes and 12 diodes are selected at random, find the probability that at least one diode is defective.	Analyze	1
2	A box with 15 transistors contains five defective ones. If a random sample of three transistors is drawn, what is the probability that all	Analyze	2
3	A coin is to be tossed until a head appears twice in a row. What is the sample space for this experiment? If the coin is fair, what is the probability that it will be tossed exactly four times?	Apply	2
4	We are given a box containing 5000 transistors, 1000 of which are manufactured by company X and the rest by company Y. 10% of the transistors made by company X are defective and 5% of the transistors made by company Y are defective. If a randomly chosen transistor is found to be defective, find the Probability that it came.from company X.	Analyze	2
5	A batch of 50 items contains 10 defective items. Suppose 10 items are selected a random and tested. What is the probability that exactly 5 of the items tested are defective?	Analyze	1
UNIT II **Distribution & Density Functions and Operation on One Random Variable – Expectations** **SHORT ANSWER TYPE QUESTIONS**			
1	Define probability density function?	Remember	2
2	Define probability distribution function?	Remember	2

3	Write any two properties of density function?	Remember	2
4	Write any two properties of distribution function?	Remember	2
5	Define uniform density function?	Remember	2
6	Define uniform distribution function?	Remember	2
7	Define Gaussian density function?	Remember	2
8	Define Gaussian distribution function?	Remember	2
9	Define Poisson distribution function	Remember	2
10	Define mean and mean square values?	Remember	3
	LONG ANSWER QUESTIONS		
1	Derive expressions for mean and variance for uniform random variable?	Analysis	4
2	Two Gaussian random variables X and Y have a correlation coefficient The standard deviation of X is 1.9A linear transformation (coordinate rotation of) is known to transform X and Y to new random variables that are statistically independent. What is variance of Y?	Evaluate	4
3	Explain density function with four properties	Remember	3
4	State and prove any four properties of distribution function?	UNDERSTAND	2
5	Derive expressions for mean and variance for Gaussian variable?	UNDERSTAND	2
6	Derive expressions for mean and variance for Poisson random	UNDERSTAND	2
7	Derive expressions for mean and variance for binomial random	UNDERSTAND	2
8	Derive expressions for mean and variance for exponential random variable?	UNDERSTAND	2
9	Derive expressions for mean and variance for Raleigh random variable?	UNDERSTAND	2
10	Explain characteristic function and moment generating function?	UNDERSTAND	2
	ANALYTICAL QUESTIONS		

1	A random variable X has probability density function $f_X(x) = \begin{cases} Cx(1-x) & ; \quad 0 \le x \le 1 \\ 0 & ; \quad else\ where \end{cases}$ i) Find C ii) Find $P\left[\frac{1}{2} \le X \le \frac{3}{4}\right]$	Apply	3
2	The characteristic function for a Gaussian random variable X, having a mean value of 0, is $\Phi X(\omega)$ =EXP(-sigma ^{2}/w ^{2}) Find all the moments of X using ΦX(w)	Apply	3
UNIT III **Multiple Random Variables and Operations** **SHORT ANSWER TYPE QUESTIONS**			
	PART-A		
1	Define probability density function for two random variables?	Remember	2
2	Define probability distribution function for two random variables?	Remember	2
3	Give properties of probability density function?	Remember	2
4	Give properties of probability distribution function?	Remember	2
	PART-B		
5	If X and Y are orthogonal what is the value of co-variance?	Remember	2
6	Define the relation between joint moments and joint central moments for n random variables?	Remember	2
7	Define skew for two random variables?	Remember	2
8	Define correlation?	Remember	2
9	Define joint central moments for x and y random variables with n=4,k=5?	Remember	2
10	What is the expected value of 2x in the interval -10<x<10?	Remember	2
11	Define marginal density function fY(y) function for joint Gaussian random variable?	Remember	2
12	If x and y are orthogonal what is the value of Rxy?	Remember	2
13	Define joint moments about the origin for n=4,k=5?	Remember	2
14	If x and y are un-correlated what is relation between co-	Remember	2

	relation between x and y and individual expectations?		
15	What is the min and max value of co-relation co-efficient?		2
16	Define joint central moments for x and y random variables?	Remember	2
17	Define covariance?	Remember	2
18	Define joint characteristic function for x and y random variables?	Remember	2
19	Define the relation between joint moments and joint central moments for two random variables x and y?	Remember	2
20	Define mean square value for two random variables?	Remember	2
21	Define Gaussian random variables for two random variables x and y?	Remember	2
22	Define joint Gaussian for n-random variables?	Remember	2
23	Define the Jacobin matrix for n-random variables?	Remember	2
24	Define the concept of transformation of multiple random variables?	Remember	2
25	Write any two properties of joint Gaussian random variables?	Remember	2
26	Define linear transformation of Gaussian random variables?	Remember	2
27	Define second order central moments?	Remember	2
28	Define first order central moments for two random variables x and y?	Remember	2
29	If co-variance is 0 what it means?	Remember	2
30	Define co-relation co-efficient?	Remember	2
31	Define third order central moments for two random variables x and y?	Remember	2
LONG ANSWER QUESTIONS			
1	State and explain probability density function for two random variables?	Remember	2
2	State and explain probability distribution function for two random variables?	Remember	2
3	State any four properties of probability density function?	Remember	2
4	State any four properties of probability distribution function?	Remember	2

5	A random process X(t)=A ,where A is a random variable find the time average of the process.	Analysis	5
6	Explain briefly about time average and Ergodicity.	Understand	5
7	Explain how random processes are classified with neat sketches.	Understand	5
8	A random process is given as X(t)=At ,where A is an uniformly distributed random variable	Creating	5
9	State and prove any four properties of auto correlation function.	Remember	2
10	State and prove any four properties of cross correlation function.	Remember	2
ANALYTICAL QUESTIONS			
1	The joint PDF of X and Y is $f_{(X,Y)}(x, y) = 5y/4$ $-1 \le x \le 1$, $x^2 \le y \le 1$, 0 otherwise. Find the marginal PDFs $f_X(x)$ and $f_Y(y)$	Analysis	2
2	The joint probability density function of random variables X and Y is $f_{X,Y}(x, y) = 6(x + y^2)/5$ $0 \le x \le 1, 0 \le y \le 1$, $= 0$ otherwise.	Analysis	2
3	X and Y have joint Pdf $f_{X,Y}(x, y) = -1/15$ $0 \le x \le 5, 0 \le y \le 3$, 0 otherwise. Find the PDF of W = max(X, Y)	Analysis	2
UNIT IV **Stochastic Processes – Temporal Characteristics:** **SHORT ANSWER TYPE QUESTIONS**			
1	Define random process?	Remember	2
2	Define ergodicity?	Remember	2
3	Define mean ergodic process?	Remember	2
4	Define correlation ergodic process?	Remember	2
5	Define first order stationary process?	Remember	2
6	Define second order stationary process?	Remember	2
7	Define wide sense stationary random process?	Remember	2
8	Define strict sense stationary random process?	Remember	2
9	Define auto correlation function of a random process?	Remember	2

