# CBCS SCHEME

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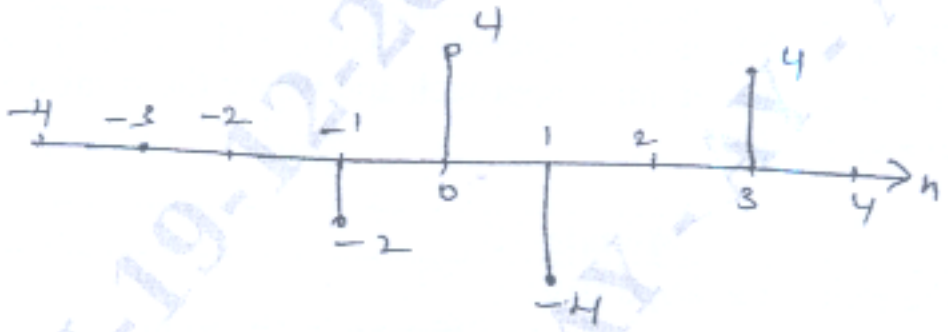
BEC502

## Fifth Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026
## Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.*
*2. M : Marks , L: Bloom's level , C: Course outcomes.*

| | | Module – 1 | M | L | C |
|---|---|---|---|---|---|
| Q.1 | a. | A discrete time signal x(n) is shown below Fig.Q1(a). Sketch (i) 2x(n – 2) (ii) 3 – x(n) (iii) 2x(– n) – 4  Fig.Q1(a) | 08 | L3 | CO1 |
| | b. | Determine whether each of the following signals is periodic or not. If periodic find the fundamental period. (i) x(n) = sin(3n) (ii) x(n) = cos(0.3πn + π/4) (iii) $x(n) = \sin\left(\frac{7\pi n}{37}\right)$ | 06 | L3 | CO1 |
| | c. | Write a program to generate the following discrete time signals: (i) Unit sample sequence (ii) Exponential sequence (iii) Random sequence | 06 | L3 | CO1 |
| | | **OR** | | | |
| Q.2 | a. | The following are the impulse response of discrete time LTI systems. Determine whether each system is memoryless, causal and stable. (i) $h(n) = e^{-n}\cos(n) * u(n)$ (ii) $h(n) = (0.99)^n * u(n+3)$ (iii) $h(n) = (1/2)^n * u(n)$ | 09 | L3 | CO2 |
| | b. | Determine whether the following systems represented by impulse response are causal and stable: (i) $h(n) = 5\,\delta(n)$ (ii) $h(n) = (1/4)^{\lvert n\rvert}$ (iii) $h(n) = (1/2)^{-n}u(-n)$ | 06 | L3 | CO1 |
| | c. | Write a program to perform the following operation on signals: (i) Signal addition (ii) Signal multiplication (iii) Scaling (iv) Shifting (v) Folding | 05 | L3 | CO1 |
| | | **Module – 2** | | | |
| Q.3 | a. | Explain the frequency domain sampling of discrete time signals and obtain the DFT and IDFT expressions. | 08 | L2 | CO3 |
| | b. | Find the 4 point DFT of the sequence x(n) = [1, 0, 0, 1] using matrix method and verify the answer by taking the 4-point IDFT of the result. | 06 | L3 | CO3 |
| | c. | Find the 4 point DFT of $x(n) = \cos\frac{\pi n}{4} + \sin\frac{\pi n}{4}$ using linearity property. | 06 | L3 | CO3 |

