Code No: RT22042 **R13** SET - 1

II B. Tech II Semester Regular/ Supplementary Examinations, April/May-2017
RANDOM VARIABLES AND STOCHASTIC PROCESSES
(Electronics and Communications 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 **THREE** Questions from **Part-B**

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PART –A

1. a) Define probability density function. (2M)
   b) X and Y are random variables related by Y= 3X+6, X is a zero mean random variable with variance 2. Find the variance of Y. (4M)
   c) Write the expressions to obtain marginal densities from joint density. (3M)
   d) Explain the concept of strict sense stationary. (3M)
   e) A random process has ACF $R_X(\tau) = \cos\omega_o\tau$. Find its power density spectrum. (4M)
   f) Write short notes on resistive noise. (6M)

PART –B

2. a) A random variable X has the following density function. Find 'k' and CDF of X. Also find P[1<X≤3]. (8M)

$$f_X(x) = \begin{cases} \frac{k}{4}, & 0 < x \le 2 \\ \frac{1}{2}, & 2 < x \le 3 \end{cases}$$

   b) Discuss the characteristics of Poisson, Gaussian random variables using relevant expressions and sketches of their distribution and density functions. (8M)

3. a) Obtain the moment generating function for uniformly distributed random variable in the interval [c,d]. (8M)
   b) X is a Gaussian random variable with zero mean and unity variance. If $Y = e^X$ obtain the density of $f_Y(y)$. (8M)

4. a) Define joint characteristic function. Obtain the joint characteristic function of X and Y if (8M)

$$f_{x,y}(x,y) = (1/2\pi)\exp\left[-\left(\frac{x^2+y^2}{2}\right)\right]$$

   b) Define joint distribution function of random variables and write its properties. (8M)

5. a) Define autocorrelation function of a random process and write its properties. (8M)
   b) Two WSS random processes are defined by $X(t) = A\cos\omega_o t + B\sin\omega_o t$, $Y(t) = B\cos\omega_o t - A\sin\omega_o t$ where ω_o is constant and A, B are uncorrelated zero mean random variables. Show that X(t) and Y(t) a jointly WSS. (8M)

6. a) Derive the expression for cross power density spectrum of a random process. (10M)
   b) Write properties of power density spectrum. (6M)

7. a) Derive the expression for average noise figure of cascaded two port networks. (10M)
   b) Explain the term band limited, band pass and narrow band random process with the help of relevant spectra. (6M)
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Code No: RT22042 **R13** SET - 2

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2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1. a) Define random variable and conditions to be satisfied by it. (3M)
   b) Discuss Chebyschev's inequality. (3M)
   c) Write the expressions to obtain marginal distributions from joint density function. (3M)
   d) Explain the concept of WSS random process. (4M)
   e) ACF of a WSS random process X(t) is $R_{XX}(\tau) = 36 + \frac{9}{1+4\tau^2}$ Find the variance of the process. (4M)
   f) Define effective noise and noise figure and write the relation between them. (5M)

PART –B

2. a) A random variable is uniformly distributed in the interval [-1,2]. Find the probabilities of the events A = $\{|X - 0.5| < 1\}$ and B = $\{X > -0.5\}$. (8M)
   b) Discuss the characteristics of Binomial, Rayleigh random variables using relevant expressions and sketches of their distribution and density functions. (8M)

3. a) Obtain the mean of Poisson random variable. (8M)
   b) X is a uniformly distributed random variable in the interval ($-\Pi/2$,0). If Y = 2tanX, obtain the density of Y. (8M)

4. a) State and prove central limit theorem for equal distributions case. (12M)
   b) Write short notes on jointly Gaussian random variables (4M)

5. a) Define cross correlation function of a random process and write its properties. (8M)
   b) A random process $X(t) = A\cos(\omega_o t+\Theta)$ where Θ, ω_o are constants and A is a uniformly distributed random variable in the interval (0,2). Check whether X(t) is ergodic in mean or not? (8M)

6. a) Derive the expression for power density spectrum of a random process. (10M)
   b) Write properties of cross power density spectrum. (6M)

7. a) Obtain the expression for power density spectrum of an LTI system excited by a random process X(t). (8M)
   b) Define band limited process and write its properties. (8M)
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Code No: RT22042 **R13** SET - 3

