INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Name	:	**PROBABILTY THOERY AND STOCHASTIC PROCESS**
Course Code	:	**AECB08**
Program	:	**B.Tech**
Semester	:	**III**
Branch	:	**Electronics and Communication Engineering**
Section	:	**A, B, C, D**
Academic Year	:	**2019 - 2020**
Course Faculty	:	**Dr. M V Krishna Rao, Professor, ECE** **Mrs. G Ajitha, Assistant Professor, ECE** **Mr. N Nagaraju, Assistant Professor, ECE**

OBJECTIVES:

The course should enable the students to:	
I	Basic understanding of random signals and processing.
II	Utilization of random signals and systems in communications and signal processing areas.
III	Known the spectral and temporal characteristics of random process.
IV	Learn the basic concepts of noise sources.

DEFINITIONS AND TERMINOLOGY QUESTION BANK

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
MODULE-I					
1	Define an experiment.	An operation which can produce some well-defined outcomes is called an experiment. Each outcome is called an event.	Understand	CLO 1	AECB08.01
2	Define random experiment.	In an experiment where all possible outcomes are known and in advance if the exact outcome cannot be predicted, is called a random experiment.	Understand	CLO 1	AECB08.01
3	Define outcome.	The possible results of an event. For example, when a die is rolled, the possible outcomes are 1, 2, 3, 4, 5, and 6.	Understand	CLO 1	AECB08.01

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4	Define sample space.	A sample space of an experiment is the set of all possible outcomes of that random experiment.	Understand	CLO 1	AECB08.01
5	Define discrete sample space.	A discrete sample space is one that is listable; it can be either finite or infinite. Examples. {H, T}, {1, 2, 3}, {1, 2, 3, 4, . . . }, {2, 3, 5, 7, 11, 13, 17, . . . } are all discrete sets.	Understand	CLO 1	AECB08.01
6	Define event.	Out of the total results obtained from a certain experiment, the set of those results which are in favor of a definite result is called the event and it is denoted as E.	Understand	CLO 1	AECB08.01
7	Define equally likely events.	When there is no reason to expect the happening of one event in preference to the other, then the events are known equally likely events.	Understand	CLO 1	AECB08.01
8	Define exhaustive events.	All the possible outcomes of the experiments are known as exhaustive events.	Understand	CLO 1	AECB08.01
9	Define Probability of Occurrence of an Event	A measure of the likeliness that an event will happen. (or) The probability of occurrence of an event is defined as: P(occurrence of an event) is the ratio of Number of trials in which event occurred to the Total number of trials	Understand	CLO 1	AECB08.01
10	Define Mutually Exclusive Events.	If there be no element common between two or more events, i.e., between two or more subsets of the sample space, then these events are called mutually exclusive events.	Understand	CLO 1	AECB08.01
11	Define Conditional Probability	The probability of an event X is given then another event Y occurred is called conditional probability of X given Y. It is denoted by P(X|Y). $P(X\|Y) = P(X \cap Y)/P(y)$ Similarly, when the probability of Y given X is $P(Y\|X) = P(X \cap Y)/P(X)$	Understand	CLO 1	AECB08.01
12	Define Odds	Odds in probability of a particular event, means the ratio between the numbers of favorable outcomes to the number of unfavorable outcomes.	Understand	CLO 1	AECB08.01
13	Define axioms of probability.	1) The probability of any event is always a non-negative real number, i.e., either 0 or a positive real number. It cannot be negative or infinite; $P(A) \geq 0$ 2) When S is the sample space of an experiment; i.e., the set of all possible outcomes, P(S) = 1. 3) If A and B are mutually exclusive events then; $P(A \cup B) = P(A) + P(B)$.	Understand	CLO 1	AECB08.01
14	Define joint probability.	Joint probability is a statistical measure that calculates the likelihood of two events occurring together and at	Understand	CLO 1	AECB08.01

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		the same point in time. Joint probability is the probability of event Y occurring at the same time that event X occurs. P(X ∩ Y)=P(X)P(Y)			
15	Define total probability.	Total Probability of an experiment means the likelihood of its occurrence. This likelihood is contributed towards by the various smaller events that the event may be composed of.	Understand	CLO 1	AECB08.01
16	Define Bayes' theorem.	theorem about conditional probabilities: the probability that an event A occurs given that another event B has already occurred is equal to the probability that the event B occurs given that A has already occurred multiplied by the probability of occurrence of event A and divided by the probability of occurrence of event B. P(A|B)=P(A∩B) / P(B) =P(A)·P(B|A) / P(B)	Understand	CLO 1	AECB08.01
17	Define independent events.	Independent Events is the events which occur freely of each other. The events are independent of each other. In other words, the occurrence of one event does not affect the occurrence of the other. The probability of occurring of the two events are independent of each other; P(A ∩ B) = P(A) P(B)	Understand	CLO 1	AECB08.01
18	Define a random variable.	A random variable is a function X: S ->R that assigns a real number X(S) to every element s ε S , where S is the sample space corresponding to a random experiment E.	Understand	CLO 2	AECB08.02
19	Define discrete random variable	If X is a random variable which can take a finite number or countably infinite number of values, X is called a discrete RV. (or) A random variable is called a discrete random variable if its probability density function fx (x) is a sum of delta function only, or correspondingly if its cumulative distribution function Fx(x) is a staircase function.	Understand	CLO 2	AECB08.02
20	Define continuous random variable	If X is a random variable which can take all values (i.e., infinite number of values) in an interval, then X is called a continuous RV. (or) A random variable is called a continuous random variable if its cumulative distribution function has no finite discontinuities or equivalently its	Understand	CLO 2	AECB08.02

