Roll No. ....

Printed Pages : 4

8616

BT–6 / M12

DIGITAL SIGNAL PROCESSING

Paper–ECE–306–E

Time allowed : 3 hours] *[Maximum marks : 100*

Unit–I

1. (a) Determine the causal signal x (n) if its z-transform X (z) is given by :

$$X(z) = \frac{1}{4} \frac{\left(1+6z^{-1}+z^{-2}\right)}{\left(1-2z^{-1}+2z^{-2}\right)\left(1-\frac{1}{2}z^{-1}\right)}$$ 5

(b) If X (z) is the z-transform of x (n), show that if

$$x_k(n) = \begin{cases} x\left(\frac{n}{k}\right), & \text{if } \frac{n}{k} \text{ integer} \\ 0, & \text{otherwise} \end{cases}$$

then $X_k(Z) = X(Z^k)$ 8

(c) Determine the convolution of following pairs of signals by means of z-transform

$x_1(n) = nu(n)$

$x_2(n) = (2^n)\, u(n-1)$ 7

2. (a) Compute the unit step response of the system with the impulse response 8

$$h(n) = \begin{cases} 3^n, & n < 0 \\ \left(\frac{2}{5}\right)^n, & n \geq 0 \end{cases}$$

(b) Determine if the following FIR system is minimum phase or not : 6

$h(n) = \{10, 9, -7, -8, 0, 5, 3\}$

(c) Compute the quantity 6

$$\sum_{n=0}^{(N-1)} x_1(n)\, x_2(n) \text{ if}$$

$$x_1(n) = \cos\left(\frac{2\pi}{N} n\right),\ x_2(n) = \sin\left(\frac{2\pi}{N} n\right),\ 0 \leq n \leq (N-1)$$

Unit–II

3. (a) Determine a direct form realization of following linear phase filter

$$h(n) = \left\{\underset{\uparrow}{1}, 2, 3, 4, 3, 2, 1\right\}$$ 5

(b) Determine the state-space model for the system described by

$y(n) = y(n-1) + 0.11\, y(n-2) + x(n)$

and sketch the type 1 and type 2 state-space realizations. 5+5+5

4. (a) Consider the system described by the difference equation

$y(n) = a\,y(n-1) - a\,x(n) + x(n-1)$

(i) Show that it is all-pass. 5

(ii) Obtain the direct form II realization of the system. 5

(b) Consider a causal IIR system with the system function

$$H(z) = \frac{1 + 2z^{-1} + 3z^{-2} + 2z^{-3}}{1 + 0.9z^{-1} - 0.8z^{-2} + 0.5z^{-3}}$$

Determine the equivalent lattice-ladder structure. 10

Unit–III

5. (a) Design an FIR linear-phase, digital filter approximating the ideal frequency response

$$H_d(w) = \begin{cases} 1, & \text{for } |w| \le \frac{\pi}{6} \\ 0, & \text{for } \frac{\pi}{6} < |w| \le \pi \end{cases}$$

(i) Determine the coefficients of a 25-tap filter based on window method with a rectangular window. 5

(ii) Repeat part (i) using Hamming window. 5

(b) Explain the Gibbs phenomenon with example. 10

6. (a) Write a short note on "Alternation theorem". 10

(b) Determine the unit sample response {h (n)} of a linear-phase FIR filter of length M = Y for which the frequency response at w = 0 and $w = \frac{\pi}{2}$ is specified as $H_r(0) = 1$, $H_r\left(\frac{\pi}{2}\right) = \frac{1}{2}$. 10

Unit–IV

7. Explain the design of digital filters based on least square's methods. 20

8. A digital low-pass filter is required to meet the following specifications :

Passband Ripple : ≤ 1 dB

Passband Edge : 4 KHz

Stopband attenuation : ≥ 40 dB

Stopband edge : 6 KHz

Sample Rate : 24 KHz ; Assume t = 1

The filter is to be designed by performing a bilinear transformation on an analog system function. Determine what order Butterworth, Chebyshev and Elliptic analog designs must be used to meet the specifications in the digital implementation. 6+6+8