

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. IIND Semester Examination – June/July- 2011

Subject code: 1722601

Subject Name: Advanced Digital Signal Processing And Applications

Date: 22/06/2011

Time: 10:30 am – 01:00 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: (i) Discrete Random Processes (ii) Stationary Random processes (iii) Ensemble Averages (iv) Aliasing (v) Prediction error **05**
(b) What is a comb filter and explain its transfer function and its characteristics **04**
(c) Explain Power density spectrum and cross power spectrum of the random process mathematically. Prove that $\Gamma_{xx}(F)$ is always real. **05**

- Q.2** (a) Compare AR and MA random processes with mathematical expressions and corresponding structures. Show that former is an all pole and the latter is an all zero system **05**
(b) Determine the impulse response of the FIR filter described by the lattice coefficients $K_1=0.5$, $K_2=0.3$, $K_3=0.4$, $K_4=0.8$ **04**

(OR)

- (b) Consider an FIR filter with coefficient vector $\{1-2r\cos\theta\}$ **04**
(i) Determine the reflection coefficients for the corresponding FIR filter
(i) Determine the value of reflection coefficient in the limit $r \rightarrow 1$.
(c) Consider the ARMA Process generated by the difference equation $x(n) = 1.6x(n-1) - 0.63x(n-2) + w(n) + 0.9w(n-1)$. Determine **05**
(i) The system function of the whitening filter and its poles and zeros
(ii) Power density spectrum of $\{x(n)\}$

- Q.3** (a) What is an optimum linear filter? For a linear Forward predictor, obtain **07**
(i) Forward prediction error $f_p(n)$
(ii) System Function
(iii) Show the direct form for FIR filter is equivalent to an all zero lattice structure filter.
(iv) P stage lattice structure, showing its input and output sequences
(iv) MSE of $f_p(n)$
(v) Minimum Mean Square prediction error E_p^f

- (b) With the help of block diagram explain the use of adaptive equalizer using FIR filter for channel distortion compensation with necessary equations. Show that minimum MSR leads to a set of linear equations for coefficient adjustment of the equalizer. **07**

OR

- Q.3** (a) What is an ARMA process? Explain ARMA Lattice-Ladder filters with the help of system function $H(z)$ and structure of pole zero system **07**
(b) How narrowband interference in wideband signal can be suppressed using adaptive filter. Show with block diagram necessary waveforms and mathematical relations. **07**

- Q.4 (a)** Explain the steps for recursive computation of filter coefficients using RLS adaptive filter algorithm **03**
- (b)** What is signal estimation? How wiener filters are used for filtering, signal prediction and signal smoothing. Explain FIR Wiener Filter **07**
- (c)** Define mean and variance of random process and state their properties. **04**
- OR**
- Q.4 (a)** Using Minimum Mean Square criterion for LMS adaptive filter, derive the Wiener - Hopf equation and the expression for Optimum Filters coefficients 'hopt'. **07**
- (b)** Explain the following with the block diagram(**Any Two**): **07**
- (i) Symbol rate echo cancellor (ii) adoptive noise canceling system
(iii) Two Channel QMF filter Bank
- Q.5 (a)** Explain Interpolation and Decimation by a factor . **06**
- (b)** For an IIR transfer function $H(z) = \frac{1 - 4z^{-1}}{1 + 6z^{-1}}$, obtain polyphase decomposition **03**
- (c)** Write a brief note on digital filter banks **05**
- OR**
- Q.5 (a)** Explain the concept of gradient search method of LMS adaptive filter considering only one weight with the performance surface as a parabola, and develop the algorithm with the solution for $w_k = w^* + (1 - 2\mu\lambda)^k (w_0 - w^*)$ where w_k, w_0, w^* are weight adjustments at kth iteration, at initial value, being optimal setting respectively, μ is the fixed step size and also state the condition for stability and convergence. **07**
- (b)** Explain the following with relevant mathematical expressions and significance(**Any Two**) **07**
- (i) Minimum Mean Square of IIR Wiener filter
(ii) CIC Filter
(iii) Backward Linear Prediction