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		probability density function fx(x) has no delta functions.			
21	Define one dimensional random variable	If a random variable X takes on single value corresponding to each outcome of the experiment, then the random variable is called one-dimensional random variables. It is also called as scalar valued RVs.	Understand	CLO 2	AECB08.02
22	Define mixed random variable	These are random variables that are neither discrete nor continuous, but are a mixture of both. In particular, a mixed random variable has a continuous part and a discrete part.	Understand	CLO 2	AECB08.02
23	Define Cumulative distribution function(CDF)	The distribution function of Random Variable, X is the function Fx(x)=P[X<=x]for any x between -∞ and ∞.	Understand	CLO 2	AECB08.02
24	Define discrete Probability Distribution	It is a mathematical function (denoted as p(x)) that satisfies the following properties: 1) The probability of any event x can take a specific value p(x) , mathematically denoted as,[P(X=x)]=p(x)=Px . 2) p(x) is non-negative for all real . 3) The sum of p(x) over all possible values of x is 1.	Understand	CLO 2	AECB08.02
25	Define Continuous Probability Distribution	It is a mathematical function (denoted as Fx(x)) that satisfies the following properties: 1) For all x, Fx(x)>=0 2) It is monotonically increasing continuous function 3) It is 1 at x=∞ and 0 at x=-∞, i.e. Fx(∞)=1 and Fx(-∞)=0 .	Understand	CLO 2	AECB08.02
26	Define Probability Density Function (PDF)	The probability density function fx (x) for a random X is a total characterization and is defined as the derivative of the cumulative distribution function fx(x)=d/dx(Fx(x))	Understand	CLO 2	AECB08.02
27	Define Bernoulli distribution function.	This describes a probabilistic experiment where a trial has two possible outcomes, a success or a failure. The parameter p is the probability for a success in a single trial, the probability for a failure thus being 1 − p (often denoted by q). Both p and q is limited to the interval from zero to one. The distribution has the simple form $p(r;p) = \begin{cases} 1-p=q & \text{if} \quad r=0 \quad \text{(failure)} \\ p & \text{if} \quad r=1 \quad \text{(success)} \end{cases}$	Understand	CLO 2	AECB08.02
28	Define Binomial Distribution function	The Binomial distribution is given by $p(r;N,p) = \binom{N}{r} p^r (1-p)^{N-r}$ where the variable r with 0 <= r <=N	Understand	CLO 2	AECB08.02

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		and the parameter N (N > 0) are integers and the parameter p (0 <= p <=1) is a real quantity. The distribution describes the probability of exactly r successes in N trials if the probability of a success in a single trial is p (we sometimes also use q = 1 − p, the probability for a failure, for convenience).			
29	Define Poisson Random Variable	A discrete random variable X is called a Poisson random variable with the parameter λ if $\lambda > 0$ and $p_X(k) = \frac{e^{-\lambda}\lambda^k}{k!}, \quad k = 0,1,2,\ldots$	Understand	CLO 2	AECB08.02
30	Define Uniform Random Variable	A continuous random variable X is called uniformly distributed over the interval [a, b], $-\infty < a < b < \infty$, if its probability density function is given by $f_X(x) = \begin{cases} \frac{1}{b-a}, & a \le x \le b \\ 0, & \text{otherwise} \end{cases}$	Understand	CLO 2	AECB08.02
31	Define gaussian random variable	A continuous random variable X is called a normal or a Gaussian random variable with parameters μ_X and $\sigma_X{}^2$ if its probability density function is given by, $f_X(x) = \frac{1}{\sqrt{2\pi}\sigma_X} e^{-\frac{1}{2}\left(\frac{x-\mu_X}{\sigma_X}\right)^2}, \quad -\infty < x < \infty$	Understand	CLO 2	AECB08.02
32	Define exponential random variable	A continuous random variable X is called exponentially distributed with the parameter $\lambda > 0$ if the probability density function is of the form $f_X(x) = \begin{cases} \lambda e^{-\lambda x}, & x \ge 0 \\ 0, & \text{otherwise} \end{cases}$	Understand	CLO 2	AECB08.02
33	Define Rayleigh random variable.	A Rayleigh random variable *X* is characterized by the PDF $f_X(x) = \begin{cases} \frac{x}{\sigma^2} e^{-x^2/2\sigma^2}, & x \ge 0 \\ 0, & x < 0 \end{cases}$ where σ is the parameter of the random variable.	Understand	CLO 2	AECB08.02
34	Define conditional distribution function	Consider the event $\{X \le x\}$ and any event *B* involving the random variable *X*. The conditional distribution function of *X* given *B* is defined as	Understand	CLO 2	AECB08.02

