

R18

Code No: 153BQ

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech II Year I Semester Examinations, September/October - 2023

PROBABILITY THEORY AND STOCHASTIC PROCESSES

(Electronics and Communication Engineering)

Time: 3 Hours

Max. Marks: 75

Note: i) Question paper consists of Part A, Part B.

ii) Part A is compulsory, which carries 25 marks. In Part A, answer all questions.

iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART - A

(25 Marks)

- 1.a) Discuss joint and conditional probabilities. [2]
- b) Define Rayleigh density function. [3]
- c) Define the expected value of a random variable. [2]
- d) Discuss the concept of transformation of random variables. [3]
- e) Define the concept of ergodicity. [2]
- f) Write the concept of first-order stationary random process. [3]
- g) Define the power density spectrum of a system response. [2]
- h) State any two differences between random variable and random process. [3]
- i) Define entropy in the context of information theory. [2]
- j) Discuss the concept of average noise figure. [3]

PART - B

(50 Marks)

- 2.a) A random variable X has a probability density function of the form:
 $f_x(x) = \frac{1}{4}[u(x) - u(x - 1)]$ for the random variable $Y = x^2$, find the variance.
 - b) A pack contains 4 white and 2 green pencils, another contains 3 white and 5 green pencils. If one pencil is drawn from each pack, find the probability that (i) Both are white. (ii) One is white and another is green. [5+5]
- OR**
- 3.a) Consider the experiment of tossing four fair coins. The random variable X is associated with the number of tails showing. Compute and sketch the CDF of X.
 - b) A random variable X has the distribution function: $f_x(x) = \sum_{n=1}^{12} \frac{n^2}{650} u(x - n)$. Find the probabilities (i) $P\{-\infty < X \leq 6.5\}$. (ii) $P\{X > 4\}$ (iii) $P\{6 < X \leq 9\}$. [5+5]
- 4.a) Let X and Y be jointly Gaussian random variables with means $\mu_x = 3, \mu_y = 4$, variances $\sigma_x^2 = 9, \sigma_y^2 = 16$, and correlation coefficient $\rho = 0.6$. Calculate the covariance between X and Y.
 - b) What is statistical independence between two random variables? How does it relate to joint distribution? Provide an example to illustrate independence and dependence. [5+5]

OR

- 5.a) State and prove the Central Limit Theorem.
- b) Let X_1, X_2, \dots, X_n be independent and identically distributed random variables with mean $\mu = 20$ and variance $\sigma^2 = 36$. If $n = 100$, calculate the mean and standard deviation of the sample mean (\bar{X}) according to the Central Limit Theorem. [5+5]



- 6.a) Show that the autocorrelation function of a stationary random process is an even function of τ .
b) Explain the difference between (N-order) and strict-sense stationarity. Provide an example of a process that is (N-order) stationary but not strict-sense stationary. [5+5]

OR

- 7.a) Explain the concept of time averages and their relationship to ergodic processes.
b) Define the autocorrelation function of a random process. Discuss its properties and how it quantifies temporal dependence. [4+6]

- 8.a) Discuss the properties of the cross-power density spectrum, including symmetry and non-negativity.

- b) For two jointly stationary random processes, the cross-correlation function is $R_{xy}(\tau) = 2e^{-2\tau}u(\tau)$. Find the two cross-spectral density function. [5+5]

OR

- 9.a) Explain the relationship between the power density spectrum of the input signal and the system's frequency response.

- b) Discuss the relationship between cross power spectrum and cross correlation function. [5+5]

- 10.a) Explain the concept of source coding using Huffman coding. How do this coding techniques help to compress data efficiently while preserving information?

- b) Explain the concept of channel capacity for a discrete channel. How does the Shannon-Hartley law relate the channel capacity to the signal-to-noise ratio? [5+5]

OR

- 11.a) Explain about resistive/thermal noise source. How does it contribute to the noise in electronic systems?

- b) Consider a communication system with a receiver that has a noise temperature of 300 K. If the receiver is connected to an antenna with a noise temperature of 200 K, calculate the overall effective noise temperature of the system. [5+5]

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