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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.

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 $x(n) = \begin{cases} 1, & 0 \leq n \leq 2 \\ 0, & \text{otherwise} \end{cases}$ 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 $x_1(n) = \{1, 2, 3, 1\}$ and $x_2(n) = \{4, 3, 2, 2\}$ 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 $X(0 \dots 7) = \{12, -1-j3, 3+j4, 1-j5, -2+j2, 6+j3, -2-j3, 10\}$. 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 Cheybshev filter (type-I). (10 Marks)
- 6 a. Obtain the cascade and parallel realization for the system function given by

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

1 of 2

(08 Marks)

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.

- b. $H(z) = (1 + 0.6z^{-1})^5$. Realize $H(z)$ in:
- direct form
 - As a cascade of first order sections only
 - 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

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

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)

- b. Determine the system function $H(z)$ of a Chebyshev filter type-I to meet the following specifications.

- Passband ripple ≤ 3 dB
- Stopband attenuation ≥ 20 dB
- Passband edge = 0.3π rad/sample
- Stopband edge = 0.6π rad/sample.

Use bilinear transformation technique and take $T = 1$ sec.

(14 Marks)

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