CBCS SCHEME

USN | | | | | | | | | | |

18EC52

Fifth Semester B.E. Degree Examination, June/July 2023
Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Explain the frequency domain sampling of discrete time signals and obtain the DFT and IDFT expressions. **(10 Marks)**

b. Given that sequence x(n) = {2, 3, -1, -2}. Obtain the sequences i) $x((-n))_4$, ii) $x((n-2))_4$ and iii) $x((2-n))_4$. Represent the data points on a circle and show the circular shift. **(06 Marks)**

c. Given the sequence x(n) = {4, 3, 2, 1}, find y(n) if $y(k) = x((k-3))_4$. **(04 Marks)**

OR

2 a. Illustrate how the DFT and IDFT can be viewed as a linear transformation on sequences x(n) and x(k) respectively. **(06 Marks)**

b. Determine the 4-point circular convolution of the sequences.

$x_1(n) = \cos\left(\frac{2\pi n}{N}\right)$ and $x_2(n) = \sin\left(\frac{2\pi n}{N}\right)$; $0 \le n \le 3$ using the time domain formula. Verify the result using frequency domain approach using DFT and IDFT. **(08 Marks)**

c. Compute the 4-point DFT of the sequence x(n) = {1, 2, 3, 4}. Using time shift property find the DFT y(k), if $y(n) = x((n-3))_4$. **(06 Marks)**

Module-2

3 a. Write the computational methodology for overlap-save method of linear filtering. **(07 Marks)**

b. Compute the 8-point DFT of the sequence x(n) = {1, -1, 0, 0, 1, -1, 0, 0} using DIF-FFT algorithm. **(08 Marks)**

c. Find the number of complex multiplications and complex additions required to compute 1024 point DFT using.
i) Direct formula
ii) FFT algorithm
What is the speed improvement factor? **(05 Marks)**

OR

4 a. Develop radix-2 decimation in frequency FFT algorithm. **(07 Marks)**

b. Using overlap-add method, compute the output of an filter with impulse response h(n) = {1, -2, 3} and input x(n) = {1, 0, 2, 0, -1, -2, 3, -3, 1, 2} use 8-point circular convolution. **(08 Marks)**

c. Given x(k) = {0, j4, 0, -j4}, find x(n) using radix-2 DIT-FFT algorithm. **(05 Marks)**

Module-3

5 a. For a symmetric FIR filter of length 'M', show that the system function $H(z) = z^{-(M-1)} H(z^{-1})$. **(06 Marks)**

b. A low pass filter is to be designed with the desired frequency response.

$$H_d(w) = \begin{cases} e^{-j3w}, & |w| < \frac{3\pi}{4} \\ 0, & \frac{3\pi}{4} \le |w| \le \pi \end{cases}$$

Determine the filter coefficients h(n) if Hamming window is used. **(08 Marks)**

c. Realize the FIR filter for the following impulse responses:

i) $h(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2) - \frac{1}{8}\delta(n-3) + \frac{1}{4}\delta(n-4) + \delta(n-5)$.

ii) $h(n) = \left(\frac{1}{2}\right)^n [u(n) - u(n-4)]$. **(06 Marks)**

OR

6 a. Obtain the magnitude and phase response function of the rectangular window function
$w(n) = \begin{cases} 1, & n = 0, 1, \quad M-1 \\ 0, & \text{otherwise} \end{cases}$. **(06 Marks)**

b. Obtain the filter coefficients h(n) for a high pass filter with the following desired frequency response,

$H_d(w) = \begin{cases} 0, & |w| < \frac{\pi}{4} \\ e^{-j2w}, & \frac{\pi}{4} \le |w| \le \pi \end{cases}$ use rectangular window function. **(08 Marks)**

c. Given the FIR filter with the difference equation y(n) = x(n) + 2x(n-1) + 3x(n-2) + 2x(n-3). Obtain the lattice realization. **(06 Marks)**

Module-4

7 a. Obtain the mapping relation between s-plane and z-plane for the bilinear transformation. List the general mapping properties. **(08 Marks)**

b. Given an analog filter with transfer function $H(s) = \frac{5}{s+5}$ convert it into the digital filter transfer function and obtain the difference equation when a sampling period T = 0.05 sec. **(06 Marks)**

c. Realize the following digital filter using direct form-II $H(z) = \frac{0.5z^2 + z + 0.5}{z^2 + 0.5z + 0.4}$. **(06 Marks)**

OR

8 a. List the analog low pass prototype transformations to different filter types and illustrate with the corresponding frequency responses. **(08 Marks)**

b. Design a digital low pass Butterworth filter with the following specifications. 3dB attenuation at the passband frequency 1.5kHz, 10dB stopband attenuation at the frequency 3kHz and sampling frequency of 8000Hz. Draw the direct form-II structure. **(12 Marks)**

Module-5

9 a. With a neat diagram, explain the Harvard architecture used in DS-processor. Draw the execution cycle. **(07 Marks)**

b. Illustrate the operation of circular buffers for four data samples and show the equivalent FIFO structure. **(07 Marks)**

c. Convert the following decimal numbers to the floating point numbers using 4 bit exponent and 12 bit mantissa. i) 0.64×2^{-2} ii) -0.64×2^{5}. **(06 Marks)**

OR

10 a. With a neat diagram, explain the basic architecture of TMS320C54× family DS processor. **(12 Marks)**

b. Perform the following:

i) Find the signed Q-15 representation of 0.16.

ii) Convert the Q-15 signed numbers to decimal

I. 0.100011110110010

II. 1.110101110000010 **(08 Marks)**

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