



**ELECTRONICS AND COMMUNICATION**

**ENGINEERING**

**QUESTION BANK**

**Course Title: Probability theory and  
stochastic processor**

**Course code: EE1231**

**Regulation: NR22**

**Course Objectives:**

1. This gives basic understanding of random variables and operations that can be performed on them.
2. To know the utilization of random signals in communication and signal processing
3. To know the characteristics of random process and Responses of LTI systems for random processes
4. To know the Spectral and temporal characteristics of Random Process.
5. To Learn the Basic concepts of Information theory Noise sources and its representation for understanding its characteristics.

**Course Outcomes:** Upon completing this course, the students will be able to:

1. Perform operations on single Random variables.
2. Perform operation on multiple random variables
3. Determine the Spectral and temporal characteristics of Random Signals.
4. Characterize LTI systems driven by stationary random process by using ACFs and PSDs.
5. Understand the concepts of Noise and Information theory in Communication systems.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	3	-	2	-	-	-	-	-	-	-	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-
CO3	3	3		2	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-

**UNIT-I**

**Probability and random variables**

S.No	Questions	BT	CO	PO
<b>Part – A (Short Answer Questions)</b>				
1	Define probability.	Remember	CO1	PO1,PO2,PO4
2	Discuss probability with axioms.	Understand	CO1	PO1,PO2,PO4
3	Write short note on conditional probability.	Remember	CO1	PO1,PO2,PO4
4	Define joint probability.	Remember	CO1	PO1,PO2,PO4
5	Discuss total probability theorem.	Understand	CO1	PO1,PO2,PO4
6	State Bayes theorem.	Remember	CO1	PO1,PO2,PO4
7	Discuss how probability can be considered as relative frequency	Understand	CO1	PO1,PO2,PO4
8	Describe random variable concept.	Understand	CO1	PO1,PO2,PO4
9	Identify a sample space for an event A.	Understand	CO1	PO1,PO2,PO4
10	State multiplication theorem .	Understand	CO1	PO1,PO2,PO4
<b>Part – B (Long Answer Questions)</b>				
11	a) Define probability .State and prove total probability theorem and Bayes' theorem.	Remember	CO1	PO1,PO2,PO4
	b) A computer manufacturer uses chips from three sources. Chips from sources A, B, and C are defective with probabilities 0.001, 0.005 and 0.01 respectively. If a randomly selected chip is found to be defective, find the probability that the manufacturer was A; that manufacturer was C.	Remember	CO1	PO1,PO2,PO4
12	a) A man wins in a gambling game if he gets two heads in five flips of a biased coin. The probability of getting a head with the coin is 0.7. i) Find the probability the man will win. Should he play this game. ii) What is the probability of winning if he wins by getting at least four heads in five flips. Should he play this new game.	Understand	CO1	PO1,PO2,PO4
	b) Define the following with example (i) Relative frequency definition of probability (ii) Conditional probability and (iii) Total probability.	Understand	CO1	PO1,PO2,PO4
13	a) 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.	Remember	CO1	PO1,PO2,PO4
	b) Mention different types of defining conditional events		CO1	PO1,PO2,PO4
14	a) Define following types of events.	Remember	CO1	PO1,PO2,PO4

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	1) Simple events 2) Compound events 3) Independent events 4) Joint events 5) Conditional events with examples	er		O2,P O4
b)	In a box there are 500 color red balls 75 black 150 green 175 red 70 white and 30 blue what are the probabilities of selecting a ball of each color.	Understand	CO1	PO1,P O2,P O4



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15	a)	Two cards are drawn from a 52 Cards i. Given the first card is a queen, what is the probability that thesecond is also a queen. ii. Repeat part a) for the first card a queen and the second card a 7 iii. What is the probability that both cards will be a queen.	Understand	CO1	PO1,P O2,P O4
	b)	Explain all properties of distribution and density functions		CO1	PO1,P O2,P O4
16	a)	In a bolt factory there are four machines A, B, C, D manufacturing 20%, 15%, 25%, 40% of the total production of these 5%, 4%, 3%, 2% are found to be defective. If a bolt is drawn at random and was found to be defective what is the probability that it was manufactured by A or D.	Remember	CO1	PO1,P O2,P O4
	b)	Describe and draw different types of distribution and density functions.		CO1	PO1,P O2,P O4

