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10EC52

CMR Institute of Technology, Bangalore - 37

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019

Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: ***Answer any 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. Find the DFT of $x(n) = \cos\omega_0 n$ where $\omega_0 = \frac{2\pi}{N}K_0$. **(05 Marks)**

b. Derive the relationship between DFT and Z.T. **(05 Marks)**

c. Find the DFT of the sequence

$$x(n) = \begin{cases} 1, & 0 \le n \le 2 \\ 0, & \text{otherwise} \end{cases}$$

for N = 8 and N = 4. Also plot magnitude and phase spectra. **(10 Marks)**

2 a. State and prove time reversal property of DFT. **(05 Marks)**

b. Find the circular convolution of the sequences $x_1(n) = \{\underset{\uparrow}{1}, 2, 3, 1\}$ and $x_2(n) = \{\underset{\uparrow}{4}, 3, 2, 2\}$ using concentric circles method. Verify the result using DFT-IDFT method. **(08 Marks)**

c. Let X(K) denote the 14 point DFT of a real valued sequence x(n) of length 14. First 8 samples of X(K) are given by X (0……7) = {12, -1-j3, 3+j4, 1-j5, -2+j2, 6+j3, -2-j3, 10}. Find the remaining samples of X(K) and also evaluate (i) x(0) (ii) x(7) (iii) $\sum_{n=0}^{13} x(n)$. **(07 Marks)**

3 a. Consider a FIR filter with impulse response h(n) = {3, 2, 1, 1}. If the input is x(n) = {1, 2, 3, 3, 2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1}, find the output. Use overlap save method and assume the length of the block as 9. **(12 Marks)**

b. Briefly explain the necessity of FFT algorithms. What are the properties of twiddle factor used in FFT algorithms? **(08 Marks)**

4 a. Using DITFFT algorithm, find the DFT of the following sequence x(n) = {1, 2, 3, 4, 4, 3, 2, 1}. **(08 Marks)**

b. With necessary equations and block diagrams, briefly explain chirp-z transform and Goertzel algorithm. **(12 Marks)**

PART – B

5 a. Derive expressions for order and cut-off frequency of a Butterworth filter. **(10 Marks)**

b. Briefly discuss the design steps involved in the design of Cheybyshev filter (type-I). **(10 Marks)**

6 a. Obtain the cascade and parallel realization for the system function given by

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

(08 Marks)

b. $H(z) = (1 + 0.6z^{-1})^5$. Realize H(z) in:
   i) direct form
   ii) As a cascade of first order sections only
   iii) As a cascade of first and second order sections only. **(08 Marks)**

c. Realize a linear phase FIR filter with $H(z) = 1 + \frac{1}{4}z^{-1} - \frac{1}{8}z^{-2} + \frac{1}{4}z^{-3} + z^{-4}$. **(04 Marks)**

7 a. A LPF is to be designed with the following desired frequency response

$$H_d(e^{j\omega}) = \begin{cases} e^{-j2\omega}; & |\omega| < \pi/4 \\ 0; & \pi/4 < |\omega| < \pi \end{cases}$$

Determine the filter coefficients $h_d(n)$ and h(n) if a rectangular window is used. Also find the frequency response. **(10 Marks)**

b. Design a 17 tap linear phase FIR filter with a cut-off frequency $\omega_C = \frac{\pi}{2}$. The design is to be done based on frequency sampling technique. **(10 Marks)**

8 a. Find the T.F. of the digital filter using impulse invariance technique

$$H(s) = \frac{s+a}{(s+a)^2 + b^2}.$$

(06 Marks)

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b. Determine the system function H(z) of a Chebyshev filter type-I to meet the following specifications.
   i) Passband ripple ≤ 3 dB
   ii) Stopband attenuation ≥ 20 dB
   iii) Passband edge = 0.3 π rad/sample
   iv) Stopband edge = 0.6 π rad/sample.
   Use bilinear transformation technique and take T = 1 sec. **(14 Marks)**

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