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		$F_X(x/B) = P[\{X \le x\}/B]$ $= \frac{P[\{X \le x\} \cap B]}{P(B)} \quad P(B) \neq 0$			
35	Define of expected value of discrete random variable.	Let X be a discrete random variable with probability function $P_X(x)$. Then the expected value of X, E(X), is defined to be $E(X) = \sum xP_X(x)$. It is also called the mean or statistical average of the random variable X	Understand	CLO 3	AECB08.03
36	Define of expected value of continues random variable	Let X be a continuous random variable with probability density function $f_X(x)$ $E[X]=\int_{-\alpha}^{\alpha} x\, fX(x)dx$	Understand	CLO 3	AECB08.03
37	Define expected value of a function of a random variable.	Let X be a discrete random variable with probability mass function $p_X(x)$ and g(X) be a real valued function of X. Then the expected value of g(X) is given by $E[g(X)] = \int_{-\alpha}^{\alpha} g(x)\, fX(x)dx$	Understand	CLO 3	AECB08.03
38	Define moments about origin	If $g(x)=x^n$ n=0,1,2… Then n^{th} moment about the origin is defined as $m_n=E[g(x)]= \int_{-\alpha}^{\alpha} x^n f_X(x)dx$	Understand	CLO 3	AECB08.03
39	Define central moment	Moments about the mean value of X are called central momets. If $g(x)=(x-\bar{X})^n$ n=0,1,2… Then n^{th} moment about the origin is defined as $\mu_n=E[g(x)]= \int_{-\alpha}^{\alpha} (x-\bar{X}^n) f_X(x)dx$	Understand	CLO 3	AECB08.03
40	Define variance	The second central moment μ_2 is called variance. $\sigma_X^2 = E(X-\mu_X)^2 = \int_{-\infty}^{\infty} (x-\mu_X)^2 f_X($	Understand	CLO 3	AECB08.03
41	Define skewness	The third central moment measures lack of symmetry of the pdf of a random variable is called the *coefficient of skewness* $\frac{E(X-\mu_X)^3}{\sigma_X^3}$	Understand	CLO 3	AECB08.03
42	Define Standard Deviation	Standard Deviation is the square root of the Variance. $\sigma_X=\sqrt{E(X-\mu_X)^2}$	Understand	CLO 3	AECB08.03
43	Define Chebychev's Inequality	Chebyshev's inequality is a probabilistic inequality. It provides an upper bound to the probability that the absolute deviation of a random variable from its mean will exceed a given threshold.	Understand	CLO 3	AECB08.03
44	Define Conditional Probability Density Function	The conditional density function $f_X(x/B)$ of the random variable *X* given the event *B* as $f_X(x/B) = \frac{d}{dx} F_X(x/B)$	Understand	CLO 3	AECB08.03

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MODULE -II					
1	Define interval conditioning.	The distribution function of one random variable X conditioned by a second random variable Y With interval $\{ya \leq y \leq yb\}$	Understand	CLO 6	AECB08.06
2	Define point conditioning.	The distribution function of one random variable X conditioned by a second random variable Y With interval $\{y-\Delta y \leq y \leq y+\Delta y\}$	Understand	CLO 6	AECB08.06
3	Define the marginal density of Y .	The marginal density of Y is $f(y))=\int_{-\infty}^{\infty} f_{X,Y}(x,y)dx$	Understand	CLO 5	AECB08.05
4	Define the pdf of y=2x-3.A random variable X has the density function f(x)=x/12 , 1<x<5 0, otherwise.	The pdf of y=2x-3 is 1/48(Y+3) by the transformation of a random variable.	Understand	CLO 4	AECB08.04
5	Define K $f_{xy}(x,y)=KXY$; 0<x<y<1 =0; elsewhere .	K=8 for a valid joint density function by finding area under the curve is one.	Understand	CLO 5	AECB08.05
6	Define the application of charateristic function.	Characteristic function is used to find moments about origin of a random variable	Understand	CLO 6	AECB08.06
7	Define the area under join density function.	The area under join density function $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f_{xy}(x,y)dxdy$ is unity.	Understand	CLO 5	AECB08.05
8	Define Characteristic Function	Consider a random variable X with probability density function $f_X(x)$. The characteristic function of X denoted by is defined as $\Phi_{X(}\omega)=E(e^{j\omega x})$	Understand	CLO 5	AECB08.05
9	Define n^{th} moment from characteristic function.	Differentiation of characteristic function by n times with respect to ω and setting ω=0 gives n^{th} moment	Understand	CLO 6	AECB08.06
10	Define Moment Generating Function	Consider a random variable X with probability density function $f_X(x)$ The characteristic function of X denoted by $M_X(V)$ is defined as $M_X(V) =E(e^{Vx})$	Understand	CLO 6	AECB08.06
11	Define n^{th} moment from moment generating function.	Differentiation of moment generating function by n times with respect to V and setting V=0 gives n^{th} moment	Understand	CLO 6	AECB08.06
12	Define Transformation of random variable.	We have a set of random variables, X1, X2, X3,...Xn, with a known joint probability and/or density function. We may want to know the distribution of some function of these random	Understand	CLO 6	AECB08.06

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		variables Y = φ(X1, X2, X3,...Xn) is known as transformation of random variables.			
13	Define monotonic increasing transformation of random variable.	A Transformation T is called monotonically increasing if $T(x_1)<T(x_2)$ for any $x_1<x_2$	Understand	CLO 4	AECB08.04
14	Define monotonic decreasing transformation of random variable.	A Transformation T is called monotonically increasing if $T(x_1)>T(x_2)$ for any $x_1<x_2$	Remember	CLO 4	AECB08.04
15	Define joint distribution.	For two random variables X and Y, the $\{X \le x, Y \le y\} = \{X \le x\} \cap \{Y \le y\}$ event is called joint distribution.	Remember	CLO 5	AECB08.05
16	Define the properties of joint distribution.	It is a mathematical function (denoted as Fx(x)) that satisfies the following properties: 1) For all x, $F_{XY}(x,y)>=0$ 2) It is monotonically increasing continuous function 3) It is 1 at x=∞ and 0 at x=-∞, i.e.$F_{XY}(\infty,\infty)=1$ and$F_{XY}(-\infty,-\infty)=0$	Remember	CLO 5	AECB08.05
17	Define marginal density function.	The marginal density functions $f_X(x)$ and $f_Y(y)$ of two joint RVs X and Y are given by the derivatives of the corresponding marginal distribution functions	Remember	CLO 5	AECB08.05
18	Define conditional distribution.	conditional distribution function is one random variables on the condition of a particular value of the other random variable $F_{Y/X}(y/x)=P(Y\le y/X\le x)$	Remember	CLO 6	AECB08.06
19	Define conditional density function.	$f_{Y/X}(y/x)$ is called the *conditional probability density function* of Y given X. $f_{Y/X}(y/x)=\frac{f_{XY}(X,Y)}{f_X(x)}$	Remember	CLO 6	AECB08.06
20	Define joint density function.	The probability density function $f_{xy}(x,y)$ for a random X is a total characterization and is defined as the derivative of the cumulative distribution function $f_{xy}(x,y)=\frac{\partial^2}{\partial x \partial y}(F_{xy}(x,y))$	Understand	CLO 5	AECB08.05
21	Define properties of joint density.	$f_{XY}(x,y)$ is always a non-negative quantity. That is, $f_{XY}(x,y)\ge 0$. The area under joint density function is unity. $\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f_{XY}(xy)\,dx\,dy = 1$	Understand	CLO 5	AECB08.05
22	Define statistical independence of random variable.	Then X and Y are independent if {X≤x} and {Y≤y} are independent events. Thus, $F_{XY}(x,y)=F_X(x)F_Y(y)$.	Understand	CLO 6	AECB08.06
23	Define distribution and density function of sum of random variables.	Probability density function of $Z = X + Y$ is convolution between $f_X(x)$ and $f_Y(y)$. $f_Z(z)=f_X(x)*f_Y(y)$	Understand	CLO 7	AECB08.07