**UNIT-II**

**Operations on single and multiple random variables**

S.No	Questions	BT	C O	PO	
<b>Part – A (Short Answer Questions)</b>					
1	Define joint probability density function for two random variables.	Remember	CO2	PO1,PO 2,PO4	
2	Define joint probability distribution function for two random variables.	Remember	CO2	PO1,PO 2,PO4	
3	Write properties of joint probability density function.	Remember	CO2	PO1,PO 2,PO4	
4	Write properties of joint probability distribution function.	Understand	CO2	PO1,PO 2,PO4	
5	Explain marginal density function.	Understand	CO2	PO1,PO 2,PO4	
6	Define marginal distribution function.	Remember	CO2	PO1,PO 2,PO4	
7	Define central limit theorem.	Remember	CO2	PO1,PO 2,PO4	
8	Discuss conditional joint distribution function.	Understand	CO2	PO1,PO 2,PO4	
9	Define conditional joint density function.	Understand	CO2	PO1,PO 2,PO4	
10	Explain distribution and density function of a sum of two random variables.	Understand	CO2	PO1,PO 2,PO4	
<b>Part – B (Long Answer Questions)</b>					
11	a)	Derive expressions for mean and variance for uniform randomvariable.	Understand	CO2	PO1,PO 2,PO4
	b)	The characteristic function for a Gaussian random variable X, having a mean value of 0, is $\Phi_X(\omega) = \text{EXP}(-w^2/2\sigma^2)$ Find all the moments of X using $\Phi_X(\omega)$ .	Understand	CO2	PO1,PO 2,PO4
12	a)	Derive expressions for mean and variance for Poisson randomvariable.	Remember	CO2	PO1,PO 2,PO4
	b)	a) Write short notes on Gaussian distribution and density function. b) Consider that a fair coin is tossed 3 times, Let X be a random variable, defined as X= number of tails appeared, find the expected value of X.	Remember	CO2	PO1,PO 2,PO4
13	a)	Derive expressions for mean and variance for exponential random variable.	Remember	CO2	PO1,PO 2,PO4
	b)	State and prove three properties of moment generating functionand calculate moment generating function of exponentially	Understand	CO2	PO1,PO 2,PO4

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		distributed random variable.			
14	a)	If X has the probability density function $f_X(x) = 1/2 e^{- x }$ , $-\infty < x < \infty$ , show that the characteristic function of X is given by $\phi_X(\omega) = 1/1 + \omega^2$ . Hence find the mean and variance of X	Understand	CO2	PO1,PO2,PO4
	b)	Find the PDF of $W = X + Y$ . X and Y have joint Pdf $f_{XY}(x, y) = 1/15$ $0 \leq x \leq 3, 0 \leq y \leq 5$ , $= 0$ otherwise.	Understand	CO2	PO1,PO2,PO4
15	a)	Calculate the density function of the random variable $Y = 2X + 3$ Where X is a uniform random variable over $(-1, 2)$ .	Remember	CO2	PO1,PO2,PO4
	b)	write short notes on Gaussian distribution and density function.	Remember	CO2	PO1,PO2,PO4
16	a)	State expressions for mean and variance for binomial random variable.	Understand	CO2	PO1,PO2,PO4
	b)	The exponential density function given by $f_X(x) = (1/b)e^{-(x-a)/b}$ for $x > a$ $= 0$ ; otherwise Find variance and co-efficient of skewness.	Understand	CO2	PO1,PO2,PO4

