Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II– EXAMINATION – WINTER - 2016

Subject Code: 2724111 Date: 18/11/ 2016

Subject Name: STATISTICAL SIGNAL PROCESSING

Time: 2:30 pm to 5:00 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 the following terms: **07**

1. Random variables.
2. Sample mean
3. Joint moments
4. Mean ergodic theorem-I
5. Wiener Hopf Equations for FIR fitler
6. Linear prediction using FIR weiner filter
7. Moving Average Process(MA Process)

(b) What do you mean by ergodic process? State mean ergodic theorem I and mean ergodic theorem II with suitable mathematics. **07**

Q.2 **(a)** Compute the power spectrum of a random process with autocorrelation $r_x(k) = \alpha^{|k|}$, where $|\alpha| < 1$. **07**

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

$$R1 = \begin{bmatrix} 2 & j & 1 \\ -j & 4j & -j \\ 1 & j & 2 \end{bmatrix}, \quad R2 = \begin{bmatrix} 1 & 1+j \\ 1-j & 1 \end{bmatrix}$$

OR

(b) Write a short note on Linear prediction. Derive the FIR Linear predictor. **07**

Q.3 **(a)** Define power spectrum of a random process. Explain the properties of power spectrum with suitable mathematical steps. **07**

(b) What is an Autoregressive (AR) Process? Derive the Yule Walker equations for AR process. **07**

OR

Q.3 **(a)** Derive the wiener-Hopf equation and minimum mean square error for Non causal IIR Wiener Filter. **07**

(b) Explain spectrum factorization in detail with suitable mathematics. **07**

Q.4 **(a)** Let $X_1, X_2, \ldots \ldots X_N$ are independent identically distributed sequence of $N(\mu, \sigma^2)$ distributed random variables. Find Maximum Likelihood estimator(MLE) for μ , σ^2. **07**

(b) Explain the maximum entropy method for power spectrum estimation in detail. **07**

OR

Q.4 **(a)** Write a short not on Bayesean Estimators. **07**

(b) Let $x(n)$ be an AR(1) process with an autocorrelation sequence $r_x(k) = \alpha^{|k|}$ with $0 < \alpha < 1$, with a first order predictor of the form $\hat{x}(n-1) = w(0)x(n) + w(1)x(n-1)$. Find out the optimum linear predictor using FIR Wiener filter. **07**

Q.5 **(a)** Compare RMS and LMS algorithms. **07**

	(b)	Explain Welch's method for Power spectrum estimation with suitable mathematics.	**07**

OR

Q.5	**(a)**	Explain adaptive LMS algorithm in detail with suitable derivations.	**07**
	(b)	Explain Bartlett method for power spectrum estimation with suitable mathematics.	**07**

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