Code No: R1621045 **R16** SET - 1

II B. Tech I Semester Regular Examinations, October/November - 2017
RANDOM VARIABLES & STOCHASTIC PROCESSES
(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1. a) What are the conditions for a function to be a random variable? [2M]
b) Define various types of transformation of Random variables. [2M]
c) Show that var(X+Y) = var(x)+var(Y), if X&Y are statistical independent random variables. [3M]
d) Differentiate between Random Processes and Random variables with an example [2M]
e) If the Auto correlation function of wide sense stationary X(t) is RXX(τ)=$4+2e^{-2\tau}$. Find the area enclosed by the power spectrum density curve of X(t). [3M]
f) Define linear system and write the expression for output response. [2M]

PART -B

2. a) Write the properties of Gaussian density curve. Find the maximum value of Gaussian density function [8M]
b) A random variable X has the distribution function [6M]

$$F_X(x)= \sum_{n=1}^{12} \frac{n^2}{650} u(x-n)$$

Find the probability of a) $P\{-\infty < X \leq 6.5\}$ b) $p\{X>4\}$ c) $p\{6< X \leq 9\}$

3. a) State and prove the chebychev‟s inequality theorem? [7M]
b) If X is a discrete random variable with a Moment generating function of Mx(0), find the Moment generating function of [7M]
i) Y=aX+b ii) Y=KX iii) $Y=\frac{X+a}{b}$

4. a) State and explain the properties of joint density function [7M]
b) State and prove the central limit theorem. [7M]

5. a) Explain the following [7M]
i) Stationarity ii) Ergodicity
iii) Statistical independence with respect to random processes
b) A random process is given as X(t) = At, where A is a uniformly distributed random variableon (0,2). Find whether X(t) is wide sense stationary or not. [7M]

6. a) The power spectral density of a stationary random process is given by [7M]

$$S_{xx}(w) = A \quad -k < w < k$$
$$= 0 \quad \text{otherwise}$$

Find the auto correlation function.
b) Derive the relationship between cross-power spectral density and cross correlation function. [7M]
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7. a) The input to an LTI system with impulse response h(t)= $\delta t + t^2 e^{-at}$. U(t) is a WSS process with mean of 3. Find the mean of the output of the system. [7M]

   b) Write Short notes on Mean and Mean Squared Value of System response of a linear system. [7M]

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PART –A

1. a) Give the classical axiomatic definitions of Probability [2M]
b) Find the variance of X for uniform density function. [3M]
c) The joint probability density function of X&Y is [3M]

$$f_{X,Y}(x,y)=\begin{cases} c(2x+y); & 0\le x\le 2, 0\le y\le 3 \\ 0; & \text{else}\end{cases}$$

Then find the value of constant c.
d) Prove that the Auto correlation function has maximum value at the origin i.e $|R_{XX}(\tau)|=R_{XX}(0)$ [2M]
e) If the Power spectrum density of x(t) is $S_{XX}(\omega)$, find the PSD of $\frac{dx(t)}{dt}$ [2M]
f) Define Effective Noise temperature and Average Noise Figure [2M]

PART -B

2. a) Define and explain the properties of CDF function of a random variable. [8M]
b) Assume that X is a continuous random variable with the following pdf: [6M]

$$fx(x)=f(x)=\begin{cases}A(2x-x^2), & 0<x<2\\ 0, & Otherwise\end{cases}$$

i)What is the Value of A? ii) Find P[X >1] iii) Evaluate CDF function.

3. a) Find the Moment generating function of exponential distribution? [6M]
b) A continuous distribution is given by [8M]

$$F_x(x)=\frac{1}{x\sqrt{2\pi}}e^{-(\log x)2}/2 \qquad x>0$$
$$=0 \qquad x<0$$

Find the mean, standard deviation and co-efficient of skewness of this distribution

4. a) State and prove any three properties of joint characteristic function. [6M]
b) Random variables X and Y have a Joint Probability density function given by [8M]

$$f_{XY}(x, y)=\frac{1}{\pi} \text{ for } x^2+y^2\le 1$$
$$= 0 \text{ otherwise}$$

Determine whether random variables x and y are
i) Statistically independent ii) Uncorrelated.

