Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER II–EXAMINATION –2016-17

Subject code: 2720505 **Date:29/05/2017**

Subject Name: Adaptive Signal Processing

Time: 02:30 p.m.-5:00 p.m. **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)** Derive the principle of orthogonality for a statistical filtering problem. Derive Wiener-Hopf equations from it. Also derive the solution of the Wiener-Hopf equations for linear transversal filters in matrix form. **07**

(b) Derive the weight update formula for LMS algorithm. Discuss about its complexity. Derive the weight update formula if LMS algorithm is to be applied when $d(n)$ is not given but the correlation function between $d(n)$ and $u(n)$ is given. **07**

Q.2 **(a)** Consider an autoregressive process $u(n)$ of order 2 described by the difference equation **07**

$$u(n) = 0.1u(n-1) + 0.8u(n-2) + v(n),$$

where $v(n)$ is white noise with zero mean and variance 0.5.

(1) Find the variance of $u(n)$.
(2) Write the Yule-Walker equations for the process.
(3) Solve these two equations for the autocorrelation function values $r(1)$ and $r(2)$.
(4) Find the correlation matrix, eigenvalues, unit eigenvectors, eigenvalue spread and minimum mean square error.

(b) (i) Write the properties of the correlation matrix R. Prove that the correlation matrix of a discrete-time stochastic process is always non-negative definite. **05**

(ii) Explain the terms: eigenvalue spread, misadjustment, smoothing, gradient noise. **02**

OR

(b) Derive augmented Wiener-Hopf equations for forward prediction and use them to find the weights and power of forward prediction-error filter of order $M = 1$. **07**

Q.3 **(a)** (i) Explain the basic idea of the steepest descent algorithm and show that the cost function is actually minimized if the weights are updated according to the formula obtained. **05**

(ii) State the Levinson-Durbin algorithm. **02**

(b) Draw the signal flow graph representation of the steepest descent algorithm. Discuss Newton's method. Compare the method of steepest descent and Newton's method. **07**

OR

Q.3 **(a)** (i) Describe the four classes of applications of adaptive filtering. **05**

(ii) Explain the three basic kinds of estimation. **02**

(b) (i) Mention some of the criteria to evaluate the performance of a recursive algorithm for adaptive filtering. **05**

(ii) Write the properties of prediction-error filters **02**

Q.4	**(a)**	Deduce Fast Block LMS Algorithm and show that it is actually faster than LMS Algorithm in computational terms.	**07**
	(b)	Write a short note: RLS Algorithm	**07**

OR

Q.4	**(a)**	In the context of Kalman Filtering, draw the signal-flow graph representation of a linear, discrete-time dynamical system. What is transition matrix? Write properties of transition matrix. Also write the process equation and measurement equation.	**07**
	(b)	Derive the weight update formula for the Normalized LMS Filter as the solution to a constrained optimization problem.	**07**
Q.5	**(a)**	What is the advantage of using an IIR filter instead of an FIR filter? Describe output error method for designing an IIR adaptive filter.	**07**
	(b)	Explain how adaptive signal processing is useful to enhance signal reception quality with an array of antennas.	**07**

OR

Q.5	**(a)**	Describe in detail: Hum removal of an ECG signal using adaptive signal processing.	**07**
	(b)	Explain how the problems of multipath for troposcatter signals can be tackled using adaptive signal processing.	**07**

****