

25UECT401	SIGNALS AND SYSTEMS	Category	L	T	P	R	Credit	Year of Introduction
		PCC	3	1	0	0	4	2025

Preamble: This course provides fundamental knowledge of continuous-time and discrete-time signals and systems, including their analysis in time and frequency domains. The course builds the analytical foundation required for advanced studies in digital signal processing, communication systems, control engineering, and emerging applications such as real-time signal analysis and data-driven signal processing.

Prerequisite: 25UMBT301 Fourier Transform and Complex Analysis

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Apply basic operations on continuous-time and discrete-time signals and analyze LTI systems for stability and causality using convolution.	K4 Analyze
CO2	Analyze continuous-time periodic signals using Fourier series and non-periodic signals using Fourier and Laplace transforms.	K4 Analyze
CO3	Apply sampling and reconstruction principles and analyze discrete-time signals and LTI systems using DTFT and Z-transform.	K4 Analyze
CO4	Interpret the use of various transforms to analyze continuous and discrete time LTI systems.	K4 Analyze

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	3	3	2
CO2	3	3	2	2	-	-	-	-	-	-	3	3	2
CO3	3	3	2	2	-	-	-	-	-	-	3	3	3
CO4	3	2	2	2	-	-	-	-	-	-	3	3	2
Avg	3	2.75	2	2	-	-	-	-	-	-	3	3	2.25

Mapping of Course Outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*			*	
CO2	*	*	*	*	*			*	
CO3	*	*	*	*	*			*	
CO4	*	*	*	*	*			*	

Wks Mapped with the Course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*			*	

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	40	60	2.5 hrs

Continuous Internal Evaluation Pattern:

Attendance	: 5 marks
Continuous Assessment Test	: 20 marks
Continuous Assessment Assignment	: 15 marks

SYLLABUS

Module 1: (14 hrs)

Signals and Operations: Elementary signals, classification of signals, and basic signal operations.

System Representation and Properties: Continuous-time and discrete-time systems; system properties including memory, causality, stability, linearity, time invariance, and invertibility.

LTI System Analysis: Determination of stability and causality of continuous-time and discrete-time LTI systems using Convolution integral and convolution sum.

Module 2: (14 hrs)

Fourier Series: Trigonometric and Exponential Fourier series representation of continuous-time periodic signals.

Fourier Transform: Continuous-Time Fourier Transform (CTFT), convergence conditions and Gibbs phenomenon, properties of Fourier transform, and inverse Fourier transform.

Laplace Transform: Bilateral Laplace transform, Region of Convergence (ROC), and relationship between Laplace transform and Fourier transform.

Module 3: (14 hrs)

Sampling of Continuous-Time Signals: Sampling theorem for low-pass signals, Nyquist criterion, and aliasing.

Discrete-Time Fourier Analysis and Z-Transform: Study of the Discrete-Time Fourier Series (DTFS) for the analysis and representation of periodic discrete-time signals. Introduction to the Discrete-Time Fourier Transform (DTFT), including its formulation, convergence requirements, key properties, and inverse transform. Coverage of the Z-transform, encompassing its definition, Region of Convergence (ROC), fundamental properties, methods of inverse Z-transform, and the connection between the Z-transform and the DTFT.

Module 4: (14 hrs)

Transfer Function and Frequency Response: Concept of transfer function, frequency response, magnitude response, and phase response of LTI systems.

Analysis of LTI Systems: Analysis of continuous-time LTI systems using Laplace transform and Fourier transform, Analysis of discrete-time LTI systems using DTFT and Z-transform; determination of stability and causality using Z-transform.

Text Books:

1. Oppenheim, A. V., Willsky, A. S., & Nawab, S. H. (2015). *Signals and systems* (2nd ed.). Pearson Education.
2. Haykin, S., & Van Veen, B. (2021). *Signals and systems* (2nd ed.). Wiley India.
3. Kumar, A. (2013). *Signals and systems* (3rd ed.). PHI Learning.

Reference Books:

1. Lathi, B. P., & Green, R. A. (2021). *Signal processing and linear systems* (2nd ed.). Oxford University Press.
2. Nahvi, M. (2015). *Signals and systems*. McGraw Hill Education (India).
3. Rao, P. R., & Prakriya, S. (2013). *Signals and systems*. McGraw Hill Education.
4. Ziemer, R. E., Tranter, W. H., & Fannin, D. R. (2013). *Signals and systems: Continuous and discrete* (4th ed.). Pearson Education.