5. a) Explain about the following random processes [6M]
i) Mean ergodic process ii) Correlation ergodic process iii) Gaussian random process
b) Prove that the random process $X(t) = A\cos(wct+q)$ is wide sense stationary if it is assumed that wc is a constant and q is uniformly distributed variable in the interval (0,2π). [8M]
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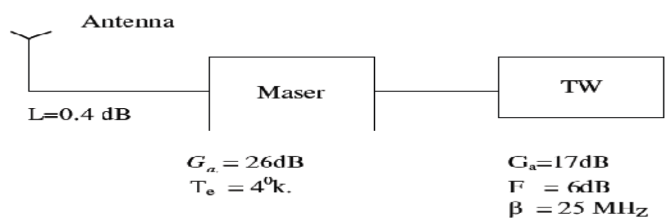
6. a) Calculate the power Spectral Density of a stationary random process for which the Autocorrelation is $R_{xx}(\tau) = \sigma^2 e^{-\propto|\tau|}$ [7M]

   b) State and prove the relationship between Power Density Spectrum and Autocorrelation Function [7M]

7. a) For the following receiver, calculate the effective noise temperature. [6M]



   b) Derive the relation between input PSD and output PSD of an LTI system [8M]

Code No: R1621045 **R16** SET - 3

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PART –A

1. a) How you can differentiate mutually exclusive events and independent event? [3M]
   b) Define skew and skewness [2M]
   c) Define Marginal Distribution Functions [2M]
   d) List out the properties of Autocorrelation Function [3M]
   e) Define Wide Sense Stationary Process and write its conditions [2M]
   f) Write the expression for average noise figure of cascaded networks. [2M]

PART -B

2. a) In a binary communication system, the probability of bit error is 0.01. If a block of 8 bits are transmitted, find the probability that [8M]
   (a) Exactly 2 bit errors will occur
   (b) At least 2 bit errors will occur
   (c) More than 2 bit errors will occur
   (d) All the bits will be erroneous
   b) For real constants b>0, c>0 and any a , find condition on constant a and relationship between a and c (for given b) such that the function is a valid probability density [6M]

$$fx(x) = \begin{cases} a(1-(x/b)) & 0 \le x \le c \\ 0 & else\ where \end{cases}$$

3. a) Find the Mean and Variance of the Poisson RV [7M]
   b) Explain Nonmonotonic Transformations of Continuous Random Variable [7M]

4. a) If X and Y are independent, show that E[XY]=E[X] E[Y]. [7M]
   b) The joint density function of two random variables X and Y is [7M]

$$f_{XY}(x,y) = \begin{cases} \frac{(x+y)^2}{40} & ; -1 < x < 1 \ and \ -3 < y < 3 \\ 0; & otherwise \end{cases}$$

   Find the variances of X and Y

5. a) Define a random process. Write the classification of random process by the form of its sample functions and explain [7M]
   b) Autocorrelation function of an ergodic stationary random process with no periodic component is given as 100+ 4/(1+6τ^2). Find the mean and variance of the process. [7M]
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6. a) Prove that Power Density Spectrum and Autocorrelation Function forms a Fourier transform pair [7M]

   b) A random process Y(t) has the power spectral density [7M]

$$S_{YY}(\omega)=\frac{9}{\omega^2+64}$$

   Find i) The average power of the process

   ii) The Auto correlation function

7. a) Derive the equivalent Effective noise temperature of a cascaded network. [7M]

   b) Explain about Band limited random process and its properties. [7M]

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PART –A

1. a) State Bayes' Theorem [2M]
   b) What are the properties of Gaussian Random variable? [3M]
   c) State Central limit theorem [2M]
   d) Define a random process. Write the classification of random process by the form of its sample functions [3M]
   e) Explain about Statistical independence with respect to random processes [2M]
   f) What is the Mean-squared value of a linear system? [2M]

PART -B

2. a) Two boxes are selected randomly. The first box contains 2 white balls and 3 black balls. The second box contains 3 white and 4 black balls. What is the probability of drawing a white ball? [7M]
   b) Write the properties of Poisson distribution and density curve. Find the maximum value of Poisson density function [7M]

3. a) Explain about Monotonic Transformations for a Continuous Random Variable [7M]
   b) Find the Moment generating function of exponential distribution? [7M]

4. a) Explain the conditions to be satisfied by an ergodic random process [7M]
   b) Two statistically independent random variables X and Y have respective densities $f_X(x) = 5\, e^{-5x}\, u(x)$, $f_Y(y) = 2\, e^{-2y}\, u(y)$. Find the density of the sum W=X+Y. [7M]

5. a) Write all the properties of joint density function. [6M]
   b) A joint probability density function is [8M]

   $$f_{x,y}(x,y) = \begin{cases} \frac{1}{24} & 0 < x < 6, 0 < y < 4 \\ 0 & \text{else where} \end{cases}$$

   Find the expected value of the function $g(X,Y) = (XY)^2$

6. a) Determine the cross-correlation function corresponding to the cross power spectrum $S_{XY}(\omega)=8/(\alpha+j\beta)^3$, where α is a constant [7M]
   b) Derive the expression for power spectral density of a random process [7M]
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7. a) Prove that [7M]

$$F = F_1 + \frac{F_2 - 1}{g a_1} + \frac{F_z^{-z}}{g_{a_1} g_{a_2}} + \ldots\ldots\ldots\ldots\ldots$$

for cascade of two-port networks

b) Write notes on modelling of thermal noise source [7M]