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10EC52

Fifth Semester B.E. Degree Examination, June/July 2019

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. Find N-point DFT of
 - (i) $x(n) = \delta(n)$
 - (ii) $x(n) = \cos\left(\frac{2\pi}{N} Kon\right)$ (06 Marks)
- b. Define DFT. Derive the relationship of DFT to the Z-transform. (06 Marks)
- c. Find 8-point DFT of $x(n) = \delta(n) + \delta(n-1) + \delta(n-2)$ and hence sketch magnitude and phase plot. (08 Marks)
- 2 a. State and prove the following properties of DFT:
 - i) Circular time shift
 - ii) Circular convolution (06 Marks)
- b. Given $x(n) = [1, 2, 3, 4]$ and $h(n) = [1, 2, 2]$, compute
 - i) circular convolution
 - ii) linear convolution
 - iii) linear convolution using circular convolution. Comment on the result. (08 Marks)
- c. Determine N-point circular correlation of $x_1(n) = \cos\left(\frac{2\pi n}{N}\right)$ and $x_2(n) = \sin\left(\frac{2\pi n}{N}\right)$. (06 Marks)
- 3 a. Find the output $y(n)$ of a filter whose impulse response is $h(n) = \{1, 2\}$ and the input signal to the filter is $x(n) = \{1, 2, -1, 2, 3, -2, -3, -1, 1, 1, 2, -1\}$ using overlap save method. (10 Marks)
- b. Prove symmetry and periodicity property of twiddle factor. (04 Marks)
- c. What are FFT algorithms? Compute number of complex multiplications, complex additions, real multiplications, real additions required to compute 1024 point DFT using direct DFT computation and FFT algorithms. (06 Marks)
- 4 a. Derive the Radix-2 DITFFT algorithm to compute 8-point DFT of a sequence, and draw the complete signal flow graph. (12 Marks)
- b. Compute 8-point DFT of a sequence $x(n) = \left\{\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}, 0, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}\right\}$ using DITFFT algorithm. (08 Marks)

PART - B

- 5 a. Derive an expression for order and cutoff frequency of Butterworth analog lowpass filter. (06 Marks)
- b. Design an analog Butterworth LPF that has a gain of -2 dB at 20 rad/sec and attenuation in excess of -10 dB beyond 30 rad/sec. (10 Marks)
- c. Compare Butterworth and Chebyshev filters. (04 Marks)



- 6 a. Obtain parallel form and cascade form realization of the transfer function:

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

(10 Marks)

- b. A FIR filter is given by $y(n) = x(n) + \frac{2}{5}x(n-1) + \frac{3}{4}x(n-2) + \frac{1}{3}x(n-3)$. Sketch lattice structure. (06 Marks)
- c. Obtain the direct form realization of linear phase FIR filter with transfer function

$$H(z) = 1 + \frac{2}{3}z^{-1} + \frac{15}{8}z^{-2} + \frac{2}{3}z^{-3} + z^{-4}$$

(04 Marks)

- 7 a. Derive an expression for frequency response of a symmetric linear phase FIR low pass filter for $N = \text{odd}$. (07 Marks)
- b. A lowpass filter is to be designed with the following desired frequency response

$$H_d(\omega) = \begin{cases} e^{-j2\omega}, & |\omega| < \frac{\pi}{4} \\ 0, & \frac{\pi}{4} \leq \omega \leq \pi \end{cases}$$

Using rectangular window, find:

- i) Impulse response
 - ii) Frequency response
 - iii) Transfer function (07 Marks)
- c. Explain the frequency sampling design of FIR filters and realize it in DF structure. (06 Marks)
- 8 a. Explain how an analog filter is mapped on to a digital filter using impulse invariant method. (06 Marks)
- b. Design a digital lowpass filter, using bilinear transformation method to satisfy the following characteristics:
- i) Monotonic stopband and passband
 - ii) -3 dB cut-off frequency of 0.5π rad
 - iii) Magnitude down atleast -15 dB at 0.75π rad. (10 Marks)
- c. Compare BLT and IIT. (04 Marks)