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24	Define central limit theorem.	Consider n independent random variables X1,X2,…. .The mean and variance of each of the random variables are assumed to be known. Suppose $E[X_i]=\mu_{xi}$ and $var(X_i)=\sigma^2_{Xi}$. Form a random variable Yn=X1+X2+……+Xn *The mean and variance of Y_n are given by* $\mu_{Yn}= \mu_{x1}+ \mu_{x2}+\dots+ \mu_{xn}$ $\sigma^2_{yn}= \sigma^2_{x1}+ \sigma^2_{x2}\dots+ \sigma^2_{xn}$	Understand	CLO 7	AECB08.07
MODULE-III					
1	Define expected value of random variables.	Let X and Y be a continuous random variables with joint probability density function $f_{XY}(x,y)$ $E[X\,Y]=\int_{-\alpha}^{\alpha}\int_{-\alpha}^{\alpha} x\,y\,fXY(x,y)dxdy$	Understand	CLO 8	AECB08.08
2	Define joint moments about the origin.	Two continuous random variables X and Y, *the joint moment of order* m+n is defined as $E[X^m Y^n]=\int_{-\alpha}^{\alpha}\int_{-\alpha}^{\alpha} x^m\,y^n\,fXY(x,y)dxdy$	Understand	CLO 8	AECB08.08
3	Define central moments.	Joint central moment of order *m+n is defined as* $E[(X-\mu_X)^m(Y-\mu_y)^n]=$ $\int_{-\alpha}^{\alpha}\int_{-\alpha}^{\alpha}(x-\mu x)^m\,(y-\mu y)^n\,fXY(x,y)dxd$	Remember	CLO 8	AECB08.08
4	Define Joint Characteristic Functions	Consider random variable X and Y with joint probability density function The characteristic function of X and Y denoted by is defined as $\Phi_{XY}(\omega_1, \omega_2)=E(e^{j(\omega1x+ \omega2x})]$	Remember	CLO 8	AECB08.08
5	Define Jointly Gaussian Random Variables	The jointly Gaussian random variables X and Y with the joint pdf $f_{X,Y}(x,y)=\frac{e^{-\frac{1}{2(1-\rho^2_{X,Y})}\left[\left(\frac{x-\mu_X}{\sigma_X}\right)^2-2\rho_{X,Y}\left(\frac{x-\mu_X}{\sigma_X}\right)\left(\frac{y-\mu_Y}{\sigma_Y}\right)+\left(\frac{y-\mu}{\sigma_Y}\right.}}{2\pi\sigma_X\sigma_Y\sqrt{1-\rho^2_{X,Y}}}$	Remember	CLO 9	AECB08.09
6	Define properties of Gaussian random variables.	The Normal or Gaussian pdf is a bell-shaped curve that is symmetric about. the mean μ and that attains its maximum value of 1.	Remember	CLO 9	AECB08.09
7	Define covariance.	The covariance between two jointly distributed real-valued random variables X and Y with finite second moments is defined as the expected product of their deviations from their individual expected values	Remember	CLO 8	AECB08.08
8	Define Orhthogonality	Two random variables X and Y are called orthognal if E(XY) = 0,	Understand	CLO 8	AECB08.08
9	Define correlation coefficient.	The correlation coefficient is a statistical measure that calculates the strength of the relationship between	Understand	CLO 8	AECB08.08

