B 2278

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Fifth Semester

Information Technology

IF 351 — DIGITAL SIGNAL PROCESSING

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Convolution sum.

2. Determine the Z transform of the signal x (n)=$\{1,2,5,7,0,1\}$.

3. State Complex conjugate DFT Property.

4. Define Gibb's Phenomena.

5. Draw the direct form I structure for the second order system function

$$H(Z) = b_0 + b_1 z^{-1} + b_2 z^{-2} / 1 + a_1 z^{-1} + a_2 z^{-2}$$

6. What is frequency sampling?

7. Convert the analog band pass filter.

$H_a(s) = 1/(s + 0.1)^2 + 9$ into a digital IIR filter by use of the mapping $s = \dfrac{1}{T} \dfrac{z-1}{z+1}$.

8. Transform the single pole low pass butter worth filter with system function $H(S) = \Omega_P / S + \Omega_P$ into a band pass filter with upper and lower band edge frequencies Ω_u and Ω_l respectively.

9. Define sampling rate conversion.

10. What is the use of Quadrature mirror filter?

PART B — (5 × 16 = 80 marks)

11. (a) (i) The impulse response of a LTI System is   (12)

h(n) = { 1 2 1 –1 }
       ↑

Determine the response of the system to the input signal

$X(n) = \{ 1\ 2\ 3\ 1 \}$
       ↑

(ii) Determine the impulse response for the cascade of two LTI systems
having impulse responses.   (4)

$h_1(n) = (1/2)^n\ u(n)$

$h_2(n) = (1/4)^n u(n)$

Or

(b) Determine the Z Transforms of the signals

(i) $x(n) = \alpha^n u(n) = \{\alpha^n$ for $n \geq 0$

$x(n) = \alpha^n u(n) = \{ 0$ for $n < 0$.   (8)

(ii) $x(n) = -\alpha^n u(-n-1) = \{ 0$ for $n \geq 0$

$x(n) = -\alpha^n u(-n-1) = \{-\alpha^n$ for $n < -1$.   (8)

12. (a) (i) A Finite duration sequence of length L is given as   (8)

$x(n) = \{1$ for $0 \leq n \leq L-1$

$x(n) = \{0$ for otherwise.

Determine the N point DFT of the sequence for N = L.

(ii) Perform the circular convolution of the following two sequences. (8)

$x_1(n) = \{ 2\ 1\ 2\ 1 \}$
        ↑

$x_2(n) = \{ 1\ 2\ 3\ 4 \}$
        ↑

Or

(b) Draw the butterfly diagram using 8 point DIT-FFT for the following
sequences.   (16)

$x(n) = \{ 1, 0, 0, 0, 0, 0, 0, 0 \}$

13. (a)

14.

13. (a) (i) Given a three stage Lattice filter with coefficients $k_1 = 1/4$ and $k_2 = 1/4$ $k_3 = 1/3$. Determine the FIR filter coefficients for the direct form structure. (10)

(ii) Determine the cascade and parallel realizations for the system described by the system function (6)

$$H(Z) = 10 \left(1 - 1/2Z^{-1}\right)\left(1 - 2/3Z^{-1}\right)\left(1 + 2Z^{-1}\right)/\left(1 - 3/4Z^{-1}\right)$$

$$\left(1 - 1/8Z^{-1}\right)\left[1 - (1/2 + j\,1/2)Z^{-1}\right]\left[1 - (1/2 - j\,1/2)Z^{-1}\right]$$

Or

(b) (i) Determine the variance of the round off noise at the output of the two cascade realizations of the filter with system function (10)

$$H(Z) = H_1(Z)H_2(Z)$$

$$H_1(Z) = 1/\left(1 - 1/2Z^{-1}\right)$$

$$H_2(Z) = 1/\left(1 - 1/4Z^{-1}\right)$$

(ii) Describe briefly about limit cycle oscillations in recursive systems.

(6)

14. (a) Determine the coefficients of a linear phase FIR filter of length $M = 15$ which has a symmetric unit sample response and a frequency response that satisfies the conditions. (16)

$$H_r\left(2\pi\,k/15\right) = \{1 \text{ for } k = 0, 1, 2, 3$$

$$H_r\left(2\pi\,k/15\right) = \{0.4 \text{ for } k = 4$$

$$H_r\left(2\pi\,k/15\right) = \{0 \text{ for } k = 5, 6, 7.$$

Or

(b) Determine the system function $H(Z)$ of the lowest order Chebyshev digital filter that meets the following specifications. (16)

(i) 1 dB ripple in the pass band $0 \le |w| \le 0.3\,\pi$

(ii) Atleast 60 dB attenuation in the stop band $0.35\,\pi \le |w| \le \pi$. Use the bilinear transformation.

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15. (a) Describe and derive sampling rate conversion by a rational factor I/D in multirate signal processing. (16)

Or

(b) Consider an audio band signal with a nominal bandwidth of 4 khz that has been sampled at a rate of 8 khz. Suppose that we wish to isolate the frequency components below 80 hz with the filter that has the band $0 \leq F \leq 75$ and a transition band $75 \leq F \leq 80$. Hence Fpc=75 Hz and Fsc=80 Hz. The signal in the band $0 \leq F \leq 80$ may be decimated by the factor D = Fx/2Fc=50 we also specify that the filter has a pass band ripple $\delta_1 = 10^{-2}$ and stop band rjpple of $\delta_2 = 10^{-4}$. Represent reduction factor in filter length. (16)

Time

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