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JK Lakshmipat University Jaipur

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, March 2026

B.Tech. Semester VI (CCE)

Roll No.....

EE1115: Digital Signal Processing

Time: 2 Hours 30 Minutes

Max. Marks: 30

Instructions to students:

1. non-programmable Scientific calculator is allowed.
2. Assume suitable data wherever required and mention it clearly.

Q.1	Design a digital low-pass Butterworth filter using the Impulse Invariance Method with the following specifications: Analog prototype cutoff frequency: $\Omega_c = 100$ rad/s Sampling period: $T_d = 0.01$ s Order of Butterworth filter: $N = 2$	05 Marks CO6
Q.2	Design a digital low-pass Butterworth filter of 2nd order using the Bilinear Transformation Method with the following specifications: Passband edge frequency: $f_p = 1$ k Sampling frequency: $f_s = 8$ kHz Gain at zero frequency = 1	05 Marks CO6
Q.3	A continuous-time signal is given by $x(t) = 4 \cos(200\pi t) + 3 \sin(500\pi t) + 2 \cos(800\pi t)$ The signal is sampled at a rate of $f_s = 600$ Hz Answer the following: (a) Determine the frequency (in Hz) of each component of the signal. (b) Find the highest frequency present in the signal. (c) Calculate the minimum Nyquist sampling rate. (d) Check whether the chosen sampling rate satisfies the sampling theorem. (e) Identify any components that undergo aliasing. (f) Determine the aliased frequency of the affected component(s). (g) Write the reconstructed output signal after ideal low-pass filtering. (h) If the sampling rate is increased to 1200Hz, state whether perfect reconstruction is possible.	05 Marks CO4
Q.4	Given the digital filter transfer function $H(z) = \frac{2 + 5z^{-1} + 3z^{-2}}{1 - 0.6z^{-1} + 0.2z^{-2}}$	05 Marks CO4

	(a) Realize the filter using Direct Form-I structure and draw the block diagram. (b) Realize the filter using Direct Form-II structure and draw the block diagram. (c) Write the corresponding difference equation. (d) Determine the number of multipliers, adders, and delay elements required in both structures. (e) Compare the memory requirement of DF-I and DF-II structures. (f) Which structure is more efficient for practical implementation? Justify your answer.	
Q.5	When the input to a causal LTI system is $x[n] = \left(\frac{1}{2}\right)^n u[n] - 2^n u[-n - 1]$ The output is $y[n] = 6\left(\frac{1}{2}\right)^n u[n] - 6\left(\frac{3}{4}\right)^n u[n]$ (a) Determine the system function $H(z)$ of the system and plot the poles and zeros of $H(z)$ and indicate the ROC. (b) Determine the impulse response $h[n]$ for all values of n. (c) Write the difference equation that characterizes the system. (d) Is the system causal ? is it stable?	05 Marks CO5
Q.6	Given the IIR system transfer function $H(z) = \frac{2 + 5z^{-1} + 2z^{-2}}{1 - 0.5z^{-1} + 0.12z^{-2}}$ (a) Factorize the numerator and denominator polynomials completely. (b) Obtain the cascade form realization of the system as a product of first-order/second-order sections. (c) Draw the block diagram of the cascade structure. (d) Perform partial fraction expansion and obtain the parallel form realization of the system. (e) Draw the block diagram of the parallel structure.	05 Marks CO4

***** All The Best *****