M.E. EXTC Sem-I (CBGS) & (old) 26/11/15

Statistical Signal Analysis

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 Four 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

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

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. $T_1, T_2, \ldots$ 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

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

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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

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

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. 10

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

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QP Code : **30055**

(3 Hours) [Total Marks : 80

N.B. : (1) Attempt any **four** questions out of **six** questions.
(2) **All** questions carry **equal** marks.

1. (a) State the difference between dispersion shifted and dispersion compensated fibers. 5
   (b) Explain SONET. 5
   (c) Explain the concept of Electrical bandwith versus Optical bandwith with necessary equation. 5
   (d) Describe Fiber Bragg Grating. 5

2. (a) Explain the different phenomena responsible for signal degradation as the light wave propagates through an optical fiber. 10
   (b) Explain any one fiber fabrication process with neat diagram and state its advantages. 10

3. (a) Explain the principle of Resonant cavity enhancement detector. Compare RCE schottky Photodiode and RCE avalanche photodiode. 10
   (b) Explain the working of semiconductor optical amplifier and compare it with erbium doped laser amplifier and Raman amplifier. 10

4. (a) What are the different netwrok topoligies ? Explain in detail. 10
   (b) Describe in detail Optical Modulators. 10

5. (a) What is Soliton ? How is it useful for optical signal communication ? 10
   (b) Discuss various types of nonlinearities in optical communication ? 10
   A long single-mode optical fiber has a attenuation of 0.5 $dBkm^{-1}$ when operating at a wavelength of 1.3 μm. The fiber core diameter is 6 μm and the laser source bandwith is 600 GHz. Compare the threshold optical power for stimulated Brillouin and Raman scattering withing the fiber at the wavelength specified.

6. Write Short notes on any two : — 20
   (a) Four wave mixing.
   (b) Photonic crystal fibers
   (c) Optical MEMS.

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