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
		the relative movements of two variables.			
10	Define variance of sum of random variables.	If X and Y random variables are independent $\sigma^2_{X+Y} = .\sigma^2_X + \sigma^2_Y$	Remember	CLO 8	AECB08.08
11	Define E $[X^2+ Y^2]$. If the X and Y random variables are independent	If the X and Y random variables are independent then E $[X^2+ Y^2]=$ E $[X^2]$+.E $[Y^2]$	Remember	CLO 8	AECB08.08
12	Define ,variance of the random variable Z=3X-Y.	X and Y are two statistically independent random variables.Then,variance of the random variable Z=3X-Y is 9.var(X)+var(Y)	Remember	CLO 8	AECB08.08
13	Define the second order joint moment about the origin .	Two continuous random variables X and Y, *the joint moment of order* 2 is defined as E[X Y]= $\int_{-\alpha}^{\alpha}\int_{-\alpha}^{\alpha} x^m y^n$ fXY(x, y)dxdy	Remember	CLO 8	AECB08.08
14	Define the covariance of X+a,Y+b. If X and Y are two random variables, then Where 'a'and 'b' are constants is	If X and Y are two random variables, then the covariance of X+a,Y+b, Where 'a'and 'b' are constants is Cov (X+a,Y+b) = Cov (X,Y) = CXY	Remember	CLO 8	AECB08.08
15	Define the mean square value of (Y-Z) . X, Y and Z are independent random variables with same mean variances	X, Y and Z are independent random variables with same mean variances the mean square value of (Y-Z) is $2\sigma^2_x$	Remember	CLO 8	AECB08.08
16	Define the correlation coefficient between (X+Y) and(Y+Z). If X Y Z are uncorrelated random variables with same variance.	If X Y Z are uncorrelated random variables with same variance.Find the correlation coefficient between (X+Y) and(Y+Z) is 0.5	Remember	CLO 8	AECB08.08
17	Define the joint characteristic function.	The joint characteristic function is fourier transform of joint density function.	Remember	CLO 8	AECB08.08
18	Define the jacobian of the transformation x=v; y=0.5(u-v)	The jacobian of the transformation x=v; y=0.5(u-v) is -0.5.	Remember	CLO 8	AECB08.08
19	Define K if X and Y are Gaussian random variables with variances σ^2_x and σ^2_y.Then the random variables V=X+kY and W=X-kY are statistically independent .	X and Y are Gaussianrandom variables with variances σ^2_x and σ^2_y.Then the random variables V=X+kY and W=X-kY are statistically independent for k equal to σx/ σy	Remember	CLO 8	AECB08.08

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20	Define E [X-E[X])n]	The nth central moment is $\int_{-\infty}^{\infty}(x-E[X])^n f_X(x)dx$	Remember	CLO 8	AECB08.08
21	Define E [X.Y] .If the X and Y random variables are independent .	If the X and Y random variables are independent E [X.Y] = E [X].E [Y]	Remember	CLO 8	AECB08.08
22	Define the relation between joint density function and characteristic function.	The joint density function is inverse fourier transform of joint characteristic function	Remember	CLO 8	AECB08.08
23	Define variance of Y.Two Gaussian RVs X1 and X2 have variances 4 and 9 respectively. Covariance is 3 then $Y_1=X_1-2X_2$ and $Y_2=3X_1+4X_2$.	The variance of y is 28,252 by using transformation of gaussian random varibles.	Remember	CLO 8	AECB08.08
24	Define covariance matrix of two random varibles.	The covariance of two random varibles $[Cx]=\begin{bmatrix}\sigma_{X1}^2 & \rho\sigma_{X1}\sigma_{X2}\\ \rho\sigma_{X1}\sigma_{X2} & \sigma_{X2}^2\end{bmatrix}$	Remember	CLO 8	AECB08.08
25	Define covariance.	Covariance is defined as $Cij=E[(X_i-\hat{X}_i)(X_j-\hat{X}_j)]$	Remember	CLO 8	AECB08.08
26	Define jacobian.	Jacobian is defined by $J=\det\begin{bmatrix}\frac{\partial g_1^{-1}}{\partial y_1} & \cdots & \frac{\partial g_1^{-1}}{\partial y_n}\\ \vdots & \ddots & \vdots\\ \frac{\partial g_n^{-1}}{\partial y_1} & \cdots & \frac{\partial g_n^{-1}}{\partial y_n}\end{bmatrix}$	Remember	CLO 8	AECB08.08
27	Define the new density function of y.	The density function of y is $g(y_1,y_2,\cdots,y_n)=\begin{cases}f_{X_1,\cdots,X_n}(g_1^{-1},g_2^{-1},\cdots,g_n^{-1})\|J\|\\ 0, otherwise\end{cases}$	Remember	CLO 8	AECB08.08
28	Define excepected value of discrete multiple random varibles.	The excepectation of discrete random varibles is $E(X^mY^n)=\sum_x\sum_y x^m y^n f_{XY}(x,y)$	Remember	CLO 8	AECB08.08
29	Define Marginal characteristic function.	Marginal characteristic function is $Ø_{XY}(\omega1, 0)$.	Remember	CLO 8	AECB08.08
MODULE-IV					
1	Define random process.	A random process is also known as stochastic process. A random process X(t) is used to explain the mapping of an experiment which is random with a sample space S which contribute to sample functions X(t,λi).For every point in time t1,X(t1) is a random variable.	Understand	CLO 10	AECB08.10

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
		1) t represents time and it can be discrete or continuous. 2) The range of t can be finite, but generally it is infinite. It means the process contains infinite number of random variables.			
2	Define continuous random process	Voltage in a circuit, temperature at a given location over time, temperature at different positions in a room.	Understand	CLO 10	AECB08.10
3	Define discrete random process	Quantized voltage in a circuit over time.	Understand	CLO 10	AECB08.10
4	Define continuous random sequence	Sampled voltage in a circuit over time.	Understand	CLO 10	AECB08.10
5	Define discrete random sequence	Sampled and quantized voltage from a circuit over time.	Understand	CLO 10	AECB08.10
6	Define deterministic random process.	When the future values of any sample function are predicted depending on the knowledge of the past values, then the random process is known as deterministic random process.	Understand	CLO 10	AECB08.10
7	Define non-deterministic random process.	A random process is the combination of time functions, the value of which at any given time cannot be pre-determined. So it is known as non-deterministic process.	Understand	CLO 10	AECB08.10
8	Define stationary random process.	All joint density functions of the random process do not depend on the time origin. Here the mean values are fixed and it does not depend on the time with absolute values.	Understand	CLO 10	AECB08.10
9	Define non-stationary random process	The probability density function depends on the time origin. At least one or more of the mean values will depend on time	Understand	CLO 10	AECB08.10
10	Define Nth order stationarity.	A random process is called stationary to order N or Nth order stationary if $f_X(x_1, ..., x_N; t_1, ..., t_N) = f_X(x_1, ..., x_N; t_1 + \Delta, ..., t_N + \Delta)$ for all possible $x_1, ..., x_N, t_1, ..., t_N$, and Δ.	Understand	CLO 10	AECB08.10
11	Define distribution Function of a random process	the cumulative distribution function (CDF) of random process X(t) at time t1 as $F_x(x_1;t_1) = P[X(t_1) \leq x_1]$	Understand	CLO 10	AECB08.10
12	Define density Function of a random process	probability density functions (PDFs) from random variables to density functions for random processes. The first order density function for random process X(t) is then $f_x(x_1;t_1) = \partial/\partial x_1 \; F_x(x_1;t_1)$	Understand	CLO 10	AECB08.10
13	Define Independent Processes	Two random process X(t) and Y(t) are called independent if all possible random variables generated by sampling from X(t) are independent of all possible random variables generated by sampling from Y(t).	Understand	CLO 10	AECB08.10
14	Define first order stationarity	A random process X(t) is called stationary to order one if its first order	Understand	CLO 10	AECB08.10

