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EC52

Fifth Semester B.E. Degree Examination, June / July 08

Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note : ***1. Answer any FIVE full questions.***
2. Use of normalized Chebyshev and Butterworth prototype tables are not allowed.

1 a. Find DFT of the sequence $x(n) = \begin{cases} 1 & 0 \le n \le 2 \\ 0 & \text{otherwise} \end{cases}$ for N = 8. Plot $|X(k)|$ and $\angle X(k)$. **(10 Marks)**

b. State and prove the following DFT properties : i) Time reversal of a sequence. ii) Circular Time shift of a sequence iii) Parseval's theorem. **(10 Marks)**

2 a. Compare linear and circular convolution. **(04 Marks)**

b. Compute circular convolution using DFT and IDFT for the following sequences.
$x_1(n) = \{2, 3, 1, 1\}$ $x_2(n) = \{1, 3, 5, 3\}$. **(12 Marks)**

c. The even samples of the 11 – point DFT of a length-11 real sequence are given by $X(0) = 2$, $X(2) = -1 - j3$, $X(4) = 1 + j4$, $X(6) = 9 + j3$, $X(8) = 5$, $X(10) = 2 + j2$. Determine the missing odd samples of the DFT. **(04 Marks)**

3 a. Let x(n)be a finite length sequence with X[k] = {0, 1+j, 1, 1 – j} using the properties of DFT, find DFT's of the following sequences. i) $x_1(n) = e^{j\pi/2\, n} x(n)$ ii) $x_2(n) = \cos\left(\frac{\pi}{2}n\right) x(n)$ iii) $x_3(n) = x((n-1))_4$ iv) $x_4(n) = (0,0,1,0) \otimes_4 x(n)$. **(08 Marks)**

b. Find x [2] , given x(n) = { 1, 0, 1, 0} using Goertzel algorithm. Assume initial conditions as zero. **(04 Marks)**

c. Write a note on Chirp Z – Transform algorithm. **(08 Marks)**

4 a. What are the generic differences and similarities between DIT and DIF FFT algorithm? Explain. **(05 Marks)**

b. Find the DFT of the sequence x(n) = {1, 2, 3, 4, 4, 3, 2, 1} using Radix – 2 DIT FFT algorithm. **(10 Marks)**

c. Compute the DFT's of the sequence $x(n) = \cos n\frac{\pi}{2}$, where N = 4, using DIF FFT algorithm. **(05 Marks)**

5 a. How the frequency transformation helps in design of filters? Explain. **(06 Marks)**

b. The system function of a Low pass digital filter is given by $H[z] = \frac{1}{2}\frac{(1+z^{-1})}{(2-z^{-1})}$. Determine i) cut – off frequency, w_p and ii) use a low pass transformation to obtain another Lowpass filter with $w'_p = 1$ rad. **(06 Marks)**

c. Design an FIR Low pass filter of length 7 using rectangular window with pass band gain of unity, cut off frequency of 200 Hz and sampling frequency of 1kHz. **(08 Marks)**

6 a. If h[n] is impulse response of an FIR filter, so that h[n] = 0 for n < 0 and n ≥N. Assume h[n] is real, symmetric with respect to midpoint for odd N. The frequency response of this filter is represented as $H(e^{jw}) = Hr(e^{jw}) \cdot e^{j\theta(w)}$. Find $Hr(e^{jw})$ and $\theta(w)$ for $0 \le w \le \pi$, when h[n] satisfies the condition h[n] = h[N – 1 – n]. **(06 Marks)**

b. Design an ideal Hilbert transformer having frequency response $H_d(e^{jw}) = \begin{cases} -j \text{ for } 0 \le w \le \pi \\ j \text{ for } -\pi \le w \le 0. \end{cases}$ using rectangular window for N = 11. **(10 Marks)**

c. Compare the FIR and IIR filters. **(04 Marks)**

7 a. Determine the order and the poles of a type – 1 low pass Chebyshev filter for the following specifications:
PassBand ripple : - 3 d B ; Stop Band attenuation : - -20dB ; PassBand edge : - 2 rad/sec
StopBand edge : - 4 rad/sec. **(08 Marks)**

b. Design a IIR Low pass Butterworth digital filter to satisfy the following analog specifications :
i) PassBand ripple : ≤ 3.01 dB ii) PassBand edge : 500 Hz iii) StopBand attenuation : ≥ 15dB iv) StopBand edge : 750 Hz v) Sample rate : 2kHz. Use Bilinear transformation technique. Also obtain the difference equation realization. **(12 Marks)**

8 a. Convert the analog filter into a digital filter whose system function is $H(s) = \dfrac{s+0.2}{(s+0.2)^2+9}$

Assume T = 1 sec. Use Impulse invariant technique. **(04 Marks)**

b. Obtain a parallel realization for the system described by

$$H(z) = \frac{(1+z^{-1})(1+2z^{-1})}{\left(1+\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)\left(1+\frac{1}{8}z^{-1}\right)}.$$

(08 Marks)

c. Consider a three stage FIR Lattice structure having the co-efficients : $K_1 = 0.65$, $K_2 = -0.34$, and $K_3 = 0.8$. Evaluate its impulse response by tracing a unit impulse δ[n] at its i/p through the Lattice structure. Also draw its direct form – I structure. **(08 Marks)**

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