Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME- SEMESTER–II • EXAMINATION – SUMMER 2014

Subject Code: 1722601 **Date:16/06/2014**

Subject Name: Advanced Digital Signal Processing and applications

Time: **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)** Explain jointly distributed random variables and joint moments. **07**

(b) Choose the most appropriate option. (Each question carries 1mark) **07**

(i) If x[n] and y[n] are i/p and o/p of a decimator with sampling rate conversion factor A, then,

(a) y[n] = x[n-A] (b) y[n]= x(n/A) (c) y[n] = x[n+A] (d) y[n] = x(An)

(ii) If x[n] and y[n] are i/p and o/p of a interpolator with sampling rate conversion factor B, then,

(a)y[n] = x[n-B] (b) y[n]= x(n/B) (c) y[n] = x[n+B] (d) y[n] = x(Bn)

(iii) To eliminate multiple images at the o/p, during interpolation by I , the o/p is filtered to have a bandwidth of,

(a) ´ I (b) ´ / I (c) I / ´ (d) ´ / I^2

(iv) The polyphase decomposition of H(z) into L sections can be represented by the equataion, (a) $H(z) = \sum_{m=1}^{L} z^{-m} E_m(z^L)$ (b)$H(z) = \sum_{m=0}^{L-1} z^{-m} E_m(z^L)$

(c) $H(z) = \sum_{m=1}^{L} z^{m} E_m(z^L)$ (d)$H(z) = \sum_{m=0}^{L-1} z^{m} E_m(z^L)$

(v) The estimate of power spectrum of random process is called,

(a) periodogram (b) energy spectrum (c) autocorrelation (d) expected value

(vi) The fourier transform of autocorrelation sequence $\gamma_{xx}(m)$ gives the,

(a)periodogram (b) energy spectrum (c) power spectrum (d) variance

(vii) The square of magnitude of X(f) gives the,

(a)periodogram (b) figure of merit (c) Quality factor (d) Energy

Q.2 **(a)** Discuss various applications of Multirate Digital Signal Processing. **07**

(b) Explain spectral factorization. **07**

OR

(b) A real valued harmonic process is given by $x[n] = ASin(n\omega_0 + \varphi)$ where A and ά$_0$ are fixed constants and φ is a uniformly distributed random variable over the range ï ´ to ´ . The probability density function for φ is $f_\varphi(\alpha) = (2\pi)^{-1}$ for $\alpha \epsilon$[-´,´) and $f_\varphi(\alpha) = 0$ otherwise. Find the given process is WSS or not. **07**

Q.3 **(a)** Explain wide sense stationary process and its property. **07**

(b) Obtain the relation between filter parameters and autocorrelation sequence and obtain Yule-Walker equation for AR process from the generalized relations for **07**

ARMA process .

OR

Q.3 **(a)** Define the followings. **07**

(i) Independent random variable (ii) Uncorrelated random variable (iii) Orthogonal random variable (iv) Cross Power density spectrum (v) Ensemble Averages (vi) Adaptive filter (vii) Forward Prediction Error

(b) White Noise with power spectral density $P_{xx}(e^{j\omega}) = \sigma^2$ is passed through a filter with impulse response $h[n] = 0.5^n u[n]$. What is the O/P PSD? **07**

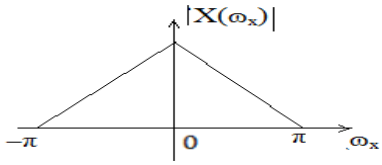
Q.4 **(a)** What is Least mean-squared error criterion? Explain in detail ćthe Stochastic-gradient-descent algorithmô for FIR adaptive filter based on steepest descent method. **07**

(b) Prove the following for the optimum IIR Wiener filter , **07**

$$\text{(i)MMSE}_\infty = \sigma_d^{\,2} - \sum_{k=0}^{\infty} h_{opt}(k)\gamma_{dx}^{*}(k) \quad \text{(ii) } Q(z) = \frac{1}{\sigma_i^{\,2}}[\Gamma_{di}(z)]_+$$

OR

Q.4 **(a)** If $X(\acute{\alpha}_x)$ is the spectrum of i/p to a decimator with decimation factor D and $Y(\acute{\alpha}_y)$ is the spectrum of o/p sequence, prove that $Y(\omega_y) = \frac{1}{D} X\left(\frac{\omega_y}{D}\right)$. Also draw the spectrums if the given $X(\acute{\alpha}_x)$ is as shown below. **07**



(b) Perform the Polyphase Decomposition of the given Transfer Function. **07**

$$H(z) = \frac{1+0.7z^{-1}}{1-0.9z^{-1}}$$

Q.5 **(a)** Model a plant (system) using Adaptive FIR filter. Draw the Block Diagram and discuss the mathematical modeling. **07**

(b) Discuss the RLS algorithm. **07**

OR

Q.5 **(a)** Write a short note on Discrete Kalman filter. **07**

(b) Compare Forward and Backward predictors. **07**

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