10	Define cross correlation function of a random process?	Remember	2
LONG ANSWER QUESTIONS			
1	Explain classification of random process	Understand	6
2	Explain wide sense stationary random process?	Understand	6
3	State and prove any four properties of cross correlation function.	Remember	2
4	State and prove any four properties of auto correlation function.	Remember	2
5	(a) State and prove the properties of Autocorrelation function. (b) Show that the process $X(t)= A \cos(w_0t+\theta)$ is wide sense stationery if it is assumed that A and w_0 are constants and θ is random variable which is uniformly distributed over interval $[0,2\pi]$.	Remember	2
6	(a) State and prove the properties of Cross correlation function. (b) Find the mean and auto correlation function of a random process X(t)=A , where A is continuous random variable with uniform distribution over (0,1).	Remember	2
7	(a) Write the conditions for a Wide sense stationary random process. (b) Let two random processes X(t) and Y(t) be defined by $X(t) = A \cos(w_0t) + B \sin(w_0t)$ and $Y(t) = B \cos(w_0t) - A \sin(w_0t)$. Where A and B are random variables and w_0 is constant. Show that X(t) and Y(t) are jointly wide sense stationery, assume A and B are uncorrelated zero- mean random variables with same variance.	Remember	2
ANALYTICAL QUESTIONS			
1	The power Spectral density of X(t) is given by $S_{xx}(w)=1/1+w^2$ for $w>0$ Find the autocorrelation function	Analysis	5
2	A random process is defined by $Y(t)=X(t).\cos(wt+\theta)$ where X(t)= $A\sin(wt+\theta)$ is a wide sense stationary random process that amplitude modulates a carrier of constant angular frequency w with a Random phase θ independent of X(t) and uniformly distributed on $(-\pi,\pi)$.	Analysis	5

3	Show that the process $X(t)= A \cos(w_0t+\theta)$ is wide sense stationery if it is assumed that A and w_0 are constants and θ is uniformly distributed random variable over the interval (0,2π).	Analysis	5
UNIT V **Stochastic Processes – Spectral Characteristics:** **SHORT ANSWER TYPE QUESTIONS**			
1	Define wiener khinchinen relations?	Remember	2
2	State any two properties of cross-power density spectrum.	Remember	2
3	Define cross –spectral density and its examples.	Remember	2
4	State any two uses of power spectral density.	Remember	2
5	Write any two properties of power spectral density?	Remember	2
6	Define Spectral density?	Remember	2
7	Write power spectral density of system response?	Remember	2
8	Write Cross power spectral density of input and output of system?	Remember	2
9	Prove that $S_{XY}(W) = S_{YX}(-W)$?	Remember	2
10	Prove that real part of S_{XY}(W is an even function?	Remember	2
LONG ANSWER QUESTIONS			
1	A random processes X(t)= Asin(wt+θ) , where A , w are constants and θ is a uniformly distributed random variable on the interval (-π ,π) .find average power?	Understand	5
2	Prove wiener khinchinen relation?	Remember	2
3	Derive the expression for power spectral density ?	Remember	2
4	Derive the expression for average power of a random process x(t)?	Remember	2
5	Derive the expression for cross average power of a random process x(t) and y(t)?	Remember	2
6	Derive the Relationship b/w power density spectrum and auto co- relation function?	Remember	2
7	Derive the Relationship b/w cross power density spectrum and cross co-relation function?	Remember	2
ANALYTICAL QUESTIONS			

1	Let the auto correlation function of a certain random process X(t) be given by $Rn(\tau)=(A^2/2)(\cos(\omega\tau))$ Obtain an expression for its power spectral density $S_n(\omega)$.	Analysis	7
2	A wide sense stationary process X(t) has autocorrelation function $R_X(\tau)=Ae^{-b\|\tau\|}$ where b > 0. Derive the power spectral density function	Analysis	7

Objective Type Questions

Unit-I: Probability

1. The sample space for the experiment of measurement of the output voltage V from a minimum of which one +5 and -5V respectively is [ ]

(a) { V: $0 \le V \le 5$ } (b) { V: $-\infty \le V \le \infty$ }

(c) { V: $1 \le V \le 5$ } (d) { V: $-5 \le V \le 5$ }

2. A∩ [BUC] is expressed as [ ]

(a) (AUB) ∩ C (b) (AUB) ∩ (AUC)

(c) (A∩B) U C (d) (A∩B) U (A∩C)

3. When two dice are throwing, the probability for the sum of the faces of the two dices to be 7 is

(a) 1/6 (b) 1/12 (c) 1/9 (d) 1/3 [ ]

4. If A is a subset of B, P (B/A) is [ ]

(a) 1 (b) P(B) (c) P(A ∩ B) (d) P(A U B)

5. Let S_1&S_2 be the sample spaces of two sub experiments. The considered sample space S is [ ] (a) S_1/S_2 (b) $S_1 * S_2$ (c) $S_1 - S_2$ (d) $S_1 + S_2$

6. Let A be any event defined on a sample space then P (A) is [ ] (a) ≥0 (b) < ∞ (c) > ∞ (d) ≥ 1

7. The conditional probability of event A, given B is expressed as [ ]

(a)P(A∩B)/P(A) (b)P(AUB)/P(A)

(c) P(AUB)/P(A) (d) P(AUB)/P(A)

8. For three events A_1, A_2, A_3 they are said to be independent allover axis if and only if they are independent as a triple then $P(A_1 \cap A_2 \cap A_3)$ is [ ]

(a) P (A_1) P(A_2) (b) P (A_1) P(A_2) P(A_3)

(c) P (A_2) P(A_3) (d) P (A_1) P(A_3)

9. Two dimensional product space is known as [ ]

(a) Vector (b) Range of sample space

(c) Sample Space (d) Phasor

10. The sample space for the experiment for measuring (in hours) the lifetime of a [ ]

Transistor is S, given by

(a) { r: $-1 \leq r \leq 100$ } (b) { r: $0 \leq r \leq -\infty$ }

(c) { r: $-\infty \leq r \leq \infty$ } (d) { r: $0 \leq r \leq \infty$ }

Fill in the blanks

11. $(AUB)^c = A^c \cap B^c$ is…………

12. If A and B are mutually exclusive events, P (AUB) is ……………

13. Probability of causes is also called …………..

14. Non deterministic experiment is also called ……………..

15. A set containing only one element is called…………..

16. The range of Probability is always ………….

17. For n= 1,2,………N . $P(B_n/A)$ is …………..

18. Let sets A={ $2 < a \leq 16$} B ={ $5 < b \leq 22$} where S={ $2 \leq S \leq 24$ } If C= A ∩ B , then C is ………..

19. Let A be any event defined on a sample space then P (A) is

20. consider A={1,3,5,12} B={2,6,7,8,9,10,11} c={1,3,4,6,7,8} hence A∩B is

Key: (1) D (2) D (3) A (4) A (5) B (6) A (7) C (8) B (9) B (10) D

(11) De-Morgens law (12) P(A)+P(B) (13)Baye's theorem
(14) Random experiment (15) singleton (16) $0 \leq P(A) \leq 1$
(17) $P(A/B_n)\, P(B_n)/P(A/B_1)\, P(B_1)+ \ldots\ldots P(A/B_n)\, P(B_n)$ (18) $\{2<c\leq 24\}$

(19) ≥ 0 (20) Zero

Unit-II: Random variables

1. The PDF $f_x(x)$ is defined as [ ]
   (a) Integral of CDF (b) Derivative of CDF
   (c) Equal to CDF (d) Partial derivative of CDF

