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10EC52

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Describe the process of frequency domain sampling and reconstruction of discrete time signals. **(10 Marks)**

b. Derive the relationship of DFT with z-transform. **(06 Marks)**

c. Compute the N-point DFT of the sequence $x(n) = 1,\ 0 \le n \le N-1$. **(04 Marks)**

2 a. Show that the multiplication of two DFTs leads to circular convolution of the corresponding sequences in time domain. **(07 Marks)**

b. Let x(n) be a finite length sequence with $x(k) = (1, j4, 0, -j4)$. Find the DFT's of,

(i) $x_1(n) = e^{j\frac{\pi}{2}n}x(n)$ (ii) $x_2(n) = \cos\left(\frac{\pi}{2}n\right)x(n)$ (iii) $x_3(n) = x((n-1))_4$. **(07 Marks)**

c. Let $x(n) = (1, 2, -1, -2, 3, 4, -3, 4)$ with a 8-point DFT x(k). Evaluate (i) $\sum_{K=0}^{7} X(k)$ (ii) $\sum_{K=0}^{7} |X(k)|^2$ without explicitly computing DFT. **(06 Marks)**

3 a. Explain the filtering of long data sequence using overlap-add method. **(06 Marks)**

b. For sequences $x_1(n) = (2, -1, 2, 1)$, $x_2(n) = (1, 1, -1, -1)$:

(i) Compute circular convolution.

(ii) Compute linear convolution using circular convolution. Compare the result. **(07 Marks)**

c. Compute the output of a filter with an impulse response $h(n) = (3, 2, 1)$ for input $x(n) = (2, 1, -1, -2, -3, 5, 6, -1, 2, 0)$ using overlap save method. Use 8-point circular convolution. **(07 Marks)**

4 a. Find the number of complex multiplications and additions required to compute 128 point DFT using (i) Direct method (ii) FFT algorithm (radix – 2). What is the speed improvement factor? **(05 Marks)**

b. Develop DIF-FFT algorithm and obtain the signal flow diagram for N = 8. **(07 Marks)**

c. Using DIT-FFT algorithm, compute the DFT of a sequence $x(n) = (1, 1, 1, 1, 0, 0, 0, 0)$. **(08 Marks)**

PART – B

5 a. Explain the Butterworth filter characteristics. Obtain the second order Butterworth polynomial. **(06 Marks)**

b. Determine the order and cutoff frequency of Butterworth analog highpass filter with
Pass band attenuation, frequency : 2 dB, 200 rad/sec.
and Stop band attenuation, frequency : 20 dB, 100 rad/sec. **(06 Marks)**

c. Let $H(s) = \frac{1}{(s+1)(s^2+s+1)}$ represent a LPF with passband of 1 rad/sec. Find H(s) for
   (i) LPF with passband 2 rad/sec.
   (ii) HPF with cutoff frequency 2 rad/sec.
   (iii) BPF with passband 10 rad/sec and center frequency of 100 rad/sec.
   (iv) BSF with stopband of 2 rad/sec and center frequency of 10 rad/sec. **(08 Marks)**

6 a. Realize the system function $H(z) = \frac{1+2z^{-1}}{(1+3z^{-1})(1+2z^{-1}+z^{-2})}$ in
   (i) Direct form I
   (ii) Direct form II
   (iii) Cascade form.
   (iv) Parallel form. **(12 Marks)**

b. Consider three stage FIR lattice structure having coefficients $K_1 = 0.2$, $K_2 = 0.4$ and $K_3 = 0.6$. Draw the lattice structure. Find the system function H(z) and realize it in direct form. **(08 Marks)**

7 a. Compare FIR and IIR filters. **(04 Marks)**

b. The desired frequency response of a LPF,

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

Find the impulse response h(n) using Hamming window. Determine the frequency response of FIR filter. **(08 Marks)**

c. A low pass filter has the desired frequency response,

$$H_d(\omega) = \begin{cases} e^{-j3\omega}, & 0 < \omega < \frac{\pi}{2} \\ 0, & \text{Otherwise} \end{cases}$$

Determine the filter coefficients based on frequency sampling technique. **(08 Marks)**

8 a. Obtain the mapping rule for bilinear transformation. What is the effect on digital frequency in this transformation? **(08 Marks)**

b. Design a digital Butterworth low pass filter to meet the following specifications:
   Pass band attenuation, frequency : 2 dB at 0.2 π rad
   Stop band attenuation, frequency : 13 dB at 0.6 π rad
   Use backward difference method with T = 1 sec. **(08 Marks)**

c. Determine the order of a digital Chebyshev 1 filter that satisfies the following constraints:

$$0.8 \le |H(\omega)| \le 1, \quad 0 \le \omega \le 0.2\pi$$
$$|H(\omega)| \le 0.2, \quad 0.6\pi \le \omega \le \pi$$

(04 Marks)

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