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~~ME-II / SSA ExTC~~.

QP Code : 30052

Duration 03 Hours | Total Marks assigned to the paper 80

Marks assigned to each question should be stated against each question.

Instructions to the candidates, if any:-

N.B.:

1) Attempt any <u>**Four**</u> questions from the **Six** questions
2) Assumptions made should be clearly stated.
3) Figures to the right indicate full marks.
4) Illustrate answer with sketches wherever required.
5) Use of **Normal** table is permitted.

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1 (a) If $X_1, X_2, \ldots, X_n$ are the Poisson variates with parameter $\lambda = 2$, use the central limit theorem to estimate $P(120 \le S_n \le 160)$ where $S_n = X_1 + X_2 + \ldots + X_n$ and $n = 75$. 10

(b) Define random process and give a detailed classification of random process with examples of discrete and continuous random process. 10

2 (a) Let $X = N(\mu; \sigma^2)$. Find μ_X and σ_X^2 10

(b) Consider the random process $X(t)$ defined by 10

$$X(t) = Y\cos(\omega t) \qquad t \ge 0$$

where ω is a constant and Y is a uniform r.v. over (0, 1).

i. Find $E(X(t))$
ii. Find the autocorrelation function of $X(t)$.
iii. Find the autocovariance function of $X(t)$.

3 (a) Let $X(t) = a\cos(2\pi f_0 t + \Theta)$ where Θ is uniformly distributed in the interval $(0, 2\pi)$. Find $S_X(f)$. 10

(b) Write a detailed note on Kalman filter. 10

4 (a) The time elapsed between the claims processed is modeled such that T_k represents the time elapsed between processing the $(k\text{-}1)^{th}$ and k^{th} claim where T_1 is the time until the first claim is processed, etc. 10

You are given:

I. T_1, $_2$, … are mutually independent; and
II. The pdf of each T_k is $f(t) = 0.1\, e^{-0.1t}$, for $t > 0$ where t is measured in half-hours.

i. Calculate the probability that at least one claim will be processed in the next 5 hrs?
ii. What is the probability that at least 3 claims processed within 5 hrs?

(b) Find the optimum causal filter for estimating a signal $Z(t)$ from the observation 10

$$X(t) = Z(t) + N(t)$$

where $Z(t)$ and $N(t)$ are independent random processes, $N(t)$ is a zero-mean white noise with noise density 1 and $Z(t)$ has power spectral density

$S_Z(f) = 2/(1 + 4\pi^2 f^2)$.

Find the Wiener optimum filter.

5 (a) Describe each of the following random walks with corresponding transition matrix: General 1-D random walk, random walk with absorbing barriers, random walk with reflecting barriers, and cyclic random walk. 10

(b) State and explain Bayes' theorem. 05

(c) Give the classification of Markov states. 05

6 (a) Explain the concept of a typical queueing system with a suitable block diagram. 05

(b) State and explain Little's formula. 05

(c) Explain in detail M/M/1 queueing system. 10

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