**UNIT-III**

**Random process and temporal Characteristics**

S.No	Questions	BT	CO	PO
<b>Part – A (Short Answer Questions)</b>				
1	Define random process.	Remember	CO3	PO1,PO2,PO4
2	Define ergodicity.	Remember	CO3	PO1,PO2,PO4
3	Define mean ergodic process.	Remember	CO3	PO1,PO2,PO4
4	State correlation ergodic process.	Remember	CO3	PO1,PO2,PO4
5	Explain the first order stationary process.	Understand	CO3	PO1,PO2,PO4
6	Discuss second order stationary process.	Understand	CO3	PO1,PO2,PO4
7	State wide sense stationary random process.	Remember	CO3	PO1,PO2,PO4
8	Define strict sense stationary random process.	Remember	CO3	PO1,PO2,PO4
9	Define auto correlation function of a random process.	Remember	CO3	PO1,PO2,PO4
10	Define cross correlation function of a random process.	Understand	CO3	PO1,PO2,PO4
<b>Part – B (Long Answer Questions)</b>				
11	a) Give classification of random processes and Write conditions for a wide sense stationary random process.	Understand	CO3	PO1,PO2,PO4
	b) Given $E[X(t)] = 6$ and $R_{XX}(t, t + \tau) = 36 + 25 \exp(-\tau)$ for a random process X(t). Indicate which of the following statements are true based on what is known with certainty: X(t) i. is first order stationary ii. has total average power of 61W iii. is ergodic iv. is wide sense stationary has a periodic component	Understand	CO3	PO1,PO2,PO4
	a) Show that the process $X(t) = A \cos(\omega_0 t + \theta)$ is wide sense stationary if it is assumed that A and $\omega_0$ are constants and $\theta$ is uniformly distributed random variable over the interval $(0, 2\pi)$ .	Remember	CO3	PO1,PO2,PO4
	B If X(t) is a stationary random process having a mean value ) $E[X(t)] = 3$ and auto correlation function $R_{XX}(\tau) = 9 + 2e^{-\tau}$ find i. The mean value and	Understand	CO3	PO1,PO2,PO4

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	ii. The variance of the random variable $y = \int_0^2 x(t) dt$			
13	a) Show that the process $X(t) = A \cos(\omega_0 t + \theta)$ is wide sense stationary if it is assumed that $A$ and $\omega_0$ are constants and $\theta$ is uniformly distributed random variable over the interval $(0, 2\pi)$ .	Remember	CO3	PO1, PO2, PO4
	b) Assume that an ergodic random process $X(t)$ has an auto correlation function $R_{xx}(\tau) = 18 + \frac{1}{6 + \tau^2} [1 + 4 \cos(12\tau)]$  i) Find $X$ ii) Does the process have a periodic component.	Understand	CO3	PO1, PO2, PO4
14	a) State and prove any four properties of cross correlation function and cross covariance function.	Remember	CO3	PO1, PO2, PO4
	b) Explain and prove any four properties of auto correlation function and auto covariance function.	Understand	CO3	PO1, PO2, PO4
15	a) A random process is defined as $X(t) = A \cos(\omega_c t + \theta)$ where $\theta$ is a uniform random variable over $(0, 2\pi)$ . Verify the process is ergodic in the mean sense and auto correlation sense.	Remember	CO3	PO1, PO2, PO4
	b) Define a random process by $X(t) = A \cos(t)$ , where $A$ is a Gaussian Random Variable with zero mean variance $\sigma_A^2$ i. Find the density function of $X(0)$ and $X(1)$ ii. Is $X(t)$ stationary in any sense	Remember	CO3	PO1, PO2, PO4
16	a) Consider two random processes $X(t) = A \cos(\omega_1 t + \theta)$ and $Y(t) = B \cos(\omega_2 t + \Phi)$ where $a, b, \omega_1, \omega_2$ are constants, while $\theta, \Phi$ are statistically independent random variables uniformly distributed on $(0, 2\pi)$ A) ST $X(t)$ and $Y(t)$ are jointly WSS B) If $\theta = \Phi$ show that $x(t)$ and $y(t)$ are not jointly wss unless $\omega_1 = \omega_2$	Understand	CO3	PO1, PO2, PO4
	b) Find mean, variance and average power for a stationary ergodic random processes has the auto correlation function with the periodic components as $R_{xx}(\tau) = 25 + \frac{4}{1 + 6\tau^2}$	Understand	CO3	PO1, PO2, PO4