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
		density function does not change with a shift in time, or in terms of our density notation: fX (x1;t1) = fX (x1;t1 + Δ), for all x1, t1 and Δ. If X(t) is stationary to order random variables X1 = X(t1) and X2 = X(t2) will have the same PDF for any selection of t1 and t2. This means that the expectation of any function of X(t) will be a constant over t. That is, E {g [X (t1)]} E {g [X (t2)]}for any function g (·), t1 and t2.			
15	Define second order stationarity.	A random process X(t) is called second order stationary or stationary to order two if fX (x1, x2;t1, t2) = fX (x1, x2;t1 + Δ, t2 + Δ) for all possible selections of x1, x2, t1, t2 and Δ.	Understand	CLO 10	AECB08.10
16	Define Wide Sense Stationarity	A random process is called Wide Sense Stationary if E [X (t)] = X, a constant over all t, and Rxx (t1, t2) = Rxx (τ) where τ = t2 − t1	Understand	CLO 10	AECB08.10
17	Define time averages	Consider a random process X(t). Let x(t) be a sample function which exists for all time at a fixed value in the given sample space S. The average value of x(t) taken over all times is called the time average of x(t). It is also called mean value of x(t). It can be expressed as $\overline{x} = A[x(t)] = \lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} x(t)dt$	Understand	CLO 10	AECB08.10
18	Define Ergodic Theorem and Ergodic Process	The Ergodic theorem states that for any random process X(t), all time averages of sample functions of x(t) are equal to the corresponding statistical or ensemble averages of X(t). i.e. $\bar{x} = \bar{X}$ or $\mathcal{R}_{xx}(\tau) = R_{XX}(\tau)$ Random processes that satisfy the Ergodic theorem are called Ergodic processes.	Understand	CLO 10	AECB08.10
19	Define mean ergodic processes	A process with a mean value X which is not dependent on t is called mean ergodic or ergodic in the mean if its statistical average, $\overline{X} = E[X]$equals the time average, $\overline{x} = A[x(t)]$of any sample function x(t) with probability 1.	Understand	CLO 10	AECB08.10
20	Define time autocorrelation function	Consider a random process X(t). The time average of the product X(t) and X(t+τ) is called time average autocorrelation function of x(t) and is denoted as $\mathcal{R}_{xx}(\tau) = A[X(t)\,X(t+\tau)]$ (or) $\mathcal{R}_{xx}(\tau) = \lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T} x(t)x(t+\tau)dt.$	Understand	CLO 11	AECB08.11

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
21	Define time mean square function	If τ = 0, the time average of x2(t) is called time mean square value of x(t) defined as $A[X^2(t)] = \lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} x^2(t)dt.$	Understand	CLO 11	AECB08.11
22	Define time cross correlation function	Let X(t) and Y(t) be two random processes with sample functions x(t) and y(t) respectively. The time average of the product of x(t) y(t+ τ) is called time cross correlation function of x(t) and y(t). Denoted as $\mathcal{R}_{xy}(\tau) = \lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} x(t)y(t+\tau)dt.$	Understand	CLO 11	AECB08.11
23	Define Autocorrelation Ergodic Process	A stationary random process X(t) is said to be Autocorrelation Ergodic if and only if the time autocorrelation function of any sample function x(t) is equal to the statistical autocorrelation function of X(t). $A[x(t)\ x(t+\tau)] = E[X(t)\ X(t+\tau)]$ (or) $\mathcal{R}_{xx}(\tau) = R_{XX}(\tau).$	Understand	CLO 11	AECB08.11
24	Define Cross Correlation Ergodic Process	Two stationary random processes X(t) and Y(t) are said to be cross correlation Ergodic if and only if its time cross correlation function of sample functions x(t) and y(t) is equal to the statistical cross correlation function of X(t) and Y(t). $A[x(t)\ y(t+\tau)] = E[X(t)\ Y(t+\tau)]$ (or) $\mathcal{R}_{xy}(\tau) = R_{XY}(\tau).$	Understand	CLO 11	AECB08.11
25	Define Auto Covariance function	Consider two random processes X(t) and X(t+ τ) at two time intervals t and t+ τ. The auto covariance function can be expressed as $C_{XX}(t, t+\tau) = E[(X(t)-E[X(t)])\ ((X(t+\tau) - E[X(t+\tau)])]$ (or) $C_{XX}(t, t+\tau) = R_{XX}(t, t+\tau) - E[(X(t)\ E[X(t+\tau)]$	Understand	CLO 11	AECB08.11
26	Define Cross Covariance Function	If two random processes X(t) and Y(t) have random variables X(t) and Y(t+ τ), then the cross covariance function can be defined as $C_{XY}(t, t+\tau) = E[(X(t)-E[X(t)])\ ((Y(t+\tau) - E[Y(t+\tau)])]$ (or) $C_{XY}(t, t+\tau) = R_{XY}(t, t+\tau) - E[(X(t)\ E[Y(t+\tau)].$	Understand	CLO 11	AECB08.11
27	Define Gaussian Random Process	Consider a continuous random process X(t). Let N random variables X1=X(t1),X2=X(t2), . . . ,XN =X(tN) be defined at time intervals t1, t2, . . . tN respectively. If random variables are jointly Gaussian for any N=1,2,…. And at any time instants t1,t2,. . . tN. Then the random process X(t) is called Gaussian random process. The	Understand	CLO 11	AECB08.11