2. A discreet RV is one having [ ]
   (a) Continuous values (b) 1, 2

(c) -∞ to 0 (d) only discreet

3. If X is Poisson RV then the distribution function is given by [ ]

(a) $e^{-b} \sum_{k=0}^{\infty} b^k/k!\ u(x-k)$

(b) $e^{-b} \sum_{k=0}^{\infty} b^k\ u(x-k)$

(c) $e^{-b} \sum_{k=0}^{\infty} b^k/k!$

(d) $e^{-b} \sum_{k=0}^{\infty} b^k/k!\ u(x-k)$

4. According to Bernoulli's trials, let number of trials N, probability is p, then P (A occurs exactly K times) is [ ]

(a) (NK) $(1-P)^{N-K}$ (b) $P^K (1-P)^{N-K}$

(c) (NK) P^K (d) $K^N (P)^K (1-P)^{N-K}$

5. If X is a discreet RV denoted by X_i , the CDF $F_x(x)$ is

(a) $\sum_{i=1}^{\infty} P(X_i)\ u(x)$

(b) $\sum_{i=1}^{\infty} P(X_i)\ u(x-x_i)$

$$(c)\ \sum_{i=1}^{\infty} P(X_i)\, u(x_i)$$

$$(d)\ \sum^{\infty} P(X_i)\, u(x_i)$$

6. The distribution function of Gaussian RV is [ ]
(a) $F(x/\ _x)$ (b) $F((x+a_x)/\ _x)$ (c) $F((x-a_x)/\ _x)$ (d) $F(x-a_x)$

7. The uniform probability density function defined by [ ]
(a) ab (b) 1/b-a for a≤x≤b (c) 1/b+a (d) b/a

8. A continuous RV is one having [ ]
(a) Continuous range of value (b) -∞ to
(c) Containing (d) some con

9. A mixed random RV is one having [ ]
(a) Discrete values only (b) - ∞ to 0 only (c) Both continuous and discrete (d) continuous values only

10. A real RV defined as [ ]
(a) A real function of the elements of Sample space.
(b) A discrete function of the elements
(c) A complex function of the elements
(d) A complex function of the elements of Sample space

<u>Fill in the blanks</u>

11. A discrete random variable can take a …………… number of values within its range
12. A continuous random variable can take any value within its ……………
13. The probability mass function is also called as …………….
14. The value of P(X=-∞) = P(X=∞) is ……………
15. The value of CDF $F_X(-\infty)$ is …….. And $F_X(\infty)$ is ……..
16. The PDF satisfy the relation …………..
17. A random variable with a uniform distribution is an example of …………
18. The Gaussian distribution function is defined as …………….
19. The PDF of sum of a large number of RV's approaches a …………..
20. Probability distribution function $F_X(x)$ is ………..

Key:

1. B	11. Finite
2. D	12. Domain or range
3. D	13. PDF
4. D	14. Zero
5. B	15. 0 and 1
6. A	16. $\int_{-\infty}^{\infty} f(x)\,dx = 1$
7. B	17. Continuous type
8. A	18. Continuous random variable
9. C	19. Gaussian distribution
10. A	20. $P(X \leq x)$

Unit-III: Operation on One Random variable

1. The normalized third central moment is known as [ ]

(a) Mean (b) Skewness of density function

(c)Standard Deviation (d) Variance of density function

2. At $\omega=0$, $\Phi_x(\omega)$ is [ ]

(a) ∞ (b) 1 (c) 0 (d) -1

3. The distribution function of one RV X conditioned by a second RV Y with interval $\{ y_a \leq y \leq y_b \}$ is known as
[ ]

(a) Moment generation (b) Point Conditioning

(c) Expectation (d) Interval Conditioning

4. $F_x (x_2 / B) – F_x (x_1 / B)$ is [ ]

(a) $P(x1/B < x \le x_2)$ (b) $P(x_2 < x \le x_2/B)$
(c) $P(x_2 /B < X)$ (d) $P\{(x_1 < x \le x_2)/B\}$

5. If X is a discreet RV denoted by X_i , the CDF F_x (x) is [ ]

(a) $\sum_{i=1}^{\infty} P(X_i) u(x)$ (b) $\sum_{i=1}^{\infty} P(X_i) u(x- x_i)$

(c) $\sum_{i=1}^{\infty} P(X_i) u(x_i)$ (d) $\sum_{i=1}^{\infty} P(X_i) u(x_i)$

6. MGF is given by $M_X(V)$ is [ ]

(a) $E[e^v]$ (b) $E[e^{vX}]$ (c) $e^V x$ (d) $E(e^{2x})$

7. The PDF of sum of a large number of RV's approaches a distribution [ ]

(a) Rayleigh (b) Uniform (c) Gaussian (d) Poisson

8.Gaussian R.V's are completely defined through only their

(a) first order moments (b) Second order moments

(c) First order moments & Second order moments (d) Covariance

9. X and Y are said to be statistically independent RV's when P(X<x, Y<y) is [ ]

(a) P(X<x) (b) P(X>x) P(Y<y)
(c) P(X<x) P(Y>y) (d) P(X<x) P(Y<y)

10. A transformation T is called monotonically decreasing if [ ]

(a) T(X1) > T(X2) for X1<X2 (b) T(X1) = T(X2) for X1<X2

(c) T(X1) < T(X2) for X1<X2 (d) T(X1) >T(X2) for X1<X2

Fill in the blanks

11. The maximum magnitude of a characteristic function is …………

12. The n^{th} central moment μ_n is ……………..

13. The second central moment is also known as ……………

14. The distribution function of Gaussian RV is …………..

15. If Y = T(X) then $F_Y(y)$ is ……………….

16. If X is discreet RV for which N possible values x_i having probabilities $P(x_i)$ of occurrence then expected value is

17. The uniform probability density function …………

18. The number $(^n{}_r)$ central to the expansion of the binomial $(x+y)^n$,the numbers $(^n{}_r)$ are called …...

19. If X is a discrete RV, then E [g(X)] is ………………….

20. If y=ax+b, the covariance of x and y is ……………..

Answer: 1. B 2. B 3. D 4. D 5. B 6. B
7.C 8. C 9. D 10. D
11. 1

12. $\int_{-\infty}^{\infty} (x- \bar{x})^n f_x(x)\, dx$

13. Variance

14. $F((x-a_x)/\sigma_x)$

15. $f_X(x)\, dx/dy$

16. **$\sum_{i=1}^{N} x_iP(x_i)$**

17. **1/(b-a) for a≤x≤b**

18. **Binomial coefficient**

19. $\sum_{i=1}^{N} g(x_i)P(x_i)$

20. $a\sigma_x^2$

Unit-IV: Multiple Random variables

1. If $y=X_1+ X_2 +$………….. $+X_N$ where X_1, X_2 ,……………. X_N are statically independent RV's then

$f_y(y)$ is

(a) $f_{x1}(x1)+ f_{x2}(x2)+$………$+ f_{xN}(x_N)$ (b) $f_{x1}(x1)- f_{x2}(x2)+$………$+ f_{xN}(x_N)$
(c) $f_{x1}(x1)* f_{x2}(x2)*$………$*f_{xN}(x_N)$ (d) $f_{x1}(x1) - f_{x2}(x2) -$ ………$- f_{xN}(x_N)$

2. The distribution function of one RV X conditioned by a second RV Y with interval $\{ y_a \le y \le y_b \}$ is known as

