JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

Supplementary Examination- 2026

B.Tech-VII Semester (CSE/IT)

COURSE CODE(CREDITS): 18B1WEC636 (2) MAX. MARKS: 75

COURSE NAME: Fundamentals of Digital Signal Processing & Applications

COURSE INSTRUCTORS: Dr. Vikas Baghel MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

(c) Use of a standard scientific calculator is allowed.

Q.No	Question	CO	Marks
Q1	**a)** State the Nyquist Sampling Theorem. Explain the concept of 'Aliasing' and how it can be prevented during the reconstruction of band-limited signals.	**CO1**	**[6]**
	b) Determine whether the system $y(n) = x(n) + n\,x(n-1)$ is: i. Linear or Non-linear ii. Time-invariant or Time-variant iii. Causal or Non-causal		**[6]**
	c) A discrete-time system is characterized by the impulse response $h(n) = \{1, 2, 1, -1\}$ and an input sequence $x(n) = \{1, 2, 3, 1\}$. • Compute the linear convolution $y(n) = x(n) * h(n)$. • Check if the system is stable and causal.		**[6]**
Q2	**a)** Find the Z-transform and the Region of Convergence (ROC) for the sequence: $$x(n) = \left(\frac{1}{2}\right)^n u(n) + (-\frac{1^n}{3}\ u(n)$$ • Plot the pole-zero pattern. • Determine the stability of the system based on the ROC.	**CO2**	**[8]**

	b) Compute the 4-point DFT of the sequence $x(n) = \{1, 1, 0, 0\}$. Show the magnitude and phase for each frequency bin $X(k)$. **c)** Use the **Radix-2 Decimation-In-Time (DIT) FFT** algorithm to compute the 8-point DFT of the sequence $x(n) = \{1, 2, 1, 2, 0, 0, 0, 0\}$. Draw the butterfly signal flow graph clearly showing all twiddle factors W_N^k.		[7] [10]
Q3	**a)** Compare FIR and IIR filters based on their stability, phase response, and computational complexity. **b)** Design a digital Low Pass Filter (LPF) using the **Bilinear Transformation** method to meet the following specifications: • Passband edge: $200\ Hz$ • Sampling frequency: $1000\ Hz$ • Use a first-order Butterworth analog prototype $H(s) = \frac{\Omega_c}{s+\Omega_c}$ **c)** A system is described by the difference equation: $y(n) = 0.5y(n-1) - 0.25y(n-2) + x(n) + 2x(n-1) + x(n-2)$ • Obtain the Transfer Function $H(z)$. • Realize the system using **Direct Form II** and **Cascade Form** structures.	**CO3**	[4] [8] [10]
Q4	**a)** Explain the role of Digital Signal Processing in RADAR systems, specifically focusing on how DSP is used for object detection and distance measurement. **b)** Discuss the application of DSP in Biomedical Engineering, highlighting its use in processing ECG (Electrocardiogram) signals for noise removal.	**CO4**	[5] [5]