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KUMARAGURU college of technology character is life

B.E DEGREE EXAMINATIONS: NOV/DEC 2016

(Regulation 2014)

Fifth Semester

ELETRONICS AND COMMUNICATION ENGINEERING

U14ECT506**:** Statistical Theory of Communication

COURSE OUTCOMES

CO1: Apply fundamental probability theory for real time problems

CO2: Classify random variables and random process

CO3: Analyze linear time invariant systems performance for random inputs

CO4: Demonstrate fundamental information theory concepts and source coding algorithms

CO5: Classify and analyze the discrete and continuous channel models

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Match List I with List II CO2 [K_3]

List I	List II
A. Mutually Exclusive Events	i. E[XY]=E[X]E[Y]
B. Orthogonal	ii. E[XY]=0
C. Uncorrelated	iii. $p(A \cap B) = 0$

	A	B	C
a)	3	1	2
b)	2	1	3
c)	3	2	1
d)	2	3	1

2. $P\left(\bigcup_{n=1}^{N} A_n\right) = \sum_{n=1}^{N} P(A_n)$ if CO1 [K_2]

a) $A_m \cap A_n = \phi \quad if \;\; m \neq n$

b) $A_m \cap A_n = \{0\} \quad if \;\; m \neq n$

c) $A_m \cap A_n = \phi \quad if \;\; m = n$

d) $A_m \cap A_n = S \quad if \;\; m \neq n$

3. P(a<x<b) is CO2 [K_3]

1. $F_X(b) - F_X(a)$
2. $\int_a^b f_X(x)dx$

3. $f_X(a) - f_X(b)$
4. $F_X(a) - F_X(b)$

Which of these are correct

a) 1,3 b) 2,3
c) 2,4 d) 1,2

4. A box contains 4 bad and 6 good tubes. Two are drawn out from the box at a time one of them is tested and found to be good. What is the probability that the other one is also good. CO1 [K_3]
a) 2/3 b) 1
c) 1/3 d) 3/6

5. Assertion (A): The third central moment is the measure of asymmetry of $f_X(x)$ about the mean value. CO2 [K_2]
Reason (R): Zero skew is the indication of asymmetry density function .
a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true and R is not the correct explanation of A
c) A is true but R is false
d) A is false but R is true

6. Arrange the following moments in increasing order of moment CO2 [K_3]
   1. Variance
   2. Mean
   3. Correlation
   4. Skew

a) 1-3-4-2 b) 1-2-3-4
c) 2-1-3-4 d) 3-4-2-1

7. The noise bandwidth of a system with magnitude transfer function $H(\omega)$ is CO3 [K_2]
a) $|H(\omega)|^2$
b) $\dfrac{\int_0^\infty |H(\omega)|^2 d\omega}{|H(0)|^2}$
c) $\dfrac{\int_{-\infty}^\infty |H(\omega)|^2 d\omega}{|H(\omega)|^2}$
d) $\dfrac{\int_0^\infty |H(\omega)|^2 d\omega}{|H(\omega)|^2}$

8. The average power of the random process with the autocorrelation function CO3 [K_3]
$Rxx(\tau) = 25 + \dfrac{4}{(1+6\tau^2)}$ is
a) 25 b) 35
c) 0 d) 29

9. Which of the following random process has no memory CO3 [K_2]
   1. Poisson
   2. Exponential
   3. Bernoulli
   4. Markov

a) 1,2,4 b) 1,4
c) 1,3 d) 1,2,3

10. If X and Y are independent random variable, then mutual information I(X;Y) is CO5 [K_3]
a) 0 b) 0.5
c) 1 d) 2

PART B (10 x 2 = 20 Marks)

(Answer not more than 40 words)

11. A pointer is spun on a fair wheel of chance having its periphery labeled from 0 to 100.Write the sample space. What is the probability of pointer stop between 20 to 35? CO1 [K_2]

12. A continuous random variable X has a Probability Density Function. $f_X(x) = Ke^{-ax}, x \geq 0$. Find the value of K. CO2 [K_4]

13. A joint probability density function is CO2 [K_3]

$$f_{X,Y}(x,y) = \begin{cases} \frac{1}{ab}, & 0 < x < a, \quad 0 < y < b \\ 0, & Otherwise \end{cases}$$

Find $f_X(x)$ *and* $f_Y(y)$

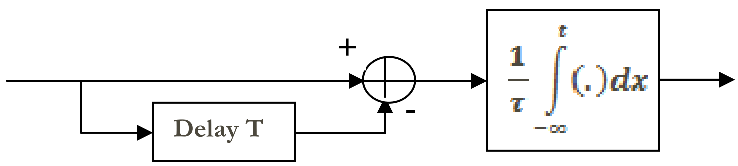
14. Aircraft arrive at an airport according to a Poisson process at a rate of 12 per hour. All aircraft are handled by one air-traffic controller. If the controller takes a 2 minutes break, what is the probability that he will miss one or more arriving aircraft? CO2 [K_3]