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2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1. a) Define probability distribution function. (2M)
   b) Express third order moments about mean of a random variable X in terms of its lower order moments like mean, variance etc. (4M)
   c) Statistical independence guarantees un correlation. Prove it. (4M)
   d) Define random process and explain the terms deterministic random process and nondeterministic random process. (5M)
   e) ACF of a random process X(t) is $R_{XX}(\tau) = e^{-|\tau|}$. Find power density spectrum. (4M)
   f) Explain the term average noise figure. (3M)

PART -B

2. a) In a restaurant the waiting time for a customer to catch the attention of a waiter is X and is specified by the following distribution function. Compute the probability that the customer will have to wait i)between 5 and 10 minutes, ii) atleast 10 minutes. (8M)

$$F_X(x) = \begin{cases} \left(\frac{x}{2}\right)^2, & \text{for } 0 \le x \le 1, \\ \frac{x}{4} & \text{for } 1 \le x \le 2, \\ \frac{1}{2} & \text{for } 2 \le x \le 10 \\ \frac{x}{20} & \text{for } 10 \le x \le 20, \\ 1 & \text{for } x \ge 20. \end{cases}$$

   b) Define conditional density function and write its properties. (8M)
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Code No: RT22042 **R13** SET - 3

3. a) Obtain the mean of Rayleigh random variable. (8M)

   b) X is a uniformly distributed random variable in the interval (a, b). If $y = \sqrt{X}$, Obtain the density of Y. (8M)

4. a) Obtain the expression for conditional density function considering the case of interval conditioning. (8M)

   b) Define Joint central moments of the random variables X and Y. Obtain the expressions for covariance, correlation coefficient and also obtain C_{XY} when X and Y are i) uncorrelated ii) orthogonal (8M)

5. a) Explain with the help of relevant expressions about WSS and SSS of a random process. (8M)

   b) Write short notes on Poisson random process. (8M)

6. Derive the relationship between cross correlation and cross spectral density of random processes. (16M)

7. a) Obtain the expression for mean value of the response of an LTI system excited by a random process X(t) (8M)

   b) Write short notes on thermal noise. (8M)

Code No: RT22042 **R13** SET - 4

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2. Answer **ALL** the question in **Part-A**
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PART –A

1. a) Write properties of density function. (5M)
   b) Write the expression for coefficient of skewness. Explain skew using a relevant density diagram. (3M)
   c) Discuss central limit theorem for unequal distributions case. (3M)
   d) Classify random processes and explain any one of them. 5M
   e) What are the expressions necessary to represent a correlation ergodic random process? (3M)
   f) An LTI system with H(f) = $\frac{R}{R+j\omega L}$ is excited by a random process with PSD $N_o/2$. Find the output PSD. (3M)

PART –B

2. a) A random variable X has $F_X(x) = (1- (1/4)\, e^{-cx})u(x)$. Find the value of 'c' and P[2<X<6] and P[X>10]. (8M)
   b) Discuss the characteristics of exponential, uniformly distributed random variables using relevant expressions and sketches of their distribution and density functions. (8M)

3. a) Find the mean of Binomial random variable. (8M)
   b) X is a Gaussian random variable with zero mean and unit variance, S/T Y = aX + b is also a Gaussian random variable. (8M)

4. a) X and Y are statistically independent random variables and W = X + Y, Find $f_W(w)$. (8M)
   b) Write the expression to obtain joint moments about the origin of random variables X and Y of order (n+k) and define correlation R_{XY}. Obtain the expressions for R_{XY} if X and Y are uncorrelated, orthogonal respectively. (8M)

5. a) Define the concept of time averages and ergodicity. Write the expressions for a random process to be ergodic in mean and autocorrelation function. (8M)
   b) A random process X(t) = Acos(ω_ot+Θ) where A, ω_o are constants and Θ is a uniformly distributed random variable in the interval (0,2Π). Check whether X(t) is Wide sense stationary process or not? (8M)

6. State and prove Wiener-Khintchine relations with reference to a random process. (16M)

7. a) Obtain the expression for cross-power density spectrum of input and output of an LTI system excited by a random process X(t). (8M)
   b) Explain the terms effective noise temperature, noise figure. (8M)
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