USN

10TE52

Fifth Semester B.E. Degree Examination, Aug./Sept.2020

Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of normalized filter tables not permitted.***

PART – A

1 a. Define DFT. Derive the relationship of DFT to the Z-transform. **(05 Marks)**

b. Compute the 8-point DFT of the sequence x(n) given by x(n) = {1, 1, 1, 1, 0, 0, 0, 0}. **(08 Marks)**

c. Let $x_p(n)$ be a periodic sequence with fundamental period N. Consider the following DFT's,

$$x_p(n) \xleftrightarrow[N]{DFT} X_1(K)$$

$$x_p(n) \xleftrightarrow[3N]{DFT} X_3(K)$$

What is the relationship between $X_1(K)$ and $X_3(K)$? **(07 Marks)**

2 a. State and prove the following properties:
(i) Time Shift Property (ii) Parseval's theorem **(06 Marks)**

b. Given the sequences $x(n) = \cos\left(\frac{\pi n}{2}\right)$ and $h(n) = 2^n$. Compute the 4-point circular convolution. **(06 Marks)**

c. Let x(n) = {1, 2, 0, 3, –2, 4, 7, 5}. Evaluate the following:
(i) X(0) (ii) X(4) (iii) $\sum_{K=0}^{7} X(K)$ (iv) $\sum_{K=0}^{7} |X(K)|^2$ **(08 Marks)**

3 a. Compute linear convolution of 2 sequences given :
x(n) = {1, 2, 0, –3, 4, 2, –1, 1, –2, 3, 2, 1, –3} and h(n) = {1, 1, 1}
Use overlap-add convolution technique. **(10 Marks)**

b. Prove the (i) Periodicity and (ii) Symmetry property of the twiddle factor W_N. **(04 Marks)**

c. In the direct computation of 256-point DFT of x(n), how many
(i) Complex multiplications
(ii) Complex additions
(iii) Real multiplications
(iv) Trigonometric function evaluations, are required. **(06 Marks)**

4 a. Find the 8-point DFT of the sequence, x(n) = {1, 2, 3, 4, 4, 3, 2, 1} using DIT-FFT radix-2 algorithm. **(10 Marks)**

b. Find X(2) using Goertzel algorithm for the sequence x(n) = {1, 0, 1, 0}. **(04 Marks)**

c. Write a short note on Chirp-z transform. **(06 Marks)**

PART – B

5 a. Compare Butterworth and Chebyshev filter. **(04 Marks)**

b. Derive the expression of order and cutoff frequency of a Butterworth low pass filter. **(06 Marks)**

c. Design a Chebyshev-I filter to meet the following specifications:
   (i) Passband ripple : ≤ 2 dB
   (ii) Passband edge : 1 rad/sec
   (iii) Stopband attenuation : ≥ 20 dB
   (iv) Stopband edge : 1.3 rad/sec **(10 Marks)**

6 a. Draw the block diagrams of Direct form – I, Direct form - II and parallel realizations for a digital IIR filter described by the system function:

$$H(z) = \frac{8z^3 - 4z^2 + 11z - 2}{\left(z - \frac{1}{4}\right)\left(z^2 - z + \frac{1}{2}\right)}$$ **(12 Marks)**

b. Realize the linear-phase FIR filter having the following impulse response,

$$h(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2) + \frac{1}{4}\delta(n-3) + \delta(n-4)$$ **(04 Marks)**

c. Determine the coefficients k_m of the lattice filter corresponding to FIR filter described by the system function, $H(z) = 1 + 2z^{-1} + \frac{1}{3}z^{-2}$. Also draw the corresponding second-order lattice structure. **(04 Marks)**

7 a. Compare FIR and IIR filters. **(06 Marks)**

b. The desired frequency response of a low pass filter is given by

$$H_d(e^{j\omega}) = H_d(\omega) = \begin{cases} e^{-j3\omega}; & |\omega| < \frac{3\pi}{4} \\ 0 & \frac{3\pi}{4} < |\omega| < \pi \end{cases}$$

Determine the frequency response of FIR filter if Hamming window is used with N = 7. **(10 Marks)**

c. Mention few advantages and disadvantages of windowing technique. **(04 Marks)**

8 a. A digital lowpass filter is required to meet the following specifications.
   (i) Monotonic passband and stopband
   (ii) -3.01 dB cutoff frequency of 0.5π rad
   (iii) Stopband attenuation of atleast 15 dB at 0.75π rad

Find the system function H(z) using Bilinear transformation. Also obtain the difference equation. **(14 Marks)**

b. Transform the analog filter, $H_a(s) = \frac{s+1}{s^2 + 5s + 6}$ into H(z) using impulse invariant transformation. Take T = 0.1 sec. **(06 Marks)**

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