(a) Moment generation (b) Point Conditioning

(c) Expectation (d) Interval conditioning

3. Given voltage Y=g (V) – V^2 ……….. The average power Y is

(a) 10 W (b) 15 W (c) 20 W (d) 5 W

4. $F_x (x_2 / B) – F_x (x_1/ B)$ is

(a) $P(x_1/B < x \le x_2)$ (b) $P(x_1< x \le x_2/B)$

(c) $P(x_2 /B < X)$ (d) $P\{(x_1< x \le x_2)/B\}$

5. Joint Distribution Function $F_{XY} (\infty , \infty)$ is

(a) 1 (b) 2 (c) 0 (d) -1

6. X and Y are said to be statistically independent RV's when P(X<x, Y<y) is

(a) P(X<x) (b) P(X>x) P(Y<y) (c) P(X<x) P(Y>y) (d) P(X<x) P(Y<y)

7. In an electrical circuit both current and voltage can be ……….. Variable.

(a) Single (b) triple (c) two (d) none

8. A continuous RV is one having

(a) Continuous range of value (b) -∞ (c) Containing (d) Some con

9. If events A and C are mutually exclusive P(AUC / B) is equal to

(a) P(A/B) + P(C) (b) P(B/A) + P(C) (c) P(A) + P(C/B) (d)) P(A/B) + P(C/B)

10. Let S_1 and S_2 be the sample space of the sub experiments. If S_1 has M elements and S_2 has N elements, then combined sample space S will have

(a) M elements (b) N elements (c) ∞ (d) MN elements

Answers: 1. C 2.D 3.D 4.D 5.A 6.D 7.C 8.A 9.D 10.D

<u>Unit-V: OPERATION ON MULTIPLE RANDOM VARIABLES</u>

1. Find the expected value of $g(X_1, X_2, X_3, X_4) = X_1^{n_1} X_2^{n_2} X_3^{n_3} X_4^{n_4}$ where n where n_1, n_2, n_3 and n_4 are integers ≥ 0 and , $f_{x_1x_2x_3x_4} (x_1, x_2, x_3, x_4) = f_{x_1x_2x_3x_4}$ for $0 < x_1 < a$; $0 < x_2 < b$;

$< x_3 < c; 0 < x_4 \angle d$

$= 0$ else where

(a) $\frac{1}{(n+1)^4}$ (b) $(n + 1)^4$ (c) $\frac{(abcd)^n}{(n+1)^4}$ (d) $\frac{(n+1)^4}{(abcd)^n}$

2. If g(x, y) is some function of two R.V's X and Y the expected value of g(x, y) is

(a) $\int_{-\infty}^{\infty} g(x,y)\,dx$

(b) $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} g(x,y)\,dx\,dy$

(c) $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} g(x,y) f_{x,y}(x,y)\,dx\,dy$

(d) $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f_{x,y}(x,y)\,dx\,dy$

3. The (n + K)[th] order joint moment of two R.V's X and Y is defined as m_{nk}

(a) $\int_{-\infty}^{\infty} x^n f(x,y)dx$

(b) $\int_{-\infty}^{\infty} y^K f(x,y)dy$

(c) $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)dxdy$

(d) $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} x^n y^K f(x,y)dxdy$

4. The (n + K)[th] order joint central moment of the R.V's X and Y is defined as m_{nk}

(a) $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} x^n y^K f(x,y)dxdy$

(b) $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} g(x,y)dxdy$

(c) $\int_{-\infty}^{\infty} (X - m_x)^n f(x,y)dx$

(d) $\int_{-\infty}^{\infty} (Y - m_y)^K f(x,y)dy$

5. Which of the following Relation is correct

(a) $|\sigma XY| \le \sigma X \sigma Y$

(b) $|\sigma XY| < \sigma X \sigma Y$

(c) $|\sigma XY| \ge \sigma X \sigma Y$

(d) $|\sigma XY| > \sigma X \sigma Y$

6. The joint moments m_{nk} can be found from the joint characteristic function as m_{nk}

(a) $(-j)^{n+K} \left.\frac{\partial^{n+K} \phi_{X,Y}(w_1, w_2)}{\partial w_1^n \partial w_2^K}\right|_{w_1=0, w_2=0}$

(b) $(j)^{n+K} \left.\frac{\partial^{n+K} \phi_{X,Y}(w_1, w_2)}{\partial w_1^n \partial w_2^K}\right|_{w_1=0, w_2=0}$

(c) $\left.\frac{\partial^{n+K}\phi_{X,Y}(w_1,w_2)}{\partial w_1^n \partial w_2^K}\right|_{w_1=0,w_2=0}$ (d) $\left.\frac{-\partial^{n+K}\phi_{X,Y}(w_1,w_2)}{\partial w_1^n \partial w_2^K}\right|_{w_1=0,w_2=0}$

7. The joint characteristic function of two r.v's X and Y is given as

$\varphi_{X,Y}(w_1,w_2)=\exp^{m_{x_1}}$ Then the means of X and Y are respectively

(a) 0, 0 (b) 0, 1 (c) 1 (d) 0

8. The joint characteristic function of two R.V's X and Y is defined by $\phi_{X,Y}(w_1, w_2) =$

(a) $E = \left[e^{w_1X+w_2Y}\right]$ (b) $E = \left[e^{w_1+w_2}\right]$

(c) $E = \left[e^{X+Y}\right]$ (d) $E = \left[e^{jw_1X+jw_2Y}\right]$

9. The expression for joint characteristic function of two r.V's X and Y in integral form is $\phi_{X,Y}(w_1, w2) =$

(a) $\int_{-\infty}^{\infty} f_{X,Y}(x,y)dx$ (b) $\int_{-\infty}^{\infty} f_{YY}(x,y)dy$

(c) $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f_{X,Y}(x,y)e^{jw_1X+jw_2Y}dx.dy$ (d) $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} F_{X,Y}(x,y)e^{jw_1X+jw_2Y}dx.dy$

10. The expression for joint characteristic function $\Phi_{X,Y}(w_1, w2)$ is recognized as the two dimensional

(a) Fourier transform of joint density function

(b) Fourier transform of joint distribute function

(c) Inverse Fourier transform of joint distribute functions

(d) Inverse Fourier transform of joint density function

11. The marginal density function of X is given by $f_X(x) =$

(a) $\frac{1}{\sqrt{2\pi\sigma_X^2}}\exp\left[\frac{-(x-\overline{X})^2}{2\sigma_X^2}\right]$ (b) $\frac{1}{\sqrt{2\pi}}\exp\left[\frac{-(x-\overline{X})^2}{2\sigma_X^2}\right]$

(c) $\frac{1}{\sqrt{2\pi\sigma_X^2}}\exp\left[\frac{(x-\overline{X})^2}{2\sigma_X^2}\right]$ (d) $\frac{1}{\sqrt{2\pi}}\exp\left[\frac{(x-\overline{X})^2}{2\sigma_X^2}\right]$

12. X and Y are Gaussian r.v's with variances σ_X^2 and σ_y^2. Then the R.V's V = X + KY and w = X - KY are statistically independent for K equal to

(a) $\sigma x \quad \sigma y$ (b) $\frac{\sigma_X}{\sigma_Y}$ (c) $\frac{\sigma_Y}{\sigma_X}$ (d) $\sigma x + \sigma y$

13. X and Y are jointly Gaussian R.Vs with same variance and ρxy = -1. The angle θ of a co-ordination rotation that generates non r.v's that are statically independent is

(a) $\frac{\pi}{2}$ (b) $-\frac{\pi}{2}$ (c) $-\frac{\pi}{4}$ (d) π

14. Two R.V's X and Y are said to be jointly Gaussian if their joint density function is of the form $f_{X,Y}(x, y)$ =

(a) $$\frac{1}{2\pi\sigma_x\sigma_y}.\exp\left\{\frac{-1}{2(1-\rho^2)}\left[\frac{(x-\bar{X})}{\sigma_x^2}-\frac{2\rho(x-\bar{X})(y-\bar{Y})}{\sigma_x\sigma_y}+\frac{(y-\bar{Y})^2}{\sigma_y^2}\right]\right.$$

