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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Sixth Semester, B.E. - Electrical and Electronics Engineering

Semester End Examination; May/June - 2019

Digital Signal Processing

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. Define N-point DFT and IDFT of a sequence and obtain the relation between DFT and Z-transform. 6

b. Find the 8-point DFT of the sequence $x(n) = \{2, 2, 2, 2\}$. 8

c. Compute the IDFT of the sequence $X(k) = (2, (1+j), 0, 1-j)$. 6

2 a. Compute the N-point DFT of the sequence, 8

i) $x(n) = a^n, \quad 0 \le n \le N-1$ ii) $x(n) = an, \quad 0 \le n \le N-1$

b. State sampling theorem and explain reconstruction of discrete time signals. 6

c. Find the IDFT of 4-point sequence $X(k) = (4, -j2, 0, 2j)$ using the DFT. 6

UNIT - II

3 a. State and prove: i) Linearity Property ii) Circular convolution in time property. 8

b. Let $x(n) = (1, 2, 0, 3, -2, 4, 7, 5)$. Evaluate the following : 7

i) $X(0)$ ii) $X(4)$ iii) $\sum_{k=0}^{7} x(k)$ iv) $\sum_{k=0}^{7} |x(k)|^2$

c. Compute the 4-point DFT of the sequence $x(n) = (1, 0, 1, 0)$. Also find $Y(n)$, if $Y(k) = X((k-2))_4$. 5

4 a. Find the 4-point circular convolution of the sequence $x_1(n) = (\underset{\uparrow}{1}, 2, 3, 1)$ and $x_2(n) = (\underset{\uparrow}{4}, 3, 2, 2)$ using time domain approach and verify the result using frequency domain approach. 8

b. State and prove Parseval's theorem. 6

c. Two length 4 sequences are defined below; 6

$x(n) = \cos\left(\frac{\pi n}{2}\right), \quad n = 0, 1, 2, 3$

$h(n) = 2^n, \quad n = 0, 1, 2, 3$

i) Calculate $x(n) \otimes_4 h(n)$ by doing circular convolution directly

ii) Calculate $x(n) \otimes_4 h(n)$ by doing linear convolution

UNIT - III

5 a. In the direct computations of N-point of a sequence, how many; 5

i) Complex multiplications ii) Complex additions iii) Real multiplications

iv) Real addition v) Trigonometric functions are required

b. Find 8-point DFT of a sequence $x(n) = \{1, 1, 1, 1, 0, 0, 0, 0\}$ using DIT-FFT radix-2 algorithm. Use butterfly diagram. 8

c. Given $X(k)$ = {20, – 5.282 – j2.414, 0, – 0.172 – j0.414, 0, – 0.172 + j0.414, 0, – 5.828 + j2.414}. Find $x(n)$ using inverse radix – 2 FFT algorithm. 7

6 a. State and prove the following properties of phase factor (twiddle factor) W_N : 4

i) Periodicity ii) Symmetry

b. Given the sequences $x_1(n)$ and $x_2(n)$ below, compute the circular convolution $x_1(n) \otimes_N x_2(n)$ for $N = 4$. Use DIT-FFT algorithm. $x_1(n) = (\underset{\uparrow}{2}, 1, 1, 2)$ and $x_2(n) = (\underset{\uparrow}{1}, 1, 1, 1)$. 8

c. First five points of the eight points DFT of a real valued sequence is given by $X(0) = 0$, $X(1) = 2 + j2$, $X(2) = -j4$, $X(3) = 2 - j2$, $X(4) = 0$. Determine the remaining points. Hence find the original sequence $x(n)$ using Decimation in frequency FFT algorithm. 8

UNIT - IV

7 a. Realize a linear phase FIR filter with the following impulse response. Give the necessary equations: 8

$$h(n) = \delta(n) + \tfrac{1}{2}\delta(n-1) - \tfrac{1}{4}\delta(n-2) + \delta(n-4) + \tfrac{1}{2}\delta(n-3)$$

b. Realize the following system function : 8

$H(z) = 1 + \frac{3}{4}z^{-1} + \frac{17}{8}z^{-2} + \frac{3}{4}z^{-3} + z^{-4}$ in i) Direct form ii) Cascaded form

c. Compare direct form-I and direct form-II realizations of IIR filters. 4

8 a. The transfer function of a discrete casual system is given as follows : 12

$$H(z) = \frac{1 - z^{-1}}{1 - 0.2^{-1} - 0.15z^{-2}}$$

i) Find the difference equation ii) Draw cascade and parallel realization

iii) Calculate the impulse response of the system

b. A linear time-invariant system is described by the following input-output relation : 8

$2y(n) - y(n-2) - 4y(n-3) = 3x(n-2)$. Realize the system in the following forms :

i) Direct form-I realization ii) Direct form-II realization iii) Transposed realization of direct form II

UNIT - V

9 a. Design Butterworth filter for the following specifications: 10

$0.8 \le |H_a(s)| \le 1$ *for* $0 \le F \le 1000Hz$ $|H_a(s)| \le 0.2$ *for* $F \ge 5000Hz$

b. The system function of an analog filter is given as $H_a(s) = \frac{1}{(s+1)(s+2)}$. Obtain $H(z)$ using impulse invariant method. Take sampling frequency of 5 samples/s. 5

c. Compare Butterworth and Chebyshev filter approximations. 5

10 a. Design the symmetric FIR low pass filter whose desired frequency response is given as, 10

$$H_d(\omega)\begin{cases} e^{-j\omega t} & \text{for } |\omega| \le \omega_c \\ 0 & \text{otherwise} \end{cases}$$

The length of the filter should be 7 and ω_c = 1 radians/sample. Use rectangular window.

b. Design a normalised linear phase FIR filter having the phase delay of $\tau = 4$ and at least 40 dB attenuation in the stop band. Use Hanning window. 10

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