Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–II EXAMINATION – SUMMER 2015

Subject Code: 2724111 **Date: 28/05/2015**

Subject Name: Statistical Signal Processing

Time: 02:30 PM to 05:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Define: Gaussian Random Variables. List out the properties of Gaussian Random Variables. **07**

(b) Compute the autocorrelation for the given harmonic process x(n) = $A\sin(nw_0 + \varphi)$ where A and w_0 are fixed constants and ⍰ has the probability density function of the form $f_\varphi(\alpha) = \begin{cases} \frac{1}{2\pi}; & -\pi \le \alpha < \pi \\ 0; & otherwise \end{cases}$ **07**

Q.2 **(a)** Define: Stationary Process. List out the three conditions which required being satisfied for a wide sense stationary process. **07**

(b) Determine whether or not each of the following is valid autocorrelation matrices. If they are not explain why not. **07**

1. $R_1 = \begin{bmatrix} 2 & 2 \\ 2 & 2 \end{bmatrix}$
2. $R_2 = \begin{bmatrix} 1 & 1+j \\ 1-j & 1 \end{bmatrix}$

OR

(b) Define power spectrum of a random process. Explain the properties of power spectrum with suitable mathematical steps. **07**

Q.3 **(a)** State and derive Cramer Rao Theorem. **07**

(b) Determine the mean and autocorrelation of the sequence x(n) generated by MA (2) process described by difference equation $(n) = w(n) - 2w(n-1) + w(n-2)$. Where W(n) is white noise process with variance σ_w^2. **07**

OR

Q.3 **(a)** Explain Bayesean estimators in detail with suitable mathematics. **07**

(b) Explain Maximum Likelihood Estimator (MLE) and list out its properties. **07**

Q.4 **(a)** Let $\text{Let } X_1, \ldots\ldots, X_N$ are Independent and Identically distributed Gaussian Random sequence with known variance σ^2 and unknown mean . Suppose $\hat{\mu} = \frac{1}{N}\sum_{i=1}^{N} X_i$ which is unbiased. Find Cramer Rao bound and hence show that $\hat{\mu}$ is an efficient estimator. **07**

(b) Derive the Wiener-Hopf equations and minimum mean square error for the Noncausal IIR Wiener Filter. **07**

OR

Q.4	**(a)**	Explain Adaptive LMS Algorithm in detail with suitable mathematics.	**07**
	(b)	Determine the optimum linear predictor using FIR Wiener filter, for AR(1) process x(n) that has an autocorrelation sequence given by $r_x(k) = \alpha^{\lvert k \rvert}$	**07**
Q.5	**(a)**	Explain Welch method for Power spectrum estimation with suitable mathematics.	**07**
	(b)	Derive the minimum variance spectrum estimation with suitable mathematics.	**07**

OR

Q.5	**(a)**	Explain Bartlett method for Power spectrum estimation with suitable mathematics.	**07**
	(b)	Explain the maximum entropy method for power spectrum estimation in detail.	**07**

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