END SEMESTER EXAMINATION – MODEL QUESTION PAPER

Course Code	25UECT401
Course Name	SIGNALS AND SYSTEMS
Max. Marks: 60	Duration: 2.5 Hours

Part A

(Answer all questions. Each question carries 3 marks)

Qn No.	Question	Marks	CO	BL
1.	A digital signal-processing system receives the discrete-time signal, $x(n) = \sin(3n)$ To determine whether the signal can be represented by a repeating sequence, examine its periodicity and determine the fundamental period, if it exists.	3	1	L3
2.	A discrete-time LTI system has input sequence, $x(n) = \{1, 4, 3, 4, 6\}$ and impulse response, $h(n) = \{1, 2, 2, 3, 2, 1\}$. Determine the output sequence $y(n)$ by performing linear convolution of $x(n)$ and $h(n)$.	3	1	L3
3.	A continuous-time signal applied to a communication system is given by $x(t) = e^{-at}u(t)$. Determine its Fourier transform and interpret the frequency-domain representation.	3	2	L3
4.	A periodic signal with sharp discontinuities is represented	3	2	L3

	using Fourier series. Examine the Gibbs phenomenon and its effect near the discontinuity points.			
5.	A discrete-time signal is processed using unilateral Z-transform for system analysis. $x(n) = a^n u(n)$ Determine the unilateral Z-transform of the given sequence.	3	3	L3
6.	A sampled signal is reconstructed using a first-order hold circuit in a digital-to-analog conversion system. Examine the signal reconstruction process using first-order hold.	3	3	L3
7.	An LTI system is represented by a given transfer function. $H(s) = \frac{s+3}{s^2+3s+2}; \operatorname{Re}\{s\} > -1$ Determine the impulse response of the system using inverse transform methods.	3	4	L3
8.	A discrete-time signal-processing system is described by a transfer function. Determine the conditions of causality and stability for the system using its ROC and pole locations. $H(z) = \frac{2 - \frac{5}{2}z^{-1}}{1 - \frac{5}{2}z^{-1} + z^{-2}}; z > 2$	3	4	L3

Part B

(Answer any one full question from each Module. Each carry 9 marks)

Module I

Qn No.	Question	Marks	CO	BL
9.	A signal-processing system is described by a mathematical input-output relation. $y(t) = t x(t - T_1); T_1 > 0$ Analyze the system and determine whether it is memoryless, causal, stable, linear, and time-invariant, providing suitable justification.	9	1	L4

OR

10.	A continuous-time LTI system is characterized by the impulse response, $h(t) = u(t) - u(t-1)$, is excited by the input, $x(t) = e^{-t}\{u(t) - u(t-2)\}$. Analyze the system output using convolution and obtain the corresponding response.	9	1	L4
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Module II

Qn No.	Question	Marks	CO	BL
11.	A periodic signal is described mathematically over one period. To represent the signal in terms of sinusoidal components, analyze the trigonometric Fourier series representation of the given signal and determine the Fourier	9	2	L4

	coefficients. $x(t) = \begin{cases} 1 & 0 \leq t < \frac{T}{2} \\ 0 & \frac{T}{2} \leq t \leq T \end{cases} \text{ and } x(t+T) = x(t)$			
OR				
12.	A signal is represented in the Laplace domain by X(s). The same algebraic expression has two different regions of convergence: $-2 < \text{Re}(s) < 1$ and $\text{Re}(s) > 1$. Analyze and determine the inverse Laplace transform of X(s) for each ROC, and compare the corresponding time-domain signals. $X(s) = \frac{4s^2 + 15s + 8}{(s-1)(s^2 + 2s + 4)}$	9	2	L4
Module III				
Qn No.	Question	Marks	CO	BL
13.	A digital signal-processing system uses two discrete-time signals for spectral analysis. Analyze and determine the DTFT of the given discrete-time signals, and interpret their frequency-domain representations. (i) $x[n] = -a^n u[-n - 1]$ (ii) $x[n] = a^{ n }$, $a < 1$	9	3	L4
OR				
14.	A band-limited continuous-time signal x(t) is sampled for digital processing. Analyze the sampling requirements of the signal using the sampling theorem, and determine the Nyquist rate and Nyquist interval necessary for faithful reconstruction. $x(t) = \cos(\pi/2)t + 3 \sin(2\pi/3)t + \sin 4\pi t$	9	3	L4
Module IV				
Qn No.	Question	Marks	CO	BL
15.	A causal LTI system is described by the difference equation, $y(n) = 1/2 y[n-1] + x(n)$. For the input, $x(n) = \delta(n-1)$. Analyze the output response y(n) of the system and determine the resulting sequence.	9	4	L4
OR				
16.	A continuous-time LTI system is initially relaxed and is represented by the equation $y''(t) + 3y'(t) + 2y(t) = 2x(t)$. Analyze the system equation to determine the transfer function H(s) and obtain the impulse response h(t) of the system.	9	4	L4