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
		Gaussian density function is given as $f_X(x_1, x_2 \ldots\ldots x_N ; t_1, t_2 \ldots\ldots t_N) =$ $\frac{1}{(2\pi)^{N/2}\lvert[C_{XX}]\rvert^{1/2}} exp(-[X-\overline{X}]^T[C_{XX}]^{-1}[X-\overline{X}])/2$ where Cxx is a covariance matrix.			
28	Define Poisson's random process	The Poisson process X(t) is a discrete random process which represents the number of times that some event has occurred as a function of time. If the number of occurrences of an event in any finite time interval is described by a Poisson distribution with the average rate of occurrence is λ, then the probability of exactly occurrences over a time interval (0,t) is $P[X(t)=K] = \frac{(\lambda t)^K e^{-\lambda t}}{k!}$, K=0,1,2, . . . And the probability density function is $f_X(x) = \sum_{k=0}^{\infty} \frac{(\lambda t)^K e^{-\lambda t}}{k!} \delta(x-k)$.	Understand	CLO 11	AECB08.11
29	Define System Response	Let a random process X (t) be applied to a continuous linear time invariant system whose impulse response is h(t). Then the output response Y (t) is also a random process. It can be expressed by the convolution integral, Y (t) = h (t) *X (t) The output response is $Y(t) = \int_{-\infty}^{\infty} h(\tau)X(t-\tau)d\tau$.	Understand	CLO 13	AECB08.13
30	Define Mean Value of Output Response	Consider that the random process X (t) is wide sense stationary process. Mean value of output response=E[Y (t)], Then E[Y (t)] = E [h (t) * X (t)]	Understand	CLO 13	AECB08.13
31	Define Mean square value of output response	Mean square value of output response is E [Y2(t)] = E [(h (t) * X (t))2] = E [(h (t) * X (t)) (h (t) * X (t))]	Understand	CLO 13	AECB08.13
32	Define Autocorrelation Function of Output Response	The autocorrelation of Y (t) is $R_{YY}(\tau_1, \tau_2)$ = E [Y (t_1) Y (t_2)] = E [(h (t1) * X (t1)) (h (t2) * X (t2))]	Understand	CLO 13	AECB08.13
33	Define Cross Correlation Function of Response	If the input X (t) is WSS random process, then the cross correlation function of input X (t) and output Y(t) is $R_{XY}(t, t+\tau)$ = E [X (t) Y (t + τ)] $R_{XY}(\tau)$ = E [X (t) $\int_{-\infty}^{\infty} h(\tau_1)$ X (t + τ - τ_1) dτ_1]	Understand	CLO 13	AECB08.13
		MODULE-V			
1	Define Power Spectral Density (PSD)	A Power Spectral Density (PSD) is the measure of signal's power content versus frequency. A PSD is typically used to characterize broadband random signals.	Understand	CLO 12	AECB08.12

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
2	Define Cross Spectral Density	For two jointly WSS random processes and we define the cross spectral density as the Fourier transform of the cross-correlation function	Understand	CLO 12	AECB08.12
3	Define Power Density Spectrum of Response	Consider that a random process X (t) is applied on an LTI system having a transfer function H(ω). The output response is Y (t). If the power spectrum of the input process is SXX (ω), then the power spectrum of the output response is given by $S_{YY}(\omega) = \lvert H(\omega)\rvert^2 S_{XX}(\omega)$.	Understand	CLO 12	AECB08.12
4	Define Spectrum Bandwidth	The spectral density is mostly concentrated at a certain frequency value. It decreases at other frequencies. The bandwidth of the spectrum is the range of frequencies having significant values. It is defined as "the measure of spread of spectral density" and is also called rms bandwidth or normalized bandwidth. $W_{rms}^2 = \frac{\int_{-\infty}^{\infty} \omega^2 S_{XX}(\omega)d\omega}{\int_{-\infty}^{\infty} S_{XX}(\omega)d\omega}$	Understand	CLO 12	AECB08.12
5	Define Low pass random processes	A random process is defined as a low pass random process X (t) if its power spectral density SXX (ω) has significant components within the frequency band	Understand	CLO 12	AECB08.12
6	Define Band pass random processes	A random process X (t) is called a band pass process if its power spectral density SXX (ω) has significant components within a band width W that does not include ω =0.	Understand	CLO 12	AECB08.12
7	Define Band Limited random processes	A random process is said to be band limited if its power spectrum components are zero outside the frequency band of width W that does not include ω =0.	Understand	CLO 12	AECB08.12
8	Define Narrow band random processes	A band limited random process is said to be a narrow band process if the band width W is very small compared to the band centre frequency, i.e. W<< ω0, where W=band width and ω0 is the frequency at which the power spectrum is maximum.	Understand	CLO 12	AECB08.12
9	Define Average cross power	The average cross power PXY of the WSS random processes X(t) and Y(t) is defined as the cross correlation function at τ =0. That is $P_{XY} = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} R_{XY}(t,t)dt$	Understand	CLO 12	AECB08.12
10	Define Wiener-Khinchin-Einstein theorem	The Wiener-Khinchin-Einstein theorem is also valid for discrete-time random processes. The power spectral density of the WSS process is the discrete-time Fourier transform of	Understand	CLO 12	AECB08.12

