



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.

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
 $x_1[n] = \cos \frac{2\pi n}{N}$, $0 \leq n \leq N-1$, $x_2[n] = \sin \frac{2\pi n}{N}$, $0 \leq n \leq N-1$. (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,
 $x_1[n] = (1, 2, 3, 1)$ and $x_2[n] = (4, 3, 2, 2)$ 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 $x[n] * h[n]$, $0 \leq n \leq 11$, 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

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

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 0.5π rad
 iii) Stopband attenuation of at least 15 dB at 0.75π 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,

$$\begin{aligned} 1110010100011111 &= 0.640136718 \times 2^{-2} \\ 0101101011100101 &= -0.638183593 \times 2^5 \end{aligned}$$

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(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)