(b) $$\frac{1}{2\pi\sigma_x\sigma_y\sqrt{1-\rho^2}}.\exp\left\{\frac{-1}{2(1-\rho^2)}\left[\frac{(x-\bar{X})}{\sigma_x^2}-\frac{2\rho(x-\bar{X})(y-\bar{Y})}{\sigma_x\sigma_y}+\frac{(y-\bar{Y})^2}{\sigma_y^2}\right]\right.$$

(c) $$\frac{1}{2\pi\sqrt{1-\rho^2}}.\exp\left\{\frac{-1}{2(1-\rho^2)}\left[\frac{(x-\bar{X})}{\sigma_x^2}-\frac{2\rho(x-\bar{X})(y-\bar{Y})}{\sigma_x\sigma_y}+\frac{(y-\bar{Y})^2}{\sigma_y^2}\right]\right.$$

(d) $$\frac{1}{\sqrt{1-\rho^2}}.\exp\left\{\frac{-1}{2(1-\rho^2)}\left[\frac{(x-\bar{X})}{\sigma_x^2}-\frac{2\rho(x-\bar{X})(y-\bar{Y})}{\sigma_x\sigma_y}+\frac{(y-\bar{Y})^2}{\sigma_y^2}\right]\right.$$

15. Gaussian R.V's are completely defined through only their

(a) first order moments (b) Second order moments

(c) First order moments & Second order moments (d) Covariance

16. X and Y are two independent normal r.v's $N(m, \sigma^2) = N(0, 4)$. Consider V = 2X + 3Y is a R.V.

(a) Rayleigh (b) Gaussian (c) poison (d) Binomial

17. If $F_X(x_1, x_2 : t_1, t_2)$ is referred to as second order joint distribution function then the corresponding joint density function is

(a) $\frac{\partial}{\partial x_1} F_X(x_1, x_2 : t_1, t_2)$

(b) $\frac{\partial}{\partial x_2} F_X(x_1, x_2 : t_1, t_2)$

(c) $\frac{\partial^2}{\partial x_1 \partial t_2} F_X(x_1, x_2 : t_1, t_2)$

(d) $\frac{\partial^2}{\partial x_1 \partial x_2} F_X(x_1, x_2 : t_1, t_2)$

18. The mean of random process X(t) is the expected value of the R.V X at time t i.e., the mean m(t) =

(a) $\int_{-\infty}^{\infty} f_X(x,t)dx$ (b) $\int_{-\infty}^{\infty} x.f_X(x,t)dx$ (c) $\int_{-\infty}^{\infty} f_X(x,t)dt$ (d) $\int_{-\infty}^{\infty} x.f_x(x,t)dt$

19. The random process X(t) and Y(t) are said to be independent, if $f_{XY}(x_1, y_1 : t_1, t_1)$ is =

(a) $f_X(x_1 : t_1)$ (b) $f_Y(y_1 : t_2)$ (c) $f_X(x_1 : t_1)\, f_Y(y_1 : t_2)$ (d) 0

20. The interval between two consecutive occurrences of Poisson process is ____r.v.

(a) Gaussian (b) Poisson (c) expential (d) binomial

21. Which of the following is correct

(a) $\rho > 1$ (b) $-\infty < \rho < \infty$ (c) $0 \le \rho \le 1$ (d) $-1 \le \rho \le 1$

22. Let Z and w be two R.V's expressed as functions of two R.V's X and Y i.e., Z = g(X, Y) and W = h (X, Y) there the joint pdf of Z and w is given as f_{Zw} (Z, W) =

(a) $f_{XY}(x, y)$ (b) $f_{XY}(x,y).|J(x,y)|$ (c) $f_{XY}(x, y)\, e^{jWX}$ (d) $f_{XY}(x, y) .\, e^{-jWX}$

23. The Jacobian of the transformation x = V , y = ? (u - v) is

(a) $\frac{1}{2}$ (b) $\frac{-1}{2}$ (c) 1 (d) 2

24. X and Y are R.V's transformed as $x = \frac{u}{v}$ and y = V. The jacobian of this transformation is

(a) V (b) -V (c) $\frac{1}{V}$ (d) $\frac{1}{V^2}$

Answers: 1.C 2.C 3.D 4.B 5.A 6.A
7. A 8.D 9.C 10.A 11.A
12.C 13.C 14.B 15.C 16.B

17.D 18.B 19.C 20. 21.D
22.B 23.B 24.C

Unit-VI: STOCHASTIC PROCESSES-TEMPORAL CHARACTERISTICS

1. Cov (X, Y) {covariance of (X, Y) is}
   (a) E(XY) (b) E(XY) - E(X)
   (c) E(XY) - E (X) E (Y) (d) E(XY) + E(X)E(Y)

2. If $R_{XY} = 0$ then X and Y are
   (a) independent (b) orthogonal
   (c) independent & orthogonal (d) Statistically independent

3. Te collection of all the sample functions is referred to a as
   (a) Ensemble (b) Assemble
   (c) Average (d) Set

4. If the future value of a sample function cannot be predicted based on its past, values, the process is referred to as.
   (a) Deterministic process (b) non-deterministic process
   (c) Independent process (d) Statistical process

5. If the future value of the sample function can be predicted based on its past values, the process is referred to as
   (a) Deterministic process (b) non-deterministic process
   (c) Independent process (d) Statistical process

6. If sample of X(t) is a R.V then the cumulative distribution function $FX(x_1 : t_1)$ is
   (a) $P(X(t_1))$ (b) $P(X(t_1) \leq 0)$
   (c) $P(X(t_1) \leq x_1)$ (d) $P(X(t_1) \geq x_1)$

7. The random process X(t) and Y(t) are said to be independent, if $f_{XY}(x_1, y_1 : t_1, t_1)$ is =
   (a) $f_X(x_1 : t_1)$ (b) $f_Y(y_1 : t_2)$
   (c) $f_X(x_1 : t_1)\, f_Y(y_1 : t_2)$ (d) 0

8. A random process is defined as $X(t) = \cos(w_o t + \theta)$, where θ is a uniform random variable over (-π, π). The second moment of the process is
   (a) 0 (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) 1

9. For the random process X(t) = A coswt where w is a constant and A is a uniform R.V over (0, 1) the mean square value is

(a) $\frac{1}{3}$

(b) $\frac{1}{3}\cos wt$

(c) $\frac{1}{3}\cos^2 wt$

(d) $\frac{1}{9}$

10. A stationary continuous process X(t) with auto-correlation function $R_{XX}(\tau)$ is called autocorrelation-ergodic or ergodic in the autocorrelation if, and only if, for all τ

(a) $\frac{1}{2T}\int_{-T}^{T} X(t).X(t+\tau)dt = R_{XX}(\tau)$

(b) $\underset{T\to\infty}{Lt}\frac{1}{2T}\int_{-T}^{T} X(t).X(t+\tau)dt = R_{XX}(\tau)$

(c) $\int_{-\infty}^{\infty} X(t).X(t+\tau)dt = R_{XX}(\tau)$

(d) $\int_{-\infty}^{\infty} X(t).dt = 0$

11. A random process is defined as X(T) = A cos(wt + θ), where w and θ are constants and A is a random variable. Then, X(t) is stationary if

