Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME SEMESTER II EXAMINATION – SUMMER 2017

Subject Code: 2724111 **Date:26/05/2017**

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 the following : **07**

1. Statistically Independent
2. Wide Sense Stationary process
3. Convergence Rate of an estimator
4. Misadjustment
5. Bias of the estimator
6. Wiener Hopf equation for FIR Filter
7. Periodogram

(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 eigen-values, mean and autocorrelation matrix of 2 X 2 values for the given harmonic process $x(n) = Asin\ (nw_0 + \varphi\ )$ where A and w_0 are fixed constants and φ 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**

(b) Explain Filtering Random Processes in detail with suitable mathematics. **07**

OR

(b) Let *x(n)* be the random process that is generated by filtering white noise *w(n)* with a first-order linear shift-invariant filter having a system function $H(z) = \frac{1}{1-0.25z^{-1}}$. If the variance of the white noise is equal to one, $\sigma_w^2 = 1$, then compute the power spectrum of *x(n)* **07**

Q.3 **(a)** An MA(2) process has the autocorrelation sequence **07**

$$r_{xx}(m) = \begin{cases} \sigma_w^2, & m = 0 \\ -\frac{35}{62}\sigma_w^2, & m = \pm 1 \\ \frac{6}{62}\sigma_w^2, & m = \pm 2 \end{cases}$$

(a) Determine the coefficients of the minimum phase system for the MA(2) process.

(b) Determine the coefficient of the maximum phase system for the MA(2) process.

(c) Determine the coefficients of the mixed-phase system for MA(2) process.

(b) Explain LMS Algorithm in detail with suitable mathematics. **07**

OR

Q.3 **(a)** Consider $\sigma_2^2 = \frac{1}{N-1}\sum_{i=1}^{N}(X_i - \hat{\mu}_x)^2$ for an Independent Identically distributed (IID) random sequence $X_1, X_2, X_3, \ldots X_N$. Show that σ_2^2 is an unbiased estimator. **07**

(b) Consider $r_x(k) = \delta(k) + (0.9)^k \cos\left(\frac{\pi k}{4}\right)$. First eight correlation values are **07**

$r_x = [2.0,\ 0.6364,\ 0,\ -0.5155,\ -0.6561,\ -0.4175,\ 0,\ 0.3382]^T$. Compute the first order one-step linear predictor using Wiener FIR filter.

Q.4 **(a)** Find the autocorrelation sequence corresponding to the following power spectral density. **07**

$$P_x(e^{jw}) = 3 + 2\cos(w)$$

(b) Compute the power spectrum of the given WSS random process **07**

(1) $r_x(k) = \delta(k) + 2(0.5)^{|k|}$

(2) $r_x(k) = \delta(k-1) + \delta(k+1)$

OR

Q.4 **(a)** Derive the Wiener-Hopf equation for FIR Wiener filter. Also derive the equation for minimum mean square error. **07**

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

Q.5 **(a)** Explain: Bayesian estimator in detail with suitable mathematics. **07**

(b) Explain Bartlett method for Power spectrum estimation with suitable mathematics. **07**

OR

Q.5 **(a)** Explain Blackman and Tukey method (smoothing the periodogram) in detail with suitable mathematics. **07**

(b) Derive the maximum entropy spectrum estimation with suitable mathematics. **07**

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