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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) $x(n) = \cos\left(\frac{2\pi}{N}\text{Kon}\right)$ **(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 DIFFFT 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 = odd. **(07 Marks)**

b. A lowpass filter is to be designed with the following desired frequency response

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

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)**

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