(a) F(A) = 2

(b) F(A) = 0

(c) A is Gaussian with non-zero mean

(d) A is Reyleigh with non-zero mean

12. For an ergodic process

(a) mean is necessarily zero

(b) mean square value is infinity

(c) all time averages are zero

(d) mean square value is independent if sine

13. Two processes X(t) and Y(t) are statistically independent if

(a) $F_{X,Y}(x_1,\ldots x_N,y_1\ldots y_M) = F_X(x_1\ldots x_N)F_Y(y_1\ldots y_M)$

(b) $f_{X,Y}(x_1,\ldots x_N,y_1\ldots y_M) = f_X(x_1\ldots x_N)f_Y(y_1\ldots y_M)$

(c) $F_{X,Y}(x_1,\ldots x_N,y_1\ldots y_M;t_1\ldots t_N,t_1^1\ldots t_M^1) = f_X(x_1\ldots x_N;t_1\ldots t_N)f_Y(y_1\ldots y_M;t_1^1\ldots t_M^1)$

(d) $f_{X,Y}(x_1,\ldots x_N,y_1\ldots y_M;t_1\ldots t_N,t_1^1\ldots t_M^1) = f_X(x_1\ldots x_N;t_1\ldots t_N)f_Y(y_1\ldots y_M;t_1^1\ldots t_M^1)$

14. Let X(t) is a random process which is wide sense stationery then

(a) E[X(t)] = constant

(b) E[X(t) . X[t + τ)] = R_{XX} (τ)

(c) E[X(t)] = constant and E[X(t) . X[t + τ)] = R_{XX} (τ)

(d) E[X^2(t)] = 0

15. A process stationary to all orders N = 1, 2, ---- &. For $X_i = X(t_i)$ where i = 1, 2, -------N is called

(a) Strict-sense stationary

(b) wide-sense stationary

(c) Strictly stationary

(d) independent

16. Time average of a quantity x(t) is defined as A[x (t)] =

(a) $\int_{-T}^{T} x(t).dt$ (b) $\frac{1}{2T}\int_{-T}^{T} x(t).dt$ (c) $\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T} x(t).dt$ (d) $\underset{T\to\infty}{Lt}\int_{-T}^{T} x(t).dt$

17. Consider a random process X(t) defined as X(t) = A coswt + B sinwt, where w is a constant and A and B are random variables which of the following its a condition for its stationary.
   (a) E (A) = 0, E(B) = 0 (b) E (AB) $\neq$ 0
   (c) E(A) $\neq$ 0; E(B) $\neq$ 0 (d) A and B should be independent

18. X(t) is a wide source stationary process with E[X(t)] = 2 and $R_{XX}(\tau)$ = 2 and $R_{XX}(\tau)$ = y + $e^{-0.1|\tau|}$. Find the mean and variance of $\int_0^1 X(t).dt$.
   (a) 2, 20 [$10e^{-0.1}$ - 9] (b) 1, 10 [$10e^{-0.1}$ + 9]
   (c) 0, 5 [$20e^{-0.1}$ - 9] (d) 0, 10 [$10e^{-0.1}$ + 9]

19. X(t) is a random process with mean 3 and autocorrelation $R(t_1, t_2)$ = $9+4e^{-0.2|t_1-t_2|}$. The covariance of the R.V's Z = X(5) and w = X(8) is
   (a) $e^{-0.6}$ (b) 4 $e^{-0.6}$ (c) 8 $e^{-0.6}$ (d) $\frac{e^{-0.6}}{6}$

20. Let X(t) and Y(t) be two random processes with respective auto correlation functions $R_{XX}(\tau)$ and $R_{YY}(\tau)$. Then $|R_{XY}(\tau)|$ is
   (a) $= \sqrt{R_{XX}(0)R_{YY}(0)}$ (b) $\geq \sqrt{R_{XX}(0)R_{YY}(0)}$
   (c) $\leq \sqrt{R_{XX}(0)R_{YY}(0)}$ (d) $> \sqrt{R_{XX}(0)R_{YY}(0)}$

21. X(t) is a Gaussian process with mean = 2 and auto correlation function $5.e^{-0.2|\tau|}$. Then the variance of the random variable X(2) is
   (a) 21 (b) 25 (c) 4 (d) 1

22. A stationary random process X(t) is periodic with period 2T. Its auto correlation function is
   (a) Non periodic (b) periodic with period T
   (c) Periodic with period 2T (d) periodic with period T/2

23. $R_{XX}(\tau)$ =
   (a) E[X^2 (t)] (b) $\int_{-\infty}^{\infty} X(t).dt$

(c) $\int_{-\infty}^{\infty} X^2(t).dt$ (d) E[x(t) . X(t +τ)]

24. Which of the following is correct

(a) $|R_{XX}(\tau)| \le R_{XX}(0); R_{XX}(-\tau) = R_{XX}(\tau)$

(b) $|R_{XX}(\tau)| < R_{XX}(0); R_{XX}(-\tau) = -R_{XX}(\tau)$

(c) $|R_{XX}(\tau)| \ge R_{XX}(0); R_{XX}(-\tau) = R_{XX}(\tau)$

(d) $|R_{XX}(\tau)| > R_{XX}(0); R_{XX}(-\tau) = -R_{XX}(\tau)$

25. If X(t) is ergodic, zero mean and has no periodic component then

(a) $\lim_{|\tau|\to\infty} R_{XX}(\tau) = 1$ (b) $\lim_{|\tau|\to\infty} R_{XX}(\tau) = 0$

(c) mean is 0 (d) constant mean

Answers: 1.C 2.C 3.A 4.B 5.A 6.C
7. C 8.B 9.C 10.B 11.B
12.D 13.D 14.C 15.A 16.C
17.A 18.A 19.B 20.C 21.D
22.C 23.D 24.A 25.B

Unit-VII: STOCHASTIC PROCESSES-SPECTRAL CHARACTERISTICS

1. The output of a filter is given by Y(t) = X(t + T) = X(t - T). Where X(t) is a WSS process with power spectrum $S_{XX}(w)$ and T is a constant the power spectrum of Y(t) is

(a) $\frac{\sin^2(wT)S_{XX}(w)}{9}$ (b) $9\sin^2(wT).S_{XX}(w)$

(c) $\frac{\sin^2(wT)S_{XX}(w)}{4}$ (d) $4\sin^2(wT).S_{XX}(w)$

2. The PSD of a random process whose auto correlation function is $a.e^{-b|\tau|}$ is

(a) $\frac{a}{a^2+w^2}$ (b) $\frac{2ab}{a^2+w^2}$ (c) $\frac{2a}{b(a^2+w^2)}$ (d) $\frac{2a}{a^2+w^2}$

3. The PSD of a random process X(t) = A.cos(Bt + Y), where Y is a uniform r.v over (0, 2π)

(a) $\frac{\pi A^2}{2}$ (b) $\frac{\pi A^2}{2}[\delta(w+B) - \delta(w-B)]$

(c) $\frac{\pi A^2}{2}[\delta(w+B) + \delta(w-B)]$ (d) $\frac{\pi^2 A}{2}[\delta(w-B) - \delta(w+B)]$