**UNIT-IV**

**Random process and Spectral Characteristics**

S.No	Questions	BT	CO	PO
<b>Part – A (Short Answer Questions)</b>				
1	Define wiener khinchine relations	Remember	CO4	PO1, PO2, PO3, PO4
2	State any two properties of cross-power density spectrum.	Understand	CO4	PO1, PO2, PO3, PO4
3	Define cross –spectral density and its examples.	Remember	CO4	PO1, PO2, PO3, PO4
4	Explain any two uses of spectral density. .	Understand	CO4	PO1, PO2, PO3, PO4
5	Define power density spectrum.	Remember	CO4	PO1, PO2, PO3, PO4
6	State any two properties of power density spectrum	Remember	CO4	PO1, PO2, PO3, PO4
7	State any two properties of an auto correlation function.	Remember	CO4	PO1, PO2, PO3, PO4



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8	Define cross correlation and its properties.	Understand	CO4	PO1,PO2,PO3,PO4
9	Prove that $R_{XY}(\tau) = R_{YX}(-\tau)$	Remember	CO4	PO1,PO2,PO3,PO4
10	Explain any two properties of cross correlation.	Understand	CO4	PO1,PO2,PO3,PO4
<b>Part – B (Long Answer Questions)</b>				
11	a) Discuss the concept of power density spectrum in detail and derive the expression for it.	Understand	CO4	PO1,PO2,PO3,PO4
	b) Discuss the concept of cross power density spectrum in detail and derive the expression for it.	Understand	CO4	PO1,PO2,PO3,PO4
12	a) Explain the concept of cross power spectral density of input and output of a linear system.	Understand	CO4	PO1,PO2,PO3,PO4
	b) Determine whether $X_1(t)$ and $X_2(t)$ are jointly wide sense stationary. $X(t)$ is a wide sense stationary random process. For each process $X_i(t)$ defined below (a) $X_1(t) = X(t + a)$ (b) $X_2(t) = X(at)$	Remember	CO4	PO1,PO2,PO3,PO4
13	a) A random process is defined as $X(t) = A \cos(\omega_c t + \theta)$ where $\theta$ is a uniform random variable over $(0, 2\pi)$ . Verify the process is ergodic in the mean sense and auto correlation sense.	Remember	CO4	PO1,PO2,PO3,PO4
	b) If the PSD of $X(t)$ is $S_{XX}(W)$ then find PSD of $d/dx(x(t))$	Understand	CO4	PO1,PO2,PO3,PO4
14	a) Show that for any WSS system response of auto correlation function also stationary		CO4	PO1,PO2,PO3,PO4
	b) A random process is defined by $Y(t) = X(t) \cos(\omega_0 t + \theta)$ where $X(t)$ is wide sense stationary random process that amplitude-modulates a carrier of constant angular frequency $\omega_0$ with a random phase $\theta$ independent of $X(t)$ and uniformly distributed on $(-\pi, \pi)$ . Determine $E[Y(t)]$ and autocorrelation of $Y(t)$ .	Remember	CO4	PO1,PO2,PO3,PO4
15	a) Consider the random process $X(t) = A \cos(\omega_0 t + \theta)$ is wide sense stationary if it is assumed that $A$ and $\omega_0$ are constants and $\theta$ is uniformly distributed random variable over the interval $(0, \pi/2)$ . Find the average power of $X(t)$	Understand	CO4	PO1,PO2,PO3,PO4
	b) The auto correlation function of a random process $X(t)$ is $R_{XX}(\tau) = 3 + e^{-4\tau^2}$ . Find the power spectrum of $X(t)$ .	Understand	CO4	PO1,PO2,PO3,PO4
16	a) A random process has the power spectrum density $S_{XX}(\omega) = \frac{6\omega^2}{1 + \omega^4}$ . Find the average power of the process.	Understand	CO4	PO1,PO2,PO3,PO4
	b) A random process has the power density spectrum $S_{XX}(w) = w^2/(w^2+1)$ . Find the average power in the random process.	Remember	CO4	PO1,PO2,PO3,PO4