15. What is Ergodic Random Process? CO2 [K_2]

16. A random process X(t) has the PSD : $S_{XX}(\omega) = 10$ Find the auto correlation of X(t). CO2 [K_3]

17. If $X(t)$ is a stationary process, find the power spectrum of $Y(t) = A_o + B_o X(t)$. CO3 [K_3]

18. Find and plot the impulse response of the system given below. CO3 [K_3]



19. A voice graded channel of the telephone network has a bandwidth of 3.4 KHz. Calculate the channel capacity of the telephone channel for a Signal to noise ratio of 30 dB. CO5 [K_4]

20. What is the difference between Channel coding and Source coding? CO4 [K_4]

Answer any FIVE Questions:-

PART C (5 x 14 = 70 Marks)

(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. i) State and Prove Wiener Khinchine Theorem (6) CO2 [K_2]

ii) A discrete memoryless source has an alphabet of five symbols with their probabilities are given as : (8) CO4 [K_4]

Symbol	S0	S1	S2	S3	S4
Probability	0.55	0.15	0.15	0.10	0.05

i. Find the Huffman codes for this source.
ii. Find average code length
iii. Entropy of the discrete memoryless channel

22. i) Spacecraft are expected to land in a prescribed recovery zone 80% of the time. Over a period time, six spacecraft land. (10) CO1 [K_3]

i. Find the probability that none lands in the prescribed zone.
ii. Find the probability that at least one will land in the prescribed zone.
iii. The landing program is called successful if the probability is 0.9 or more that three or more out of six spacecraft will land in the prescribed zone. Is the program successful?

ii)Use De Morgan's law to prove (4) CO1 [K_3]

$$\overline{(A \cap B \cap C)} = \overline{A} \cup \overline{B} \cup \overline{C}$$

23. i) A Gaussian random voltage X with $a_X = 0$ and $\sigma_X = 4.2V$ appears across a 100Ω resistor with a power rating of 0.25W. What is the probability that the voltage will cause an instantaneous power that exceeds the resistors rating? (6) CO2 [K_4]

ii) Derive the mean and variance of uniformly distributed random variable. (8) CO2 [K_3]

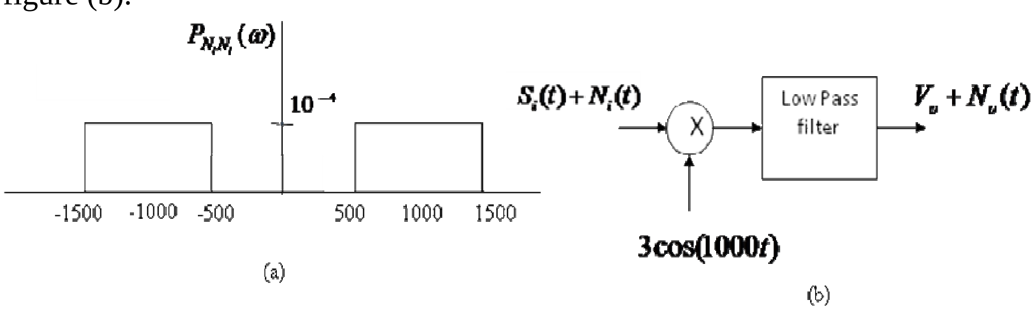
24. i) The density function $f_{X,Y}(x,y) = \begin{cases} \frac{xy}{9} & 0 < x < 2 \text{ and } 0 < y < 3 \\ 0 & elsewhere \end{cases}$ applies to two random variables X and Y. Are X, Y uncorrelated? (6) CO2 [K_4]

ii) Show that the signal $X(t) = A\cos(\omega_0 t + \theta)$ is a wide sense stationary process where A and ω_0 are constants and θ is uniformly distributed random variable on the interval (0,2π). Also find the power of the signal X(t). (8) CO2 [K_3]

25. The random process y(t) is generated by filtering a random process x(t) with a LTI system having transfer function H(w). Find the mean, autocorrelation and PSD of y(t) in terms of the mean, autocorrelation and power spectrum of x(t). CO3 [K_2]

26. i) Derive the impulse response of the matched filter. Calculate the maximum SNR that can be obtained at the output of the matched filter. (8) CO3 [K_2]

ii) A signal $s(t) = 2.3\cos(1000t)$ plus an input noise process $N_i(t)$ having the power spectrum shown in the figure (a) are applied to a product device shown in figure (b). (6) CO3 [K_4]



i. Find the output dc voltage?
ii. Sketch the power density spectrum of $N_o(t)$?

27. State and prove the Shannon's Channel Capacity Theorem. CO5 [K_2]

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