CBCS SCHEME

USN

18EC52

Fifth Semester B.E./B.Tech. Degree Examination, June/July 2025
Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

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

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.

Module-1

1 a. Compute the DFT of the sequence, $x[n] = [-1]^n$ for : i) N is even ii) N is odd. **(06 Marks)**

b. State and prove the circular frequency shift property of discrete Fourier transform. **(10 Marks)**

c. Find the IDFT of 4-point sequence, $X(k) = (4, -j2, 0, j2)$ using the DFT. **(04 Marks)**

OR

2 a. Perform the circular convolution of the sequences $x_1[n]$ and $x_2[n]$, where

$x_1[n] = \cos\dfrac{2\pi n}{N}, 0 \le n \le N-1, \quad x_2[n] = \sin\dfrac{2\pi n}{N}\ 0 \le n \le N-1.$ **(07 Marks)**

b. Find the 6 – point DFT of the sequence :
$x[n] = 4\delta[n] + 3\delta[n-1] + 2\delta[n-2] + \delta[n-3]$. **(06 Marks)**

c. Find the 4-point 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 frequency – domain approach. **(07 Marks)**

Module-2

3 a. Given : $x[n] = (1, 2, 0, -3, 4, 2, -1, 1, -2, 3, 2, 1, -3)$
$h[n] = (1, 1, 1)$, perform $x(n) * h(n)$, $0 \le n \le 11$, using overlap – save technique. **(10 Marks)**

b. Given $x[n] = (0, 1, 2, 3, 4, 5, 6, 7)$, find X(k) using DIT – FFT algorithm. **(10 Marks)**

OR

4 a. Find the 4 – point circular convolution of x[n] and h[n] using radix – 2 DIF – FFT algorithm $x[n] = (1, 1, 1, 1)$ and $h[n] = (1, 0, 1, 0)$. **(10 Marks)**

b. Explain Decimation – in – frequency FFT algorithm. **(10 Marks)**

Module-3

5 a. Obtain an expression for the frequency response of the symmetric FIR digital filter. **(10 Marks)**

b. The desired frequency response of a low pass filter is given by

$$H_d(e^{j\omega}) = H_d(\omega) = \begin{cases} e^{-j3\omega} & |\omega| < \dfrac{3\pi}{4} \\ 0 & \dfrac{3\pi}{4} < |\omega| < \pi \end{cases}$$

Determine the frequency response of the FIR filter, if hamming window is used with N = 7. **(10 Marks)**

OR

6 a. Design a 17-tap linear-phase FIR filter with a cutoff frequency, $\omega_C = \pi/2$. The design is to be done based on frequency sampling technique. **(10 Marks)**

b. Given the FIR filter with the following difference equation :

$$y[n] = x[n] + 3.1x[n-1] + 5.5x[n-2] + 4.2x[n-3] + 2.3x[n-4]$$

Sketch the Lattice realization of the filter. **(10 Marks)**

Module-4

7 a. Design a Butterworth analog highpass filter that will meet the following specifications :

i) Maximum passband attenuation = 2dB
ii) Passband edge frequency = 200 rad/sec
iii) Minimum stopband attenuation = 20 dB
iv) Stopband edge frequency = 100 rad/sec. **(10 Marks)**

b. A linear time-invariant digital IIR filter is specified by the following transfer function :

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

Realize the system using direct form – I representation. **(10 Marks)**

OR

8 a. A digital lowpass filter is required to meet the following specifications :

i) Monotonic passband and stopband
ii) –3.01dB cutoff frequency of 0.5 Π rad
iii) Stopband attenuation of atleast 15 dB at 0.75 Π rad

Find the system function H(z) using bilinear transformation and also the difference equation realization. **(10 Marks)**

b. Obtain the direct form I and II realizations by the following for a linear time – invariant system described by the following input – output relation,

$$2y(n) - y(n-2) - 4y(n-3) = 3x(n-2).$$ **(10 Marks)**

Module-5

9 a. Explain the IEEE single precision and double precision floating – point formats. **(10 Marks)**

b. i) Find the signed Q – 15 representation for the decimal number – 0.160123
ii) Convert the Q – 15 signed number 1.110101110000010 to the decimal number
iii) Add the two floating – point numbers given below,

$$1110010100011111 = 0.640136718 \times 2^{-2}$$
$$0101101011100101 = -0.638183593 \times 2^{5}.$$ **(10 Marks)**

OR

10 a. With a neat diagram, explain the TMS320C3X floating –point DS processor. **(12 Marks)**

b. With an example discuss overflow and underflow in the floating –point number system. **(08 Marks)**

* * * * *