CBCS SCHEME

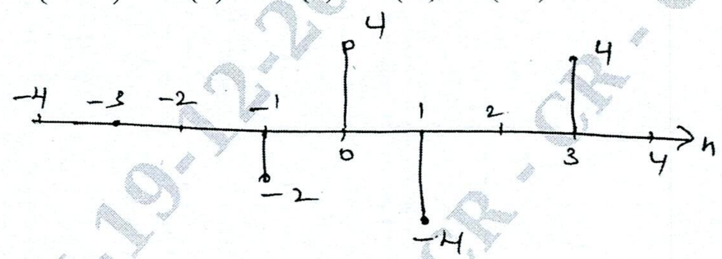
USN

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) $x(n)=\cos(0.3\pi n+\pi/4)$ (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 LT1 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

		OR	M	L	C
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 $x(n)=\delta(n)+2\delta(n-5)$ Find (i) The 10 point DFT X(k) (ii) The sequence that has a DFT $Y(k)=e^{\frac{-j4\pi k}{10}}X(k)$ (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 : (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 $H_d(e^{jw})=H_d(w)=\begin{cases}e^{-j2w} & \lvert w\rvert<\pi/4\\ 0 & \pi/4<\lvert w\rvert<\pi\end{cases}$ 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 $H(z)=1+2z^{-1}-3z^{-2}+4z^{-3}+5z^{-4}$	04	L3	CO4
	c.	Write a program to design digital low pass FIR filter using a window.	06	L3	CO4

		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 (i) Passband ≤ 3.01 dB (ii) Passband edge frequency : 500 Hz (iii) Stopband attenuation ≥ 15 dB (iv) Stopband edge frequency : 750 Hz (v) Sampling rate f_s = 2 KHz 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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