**UNIT-V**

**Noise sources and Information theory**

S.No	Questions	BT	CO	PO
<b>Part – A (Short Answer Questions)</b>				
1	What is thermal noise how is it quantified?	Remember	CO5	PO1,PO2,PO3,PO4

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2	Write short notes on different types of noises	Understand	CO5	PO1,PO2,PO3,PO4
3	Explain the concept of effective input noise temperature.	Remember	CO5	PO1,PO2,PO3,PO4
4	Define information ?Explain about information rate?	Remember	CO5	PO1,PO2,PO3,PO4
5	What is entropy?	Understand	CO5	PO1,PO2,PO3,PO4
6	Write the expression for code efficiency in terms of entropy	Understand	CO5	PO1,PO2,PO3,PO4
7	What is the power spectrum of of white noise	Remember	CO5	PO1,PO2,PO3,PO4
8	Explain about channel Channel Capacity Theorem,	Remember	CO5	PO1,PO2,PO3,PO4
9	What is the entropy H, in bits, of the following source alphabet whose letters have the probabilities shown? A B C D 1/4 1/8 1/2 1/8	Understand	CO5	PO1,PO2,PO3,PO4
10	Explain Shannon-Fano coding.	Remember	CO5	PO1,PO2,PO3,PO4

**Part – B (Long Answer Questions)**

11	a)	Describe the mathematical description of noise figure	Remember	CO5	PO1,PO2,PO3,PO4
	b)	Write expression for Narrow band noise and give diagrams how to extract in phase components and quadrature components from narrow band noise	Remember	CO5	PO1,PO2,PO3,PO4
12	a)	Five source messages are probable to appear as $m_1=0.4, m_2=0.15, m_3=0.15, m_4=0.15, m_5=0.15$ find coding efficiency for a)Shanon coding b) huff mam coding	Understand	CO5	PO1,PO2,PO3,PO4
	b)	Explain the concept of entropy and its properties	Remember	CO5	PO1,PO2,PO3,PO4
13	a)	From Shannon hartley law find the maximum value of the channel capacity if band width is provided as $\infty$ .		CO5	PO1,PO2,PO3,PO4
	b)	Define Mutual information and Entropy of two two variables $H(x:y)$ ? State all properties of mutual information?	Remember	CO5	PO1,PO2,PO3,PO4
14	a)	Derive the Expression for effective input noise temperature of a cascaded system in terms of its individual input noise temperature	Remember	CO5	PO1,PO2,PO3,PO4
	b)	The a noise figure of a system is 0.3db and the power gain is $10^8$ . Find the output noise power at room temperature. Bandwidth is 10MHZ	Understand	CO5	PO1,PO2,PO3,PO4
15	a)	Prove that the output power spectral density equals the input power spectral density multiplied by the squared magnitude of the transform of the filter $S_{yy}(w)=H(W)^2 S_{xx}(W)$	Understand	CO5	PO1,PO2,PO3,PO4
	b)	What is a binary symmetric channel? Write down its transition matrix in terms of p, the transition probability	Understand	CO5	PO1,PO2,PO3,PO4



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16	a)	A message source generates one of four messages randomly every microsecond. The probabilities of these messages are 0.4, 0.3, 0.2, and 0.1. Each emitted message is independent of the other messages in the sequence. Find the rate of information generated by this source (in bits per second).	Understand	CO5	PO1,PO2,PO3,PO4
	b)	An analog signal band limited to 10kHz is quantized in 8 levels of a PCM system with probabilities of 1/4, 1/5, 1/5, 1/10, 1/10, 1/20, 1/20 and 1/20 respectively. Calculate the entropy and the rate of information.	Understand	CO5	PO1,PO2,PO3,PO4



\* **Blooms Taxonomy Level (BT)** (L1 – Remembering; L2 – Understanding; L3 – Applying; L4 – Analyzing; L5 – Evaluating; L6 – Creating)

**Course Outcomes (CO)**

**Program Outcomes (PO)**

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