KUMARAGURU
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B.E DEGREE EXAMINATIONS: NOV/DEC 2024

(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. If A is a subset of B then which of the following statements are true   CO1 [K3]

   1. $A \cap B = A$
   2. $A \cup B = A$
   3. $P(A) \le P(B)$
   4. $P(A) > P(B)$

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

2. If a sample space consists of 2 outcomes then total number of subsets can be formed is   CO1 [K2]

   a) 2   b) 1
   c) 4   d) 8

3. The autocorrelation of a random process is $\frac{\eta}{2}\delta(t)$. What is the PSD of the random process   CO3 [K3]

   a) $\dfrac{\eta}{4}$ b) $\dfrac{\eta}{2}$
   c) 2η d) η

4. A box contains 4 red balls and 10 green balls. One ball is drawn out from the box and found to be green. What is the probability?   CO1 [K3]
   a) 10/14   b) 4/14
   c) 1/10   d) 1/9

5. A: If X and Y are independent, then they are also Uncorrelated
   R: If X and Y are Uncorrelated , they are also Independent   CO2 [K2]

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. Match List I with List II   CO2 [K$_3$]

LIST I	LIST II
I. First Moment about Origin	A. Skewness
II. 2nd Central Moment	B. Mean
III. 3dr Central Moment	C. kurtosis
IV. 4th central Moment	D. Variance

a) I- B, II- D, III-A, IV- C.
b) I- B, II- D, III-C, IV- A.
c) I- C, II- A, III-D, IV- B.
d) I- B, II- A, III-D, IV- C.

7. A LTI System with impulse response $h(t) = 3t$ is a _____ system.   CO3 [K$_2$]

a) Unstable and non-causal
b) Unstable and causal

c) stable and non-causal
d) stable and causal

8. Mean of a Poisson random process is   CO2 [K$_3$]
a) 1
b) 0

c) constant
d) λt

9. The noise band width if the system is 32 KHz. The PSD of the white noise is 10. What is the average noise power at the output.   CO5 [K$_4$]
a) 10
b) 32000

c) 320000
d) 3200

10. The mutual information I(X;Y) of two independent random variables X and Y is   CO4 [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. Write any two properties of autocorrelation.   CO3 [K$_2$]

12. If $A \subset B \subset S$, then prove that P(A) >= P(B)   CO1 [K$_4$]

13. Derive the variance of uniform Random Variable.   CO2 [K$_3$]

14. What are the conditions for a random process to be a wide sense stationary?   CO2 [K$_3$]

15. What is Ergodic Random Process?   CO2 [K$_2$]
16. State Central Limit Theorem   CO2 [K$_3$]

17. The random variable X has mean μ = 6 and variance σ_x^2 =3. Find E[X^2]   CO2 [K$_3$]
18. What is the impulse response of the system given below.   CO4 [K$_3$]
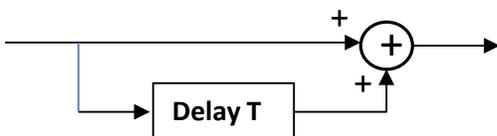
19. A voice graded channel of the telephone network has a bandwidth of 3.4 KHz. Calculate the channel capacity of the telephone channel for a Signal to Noise Ratio (SNR) of 30 dB .   CO4 [K4]

20. Differentiate Channel coding and Source coding?   CO5 [K4]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. A discrete memoryless source has an alphabet of five symbols with their probabilities are given as :   14   CO4 [K4]

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.a. Use De Morgan's law to prove   4   CO1 [K3]
$$\overline{(A \cap B \cap C)} = \overline{A} \cup \overline{B} \cup \overline{C}$$

22.b. Shade Venn diagram to illustrate the following sets   10   CO1 [K3]
    i) $(A \cap B \cap \overline{C}) \cup (\overline{B} \cap C \cap D)$ ii) $(A \cup B) - C$ iii) $(A \cup \overline{B}) \cap \overline{C}$

23.a. State and Prove Wiener Khinchine Theorem   10   CO2 [K3]

23.b. Write the properties of Probability density function   4   CO2 [K2]

24. Spacecraft are expected to land in a prescribed recovery zone 80% of the time. Over a period time, six spacecraft land.   14   CO1 [K4]
    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?

25. Derive the impulse response of the matched filter. Calculate the maximum SNR that can be obtained at the output of the matched filter.   14   CO3 [K2]

26. 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).   14   CO4 [K2]

27. State and prove the Shannon's Channel Capacity Theorem.   14   CO5 [K2]

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