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
		autocorrelation sequence. $S_X(\omega)=\sum_{m=-\infty}^{\infty} R_X[m]e^{-j\omega m} \quad -\pi \le w \le \pi$			
11	Define Energy-Spectral Density	Energy, or power, spectrum analysis is concerned with the distribution of the signal energy or power in the frequency domain. For a deterministic discrete-time signal, the energy-spectral density is defined as $\lvert X(f)\rvert^2=\left\lvert \sum_{m=-\infty}^{\infty} x(m)e^{-j2\pi fm}\right\rvert^2$	Understand	CLO 12	AECB08.12
12	Define fourier transform	The Fourier Transform is a magical mathematical tool. The Fourier Transform decomposes any function into a sum of sinusoidal basis functions. Each of these basis functions is a complex exponential of a different frequency. The Fourier Transform therefore gives us a unique way of viewing any function - as the sum of simple sinusoids.	Understand	CLO 12	AECB08.12
13	Define inverse Fourier transform	A mathematical operation that transforms a function for a discrete or continuous spectrum into a function for the amplitude with the given spectrum; an inverse transform of the Fourier transform.	Understand	CLO 12	AECB08.12
14	Define energy signal	A signal x(t) is said to be an energy signal if its normalized energy is non-zero and finite. Hence for the energy signals, the total normalized energy (E) is non-zero and finite. i.e., $0<E<\infty$	Understand	CLO 12	AECB08.12
15	Define power signal	The signal having finite non-zero power are called as Power Signals $0<P<\infty$.	Understand	CLO 12	AECB08.12
16	Define average power of a random process	The average power of a random process is $E[\lvert x(t)\rvert^2]=R_{xx}(0)=\int_{-\infty}^{\infty} S_{xx}(f)\,df$ (or) $\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T}\lvert x(t)\rvert^2\,dt$	Understand	CLO 12	AECB08.12
17	Define the even signal property of power spectral density.	Power spectral density is said to be even $S_{XX}(\omega)=S_{XX}(-\omega)$	Understand	CLO 12	AECB08.12
18	Define power spectral density if X(t) & Y(t)are uncorrelated and have constant mean values .	The power spectral density is $S_{XX}(\omega)=2\pi\mu_x\mu_y\delta(\omega)$ if X(t) & Y(t) are uncorrelated and have constant mean values.	Understand	CLO 12	AECB08.12
19	Define linear system.	System satisfies superposition and homogeneity then it is called linear system.	Understand	CLO 12	AECB08.12

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
20	Define the mean value of Response of a linear system.	The response of the system y(t)= x(t)*h(t)= $\int_{-\infty}^{\infty} h(\tau) . x(t-\tau) . d\tau$ Mean value of the Output Process Expected Value of the output is $E[y(t)] = E[\int_{-\infty}^{\infty} h(\tau) . x(t-\tau)] . d\tau$ $= \int_{-\infty}^{\infty} h(\tau)$. E(x(t – τ)) dτ	Understand	CLO 13	AECB08.13
21	Define autocorrelation Function of the Output Process.	autocorrelation Function $R_{YY}(\tau) = \int_{-\infty}^{\infty} h(\tau 1) . h(\tau 2) .Rxx(\tau - \tau 2 + \tau 1). d\tau 1 \ d\tau 2$	Understand	CLO 13	AECB08.13
22	Define the properties of power spectral density.	The area under power spectral is equal to the average power of that signal. The autocorrelation function and power spectral density form a fourier transform.	Understand	CLO 13	AECB08.13
23	Define cross correlation Function of the Output Process.	Cross correlation Function of the Output Process is convolution between auto correlation of input and system function .	Understand	CLO 13	AECB08.13
24	Define mean square value of the Output Process.	Mean square value of the Output is $E[y^2(t)] = Ryy(0)$ $\int_{-\infty}^{\infty} h(\tau 1) . h(\tau 2) .Rxx(-\tau 2 + \tau 1). d\tau 1 \ d\tau 2$	Understand	CLO 13	AECB08.13
25	Define the power at the output of the LTI system	The power at the output of the LTI system is the area enclosed by the output PSD	Understand	CLO 13	AECB08.13
26	Define relation between the PSDs of the input process and output process of an LTI Systems	The output power spectral density is the product of input power spectral density and square of the transfer function.	Understand	CLO 13	AECB08.13
27	Define parseval's theorem	Parseval's theorem defines the power of the signal in terms of its fourier series coefficients.	Understand	CLO 12	AECB08.12
28	Define average power.	The average power is defined as the power dissipated by a voltage x(t) applied across a 1 ohm resistor.	Understand	CLO 12	AECB08.12
29	Define energy spectral density.	Energy spectral density is defined as the distribution of energy of a signal in frequency domain.	Understand	CLO 12	AECB08.12
30	Define spectrum.	Any waveform can be represented by a summation of a (possibly infinite) number of sinusoids, each with a particular amplitude and phase. Such a representation is referred to as the signal's spectrum	Understand	CLO 12	AECB08.12
31	Define convolution	Convolution is a mathematical operation on two functions (f and g) to produce a third function that expresses how the shape of one is modified by the other.	Understand	CLO 12	AECB08.12

S.No	Question	Answer	Blooms Taxonomy Level	CLO	CLO Code
32	Define power spectral density of $A_c\cos(\omega ct)$	Two impulses at ω=ωc and ω=-ωc with an amplitude of π.	Understand	CLO 12	AECB08.12

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