4. The auto correlation function of a random process whose PSD is $\frac{4}{1+\frac{w^2}{4}}$ is

(a) $e^{-2|\tau|}$ (b) $2e^{-2|\tau|}$ (c) $3e^{-2|\tau|}$ (d) $4e^{-2|\tau|}$

5. The power density spectrum or power spectral density of $x_T(t) = x(t)$ for $-T \angle t \angle T$.
= 0 elsewhere is $S_{XX}(w)$=

(a) $\frac{1}{2\pi}\int_{-\infty}^{\infty}\frac{|X_T(w)|^2}{2T}dw$ (b) $\int_{-\infty}^{\infty}\frac{|X_T(w)|^2}{2T}dw$

(c) $\lim_{T\to\infty}\frac{E\{|X_T(w)|^2\}}{2T}$ (d) $\frac{1}{2\pi}\lim_{T\to\infty}\frac{E\{|X_T(w)|^2\}}{2T}$

6. The average power of the above described random process is P_{XX} =

(a) $\int_{-\infty}^{\infty}S_{XX}(w)dw$ (b) $\frac{1}{2\pi}\int_{-\infty}^{\infty}S_{XX}(w)dw$ (c) $2\pi\int_{-\infty}^{\infty}S_{XX}(w)dw$ (d) zero

7. Time average of auto correlation function and the power spectral density form __ pair.

(a) Fourier Transform (b) Laplace Transform

(c) Z-Transform (d) Convolution

8. The rms band-width in terms of PSD is

(a) $\frac{\int_{-\infty}^{\infty}w^2S_{XX}(w)dw}{\int_{-\infty}^{\infty}S_{XX}(w)dw}$ (b) $\frac{\int_{-\infty}^{\infty}S_{XX}(w)dw}{\int_{-\infty}^{\infty}w^2S_{XX}(w)dw}$

(c) $\frac{\int_{-\infty}^{\infty}S_{XX}(w)dw}{2\pi\int_{-\infty}^{\infty}w^2S_{XX}(w)dw}$ (d) $\frac{2\pi\int_{-\infty}^{\infty}w^2S_{XX}(w)dw}{\int_{-\infty}^{\infty}S_{XX}(w)dw}$

9. PSD of a WSS is always

(a) Negative (b) non-negative

(c) Positive (d) can be negative or positive

10. The average power of the periodic random process signal whose auto correlation function $R_{XX}(\tau) = \exp\left[-\frac{\tau^2}{2\sigma^2}\right]$ is

(a) 0 (b) 1 (c) 2 (d) 3

11. If $S_{XY}(w) = \frac{16}{w^2+16}$ and $S_{YY}(w) = \frac{w^2}{w^2+16}$ and X(t) and Y(t) are of zero mean, then let U(t) = X(t) + Y(t). Then $S_{XU}(w)$ is

(a) $\frac{w^2}{w^2+16}$ (b) $\frac{w}{w^2+16}$ (c) $\frac{4w}{w^2+16}$ (d) $\frac{16}{w^2+16}$

12. If Y(t) = X(t) - X(t - a) is a random process and X(t) is a WSS process and a > 0, is a constant, the PCD of y(t) in terms of the corresponding quantities of X(t) is

    (a) $S_{XX}(w)\sin^2\left(\frac{wa}{2}\right)$ (b) $2S_{XX}(w)\sin^2\left(\frac{wa}{2}\right)$

    (c) $3S_{XX}(w)\sin^2\left(\frac{wa}{2}\right)$ (d) $4S_{XX}(w)\sin^2\left(\frac{wa}{2}\right)$

13. A random process is given by Z(t) = A. X(t) + B.Y(t) where 'A' and 'B' are real constants and X(t) and Y(t) are jointly WSS processes. The power spectrum $S_{ZZ}(w)$ is

    (a) AB S_{XY} (w) + AB S_{YX} (w) (b) $A^2 + B^{2,}$ + AB S_{XY} (w) + AB S_{YX} (w)

    (c) A^2 SXX(w) + AB S_{XY} (w) + AB S_{YX} (w) + B^2 S_{YY} (w) (d) 0

14. A random process is given by Z(t) = A. X(t) + B.Y(t) where 'A' and 'B' are real constants and X(t) and Y(t) are jointly WSS processes. If X(t) and Y(t) are uncorrelated then S_{ZZ} (w)

    (a) $A^2 + B^2$ (b) A^2 S_{XX} (w) + B^2 S_{YY} (w)

    (c) AB S_{XY}(w) + AB S_{YX} (w) (d) 0

15. PSD is _________ function of frequency

    (a) even (b) odd (c) periodic (d) asymmetric

16. For a WSS process, PCD at zero frequency gives

    (a) The area under the graph of power spectral density (c) Mean of the process

    (b) Area under the graph auto correlation of the process (d) variance of the process

17. The mean square value of WSS process equals

    (a) The area under the graph of PSD (c) mean of the process

    (b) The area under the graph of auto correlation of process (d) zero

18. X(T) = A cos ($w_o t$ + θ), where A and w_o are constants and θ is a R.V uniformly distributed over (0, π). The average power of X(t) is

    (a) θ (b) $\frac{A^2}{2}$ (c) $\frac{A^2}{4}$ (d) $\frac{A^2}{8}$

19. A WSS process X(t) has an auto correlation function $R_{XX}(\tau) = e^{-3|\tau|}$. The PSD is

    (a) $\frac{6}{9+w^2}$ (b) $\frac{9}{6+w^2}$ (c) $\frac{3}{9+w^2}$ (d) $\frac{9}{3+w^2}$

20. The real part and imaginary part of S_{YX} (w) is ________ and ___________ function of w respectively.
(a) odd, odd (b) odd, even (c) even, odd (d) even, even

21. If cross correlation is $R_{XY}(t,t+\tau)=\frac{AB}{2}\left[\sin w_0\tau+\cos w_0(2t+\tau)\right]$ the cross power spectrum is S_{XY} (w) =
(a) $\frac{J\pi AB}{2}\left[\delta(w-w_0)-\delta(w+w_0)\right]$ (b) $\frac{\pi AB}{2}\left[\delta(w-w_0)-\delta(w+w_0)\right]$
(c) $\frac{AB}{2}\left[\delta(w-w_0)-\delta(w+w_0)\right]$ (d) $-J\frac{\pi AB}{2}\left[\delta(w-w_0)-\delta(w+w_0)\right]$

22. If X(t) and Y(t) are uncorrelated and of constant means E(X) and E(Y), respectively then S_{XY} (w) is
(a) E(X) E(Y) (b) 2E(X) E(Y) δ (w)
(c) 2πE(X) E(Y) δ (w) (d) $\frac{E(X)E(Y)\delta(w)}{2}$

23. The means of two independent, WSS processes X(t) and Y(t) are 2 and 3 respectively. Their cross spectral density is
(a) 6 δ (w) (b) 12πδz(w) (c) 5πδ(w) (d) δ(w)

24. The cross spectral density of two random processes X(t) and Y(t) is S_{XY} (w) is
(a) $\underset{T\to\infty}{Lt}\frac{E\left[X_T{}^*(w).Y_T(w)\right]}{2T}$ (b) $\frac{E\left[X_T{}^*(w).Y_T(w)\right]}{2T}$
(c) $\underset{T\to\infty}{Lt}\frac{E\left[X_T{}^*(w).Y_T(w)\right]}{2\pi}$ (d) $\frac{E\left[X_T{}^*(w).Y_T(w)\right]}{2\pi}$

25. Time average of cross correlation function and the cross spectral density function from ________ pair
(a) Laplace Transform (b)Z-Transform (c) Fourier Transform (d) Convolution

Answer:

1.D 2.B 3.C 4.D 5.C 6.B
7. A 8.A 9.B 10.B 11.D
12.D 13.C 14.B 15.A 16.B 17.A
18.B 19.A 20.C 21.D 22.C
23.B 24.A 25.C

UNIT – VIII: NOISE

1. A TV receiver has a 4KΩ input resistance and operates in a frequency range of 54-56 MHZ. At an ambient temperature of 27^0C, the RMS thermal noise voltage at the i/p of the receiver is
   (a) 25μV (b) 19.9μV (c) 14.8μV (d) 22μV

2. The RMS noise voltage across a 2μF capacitor over the entire frequency band when the capacitor is shunted by a 2KΩ resistor maintained at 300^0K is
   (a) 0.454μV (b) 4.54μV (c) 45.4μV (d) 0.0454μV

3. When noise is mixed with a sinusoid the amplitude and PSD of the resulting noise component becomes & of the original respectively
   (a) Same as that of original (b) Half, half
   (c) Half, one-third (d) half, one-fourth

4. The available noise power per unit bandwidth at the input of an antenna with a noise temperature of 15^0K, feeding into a microwave amplifier with Te = 20^0K is
   (a) 483×10^{-23}w (b) 4.83×10^{-23}w (c) 48.3×10^{-23}w (d) 483w

5. Two resistor with resistances R_1 and R_2 are connected in parallel and have physical temperatures T_1 and T_2 respectively. The effective noise temperature TS of an equivalent resistor with resistance equal to the parallel combination R_1 and R_2 is
   (a) $\frac{T_1R_1 + R_2T_2}{R_1 + R_2}$ (b) $\frac{R_1T_2 + R_2T_1}{R_1 + R_2}$ (c) $\frac{R_1T_2}{R_2}$ (d) $\frac{R_2T_1}{R_1}$

6. Let n(t) be the narrow band representation of noise where $n(t) = n_c(t) \cos w_c t - n_s(t) \sin w_c t$, and let P_1, P_2, P_3 are powers of n(t), $n_c(t)$ and $n_s(t)$ respectively then
   (a) $P_1 = 2P_2 = 3P_3$ (b) $P_1 = \frac{P_2}{2} = \frac{P_3}{3}$
   (c) $P_1 = P_2 = P_3$ (d) $3P_1 = 2P_2 = P_3$

7. The equivalent noise temperature of parallel combination of two resistors $R_1 = R_2 = R$ operating at noise temperature T_1, and T_2 respectively is
   (a) $T_1 + T_2$ (b) $(T_1 + T_2)^2$ (c) $\frac{T_1+T_2}{2}$ (d) $T_1 . T_2$

8. In defining the noise bandwidth of a real system, it is required that the noise power N_1 passed by ideal filter and noise powder N_2 passed by real filter should be related as
   (a) $N_1 = 2N_2$ (b) $N_2 = 2N_1$ (c) $N_1 + N_2 = 1$ (d) $N_1 = N_2$

9. Two resistor with resistances R_1 and R_2 are connected in parallel and have physical temperatures T_1 and T_2 respectively
   If $T_1 = T_2 = T_1$, what is T_s ?
   (a) T (b) $\frac{T}{2}$ (c) $\frac{T}{3}$ (d) $\frac{T}{4}$

10. Two resistor with resistances R_1 and R_2 are connected in parallel and have physical temperatures T_1 and T_2 respectively
    If the resistors are in series, T_S =

(a) $\frac{T_1R_1 + R_2T_2}{R_1 + R_2}$ (b) $\frac{R_1T_2 + R_2T_1}{R_1 + R_2}$ (c) $\frac{R_1T_2}{R_2}$ (d) $\frac{R_2T_1}{R_1}$

11. An amplifier has three stages for which $T_{e1} = 150^0K$ (first stage), $T_{e2} = 350^0K$ and $T_{e3} = 600^0K$ (output stage). Available power gain of the first stage is 10 and overall input effective noise temperature is 190^0K then the available power gain of second stage and cascade's noise figure are respectively.
    (a) 12, 1.655 (b) 1.655, 12 (c) 14,3.65 (d) 3.65, 14

12. In an amplifier, the first stage in a cascade of 5 stages has $T_{e1} = 75^0K$ and $G_1 = 0.5$. Each succeeding stage has an effective input noise temperature and an available power gain that are each 1.75 times that of the stage preceding it. The cascade's effective input noise temperature is
    (a) 50.26^0K (b) 500.26^0K (c) 400.26^0K (d) 550.26^0K

13. The total available output noise power spectral density for a noisy two port network is G_{a0}=
    (a) $g_a(f)(T_0 + T_e)$ (b) $g_a(f)\,k.(T_e + T_o)$
    (c) $g_a(f).\frac{K}{2}(T_e + T_0)$ (d) $g_a(f)\,k.(T_e + T_o)$

14. The noise present at the input of a two port network is 1μw. The noise figure of the network is 0.5dB and its gain is 10^{10}. The available noise power contributed by two port is
    (a) 1.22 KW (b) 12.2KW (c) 122KW (d) 1220KW

15. For the above problem the available output noise power is
    (a) 12.2 KW (b) 11.2KW (c) 122KW (d) 112 KW

16. If $g_a(f)$ is the available gain of the network these the noise figure in terms of (effective noise temperature) and T_0 is
    (a) $\frac{T_e}{T_0}$ (b) $1 + \frac{T_e}{T_0}$ (c) $\frac{T_0}{T_e}$ (d) $1 + \frac{T_0}{T_e}$

17. The average noise figure $\overline{F}$ is =
    (a) $\frac{\int_{f_1}^{f_2} F.g_a(f)df}{\int_{f_1}^{f_2} g_a(f)df}$ (b) $\frac{\int_{f_1}^{f_2} g_a(f)df}{\int_{f_1}^{f_2} F.g_a(f)df}$ (c) always (d) $\frac{\int_{f_1}^{f_2} g_a(f)df}{\int_{f_1}^{f_2} F.g_a^2(f)df}$

$$Te_2 + \frac{Te_1}{g_{a_1}}$$

Answer:

1.B 2.D 3.D 4.C 5.B 6.C
7. C 8.D 9.A 10.A 11.D
12.C 13.C 14.A 15.B 16.B
17.A 18.D 19.A 20.B

WEBSITES

1. http://higheredbcs.wiley.com/legacy/college/yates/0471272140/quiz_sol/quiz_sol.pdf
2. http://www.egwald.ca/statistics/
3. http://math.niu.edu/~rusin/known-math/index/60-XX.html
4. http://www.math.harvard.edu/~knill/teaching/math144_1994/probability.pdf

JOURNALS

1. An International Journal of Probability and Stochastic Processes (ISSN: 1744-2508)
2. Journal of Theoretical Probability (ISSN: 0894-9840)
3. Probability Theory and Related Fields (ISSN: 0178-8051)
4. Theory of Probability and Its Applications (ISSN: 0040-585X)

STUDENTS SEMINAR TOPICS

1. Set theory principles.
2. Examples of random variables, CDF and PDF.
3. Conditional distributions and density functions and properties.
4. Mean, variance, MGF and characteristic functions of Rayleigh random variable.
5. Interval and point conditioning of distribution and density function.
6. Unequal Distribution and Equal Distributions.
7. Linear transformation of Gaussian random variables.
8. Distinguish between random variables and random process.
9. Product Device Response to a random signal.
10. Average Noise Figures, Average Noise Figure of cascaded Networks