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| | | **OR** | | | |
| Q.4 | a. | Show that the multiplication of two DFT's lead to circular convolution of the corresponding time sequences. | 06 | L2 | CO3 |
| | b. | Consider the finite N sequence<br>$x(n) = \delta(n) + 2\delta(n-5)$<br>Find (i) The 10 point DFT X(k)<br>(ii) The sequence that has a DFT $Y(k) = e^{\frac{-j4\pi k}{10}} X(k)$<br>(iii) Find the 10 point sequence y(n) that has DFT Y(k) = X(k)W(k) where X(k) is the 10 point DFT of x(n) and W(k) is the 10 point DFT of $w(n) = u(n) - u(n-7)$. | 06 | L3 | CO3 |
| | c. | Find the circular convolution of sequences $x_1(n) = [1, 2, 3, 1]$ and $x_2(n) = [4, 3, 2, 1]$ using time domain approach and verify the result using frequency domain approach. | 08 | L3 | CO3 |
| | | **Module – 3** | | | |
| Q.5 | a. | State and prove the following properties :<br>(i) Circular time shift of a sequence (ii) Parseval's Theorem | 06 | L2 | CO1 |
| | b. | Find the output y(n) of a filter whose impulse response is h(n) = [1, 1, 1] and the input signal x(n) = [3, –1, 0, 1, 3, 2, 0, 1, 2, 1 ] using overlap save method. Assume the length of each block N is 5. | 07 | L3 | CO3 |
| | c. | Given x(n) = [1, 2, 3, 4, 4, 3, 2, 1] . Find X(k) using Radix – 2 DIT-FFT Algorithm. | 07 | L3 | CO3 |
| | | **OR** | | | |
| Q.6 | a. | Derive the radix – 2 DIT-FFT algorithm and draw the signal flow graph for N = 8. | 08 | L2 | CO3 |
| | b. | 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 y(n). Use overlap add method assuming the length of the block is 7. | 07 | L3 | CO3 |
| | c. | A length 8 sequence x(n) = [– 4, 5, 2, –3, 0, –2, 3, 4] with 8-point DFT given ny X(k). Determine the sequence y(n) whose 8-point DFT is given by $Y(k) = W_4^{3k} X(k)$. | 05 | L3 | CO3 |
| | | **Module – 4** | | | |
| Q.7 | a. | A low pass filter is to be designed for the desired frequency response<br>$H_d(e^{jw}) = H_d(w) = \begin{cases} e^{-j2w} & \lvert w \rvert < \pi/4 \\ 0 & \pi/4 < \lvert w \rvert < \pi \end{cases}$<br>Determine the filter coefficients $h_d(n)$ and h(n) if rectangular window is used. Also find the frequency H(w) of the resulting FIR filter. | 10 | L3 | CO4 |
| | b. | Determine the Direct form realization of the system function<br>$H(z) = 1 + 2z^{-1} - 3z^{-2} + 4z^{-3} + 5z^{-4}$ | 04 | L3 | CO4 |
| | c. | Write a program to design digital low pass FIR filter using a window. | 06 | L3 | CO4 |

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| | | **OR** | | | |
| **Q.8** | **a.** | Design a FIR filter with desired frequency response $H_d(e^{jw}) = \begin{cases} e^{-j4w} & -\pi/4 \le w \le \pi/4 \\ 0 & \pi/4 \le \lvert w \rvert \le \pi \end{cases}$ Find filter specifications and transfer function using Bartlett window. | **10** | **L3** | **CO4** |
| | **b.** | Realize the system function in cascade form $H(z) = 1 + \frac{5}{2}z^{-1} + 2z^{-2} + 2z^{-3}$ | **04** | **L3** | **CO4** |
| | **c.** | Write a program to design digital high pass FIR filter using a window. | **06** | **L3** | **CO4** |
| | | **Module – 5** | | | |
| **Q.9** | **a.** | Design an analog Butterworth lowpass filter that has – 2dB or better (ie., lesser than – 2 dB) at frequency of 20 rad/sec and atleast – 10 dB of attenuation at 30 rad/sec. | **10** | **L3** | **CO5** |
| | **b.** | Obtain the direct form – I and direct form – II structure for the filter given by system function $H(z) = \frac{1 + 0.4z^{-1}}{1 - 0.5z^{-1} + 0.06z^{-2}}$ | **04** | **L3** | **CO5** |
| | **c.** | Write a program to design digital IIR Butterworth low pass filter. | **06** | **L3** | **CO5** |
| | | **OR** | | | |
| **Q.10** | **a.** | Design a digital Butterworth lowpass filter with frequency specifications given by<br>(i) Passband ≤ 3.01 dB<br>(ii) Passband edge frequency : 500 Hz<br>(iii) Stopband attenuation ≥ 15 dB<br>(iv) Stopband edge frequency : 750 Hz<br>(v) Sampling rate $f_s$ = 2 KHz<br>Use Bilinear transformation metod. | **10** | **L3** | **CO5** |
| | **b.** | A filter is given by the difference equation $y(n) - \frac{1}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) + \frac{1}{2}x(n-2)$ Draw direct form – I and direct form – II realizations. | **04** | **L3** | **CO5** |
| | **c.** | Write a program to design digital IIR Butterworth high pass filter. | **06** | **L3** | **CO5** |

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