U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

April 2025 Semester End Make-Up Examinations

Programme: B.E. **Semester: III**

Branch: Electronics & Telecommunication Engineering **Duration: 3 hrs.**

Course Code: 23ET3PCSSA **Max Marks: 100**

Course: SIGNALS AND SYSTEMS: ANALOG

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	Define an analog signal and provide examples of analog signals used in real-world applications.	CO1	-	**05**
	b)	Classify signals based on their characteristics. Explain with suitable examples for each classification.	CO1	-	**07**
	c)	Consider a Linear Time-Invariant (LTI) system described by the differential equation: $$\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} = 3x(t) + 2\frac{dx(t)}{dt}$$ where x(t) is the input and y(t) is the output. i)Determine the system's transfer function H(s). ii)Given that $x(t)=e^{-2t}u(t)$, find the output y(t) of the system using the transfer function.	CO2	PO1	**08**
		OR			
2	a)	Define a system and explain the key properties used to classify systems. Illustrate each property with examples specific to analog systems.	CO1	-	**07**
	b)	For an analog system described by $y(t) = 2x(t) + 3\frac{dx(t)}{dt}$, determine if the system is linear, time-invariant, and causal. Justify your answer.	CO2	PO1	**07**
	c)	Consider the analog signal $x(t) = 2u(t)\cos(10\pi t) + 3\sin(4\pi t + \pi/3) + 4e^{-2t}\cos(6\pi t)$, where u(t) is the unit step function. Determine whether x(t) is periodic. Justify your answer.	CO2	PO1	**06**

			UNIT - II			
	3	a)	Given a continuous-time LTI system with input $x(t) = \cos(2\pi t)$ and impulse response $h(t)=e^{-t}u(t)$, determine the output of the system. Show all necessary steps and use the convolution integral for calculation.	*CO2*	*PO1*	**07**
		b)	For an analog signal $x(t) = \sin(2\pi t) + \cos(4\pi t)$, compute its autocorrelation $R_{xx}(\tau)$ and cross-correlation with a delayed version $y(t) = x(t - 1)$. Show all steps and provide the interpretation of the results.	*CO2*	*PO1*	**07**
		c)	Discuss the properties of the impulse response for an LTI system with respect to time-shifting, scaling, and linearity. Give an example to demostrate the properties	*CO2*	*PO1*	**06**
			OR			
	4	a)	For an LTI system with impulse response h(t) and input x(t), derive the convolution integral in the context of a causal system. Discuss the necessary conditions for its application and analyze the case when x(t) is a step function u(t), and $h(t)=e^{-t}u(t)$.	*CO2*	*PO1*	**07**
		b)	Define and explain correlation in the context of analog signals. Discuss the significance of autocorrelation and cross-correlation, providing real-world examples for each.	*CO2*	*PO1*	**07**
		c)	Given $x(t)=e^{-t}u(t)$ and $h(t)=te^{-t}u(t)$, calculate the output y(t) of the system using the convolution integral.	*CO3*	*PO2*	**06**
			UNIT - III			
	5	a)	A continuous-time signal $x(t)=e^{-2\|t\|}$ is given. i) Derive its Fourier Transform *X(f)*. ii) Prove that the magnitude of *X(f)* is even, and its phase is odd. iii) Interpret the result in terms of the signal's energy distribution over frequencies. .	*CO2*	*PO1*	**07**
		b)	Analyze how the properties of the Fourier Transform—linearity, time-shifting, and scaling—affect signal processing. Provide mathematical examples for each property and discuss their significance in real-world applications.	*CO2*	*PO1*	**07**
		c)	For the continuous-time signal $x(t) = e^{-2t}u(t)$, compute its Fourier Transform and sketch the magnitude and phase spectra.	*CO2*	*PO1*	**06**
			OR			
	6	a)	Define the Fourier series for continuous-time periodic signals. Derive the Fourier series representation of a square wave signal with period $T = 2\pi$ and amplitude A.	*CO2*	*PO1*	**07**

		b)	Find the Fourier series representation of the continuous-time periodic signal $x(t) = \begin{cases} A, 0 \leq t < T/2 \\ -A, T/2 \leq t < T \end{cases}$ T = 2π and A is a constant.	*CO1*	-	**07**
		c)	Given a periodic analog signal x(t) = cos(2πt) + sin(4πt), calculate and plot its magnitude spectrum, phase spectrum, and energy spectral density.	*CO2*	*PO1*	**06**
			UNIT - IV			
	7	a)	Given an LTI system with input x(t) and output y(t) described by the following differential equation: $\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 5y(t) = 3\frac{d^2x(t)}{dt^2} + 2x(t),$ i)Derive the transfer function H(s) of the system. ii)Determine the system's impulse response h(t). iii)Discuss the stability of the system.	*CO2*	*PO1*	**08**
		b)	Assume H(s)=1/(s+2) and the input is x(t)=e^{-t}u(t). Compute the output y(t) using the Laplace transform approach. Additionally, determine the time-domain behavior of the output, including whether it has any oscillatory components.	*CO1*	-	**06**
		c)	For the system described by the constant coefficient differential equation: $\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = x(t)$ For the input x(t)= sin(t), determine the output y(t) using the Laplace Transform method.	*CO3*	*PO2*	**06**
			OR			
	8	a)	Consider the signal x(t)=e^{-t}u(t). Compute the Laplace Transform and Fourier Transform of the signal and analyze how the Laplace Transform extends the Fourier Transform for analyzing the system's behavior.	*CO2*	*PO1*	**06**
		b)	Define the system transfer function. Derive the transfer function H(s) of a system described by the differential equation $\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} + 3y(t) = 4x(t)$, and explain the significance of this transfer function in analyzing system behavior.	*CO3*	*PO2*	**08**
		c)	Draw the pole-zero plot for the transfer function $H(s) = \frac{s+2}{s^2+2s+5}$. Use this plot to explain stability and frequency response of the system	*CO3*	*PO2*	**06**

			UNIT – V			
	9	a)	Define ideal filters. Compare the different types of filters (LPF, HPF, BPF, BSF) and their characteristics in signal processing. Discuss the limitations of ideal filters in practical implementations.	*CO1*	-	**07**
		b)	Given a second-order low-pass filter with the following transfer function: $$H(s) = \frac{16}{s^2 + 4s + 16}$$ i)Derive the transfer function for the corresponding high-pass filter (HPF) using the standard frequency transformation. ii)Calculate the cutoff frequency for both the LPF and HPF. iii)Discuss the impact of the quality factor Q on the frequency response of both filters.	*CO2*	*PO1*	**07**
		c)	Design a low-pass prototype Butterworth filter with a cutoff frequency ω_c = 1000 rad/s and a filter order of 3. Calculate and plot the magnitude and phase response of the filter.	*CO3*	*PO2*	**06**
			OR			
	10	a)	Discuss the concept of frequency transformation in the design of analog filters. Explain how frequency transformations are used to convert a prototype filter into a low-pass, high-pass, band- pass, or band-stop filter.	*CO2*	*PO1*	**07**
		b)	Analyze the frequency response characteristics of a Butterworth filter. Discuss how the order of the filter affects its performance, particularly focusing on the passband flatness, transition band, and stopband attenuation. How do the poles of the Butterworth filter influence the overall system behavior in both magnitude and phase responses?	*CO2*	*PO1*	**06**
		c)	Design a Butterworth high-pass filter with a cutoff frequency of ω_c = 500 rad/s and order 4.	*CO3*	*PO2*	**07**

******