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JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST–2 EXAMINATION – 2026

B.Tech–IV Semester (ECE)

COURSE CODE (CREDITS): ~~25B11EC419~~/25B11EC413 (4) **MAX. MARKS:** 25

COURSENAME: DIGITAL SIGNAL PROCESSING

COURSE INSTRUCTORS: Dr. Vikas Baghel **MAX. TIME:** 1 Hour 30 Min

Note: (a) All questions are compulsory.

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

(c) Use of calculators is allowed.

Q.No	Question	CO	Marks
Q1	**(a)** Explain the significance of digital signal processing and discuss any two advantages of DSP systems over analog signal-processing systems.	CO3	[1]
	(b) Using the sequences $$x[n] = \{1, 2, 1, 0, 0, 0, 0, 0\}, \quad h[n] = \{1, 1, 1\},$$ (i) Compute the 8-point DFT $X[k]$ and identify the dominant frequency bins, (ii) Explain how linear filtering $y[n] = x[n] * h[n]$ is implemented using DFT-based convolution.		[4]
Q2	**(a)** For the digital filter with transfer function $$H(z) = \frac{1 - 0.5z^{-1} + 0.25z^{-2}}{1 - 1.2z^{-1} + 0.36z^{-2}},$$ construct the Direct Form-I and Direct Form-II structures, and determine which structure requires fewer delay elements.	CO2	[3]
	(b) The roundoff error is defined as $e = x - x_B$. Derive the roundoff step-size bound $$\Delta = \frac{\text{range}}{\text{number of steps}} = \frac{2X_m}{2^{B+1}} = \frac{X_m}{2^B}.$$ For $X_m = 1$ (Q15 format), evaluate the value of Δ.		[3]

Q.No	Question	CO	Marks
Q3	(a) Obtain a digital IIR filter corresponding to the given analog filter with system function $$H_a(s) = \frac{s-2}{(s+3)^2+9}$$ using the impulse invariance method..	CO4	[3]
	(b) Convert the analog filter with system function $$H_a(s) = \frac{s+0.1}{(s+0.1)^2+16}$$ into a digital IIR filter using the bilinear transformation. Ensure that the digital filter has a resonant frequency of $\omega_r = \pi/2$.		[3]
Q4	(a) Convert the single-pole lowpass Butterworth filter with system function $$H(z) = \frac{0.245(1+z^{-1})}{1-0.509z^{-1}}$$ into a bandpass filter with upper and lower cutoff frequencies ω_u and ω_l, respectively. Assume the lowpass filter has 3-dB bandwidth $\omega_p = 0.2\pi$.	CO4	[3]
	(b) Design an FIR linear-phase digital filter that approximates the ideal frequency response $$H_d(\omega) = \begin{cases} 1, & \lvert\omega\rvert \le \frac{\pi}{6}, \\ 0, & \frac{\pi}{6} < \lvert\omega\rvert \le \pi \end{cases}$$ (i) Determine the coefficients of a 25-tap filter using the window method with a rectangular window. (ii) Compute and plot the magnitude and phase response of the filter.		[5]