GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)
Bachelor of Engineering
Subject Code: 3131705
Semester – III
Subject Name: Dynamics of Linear Systems

Type of course: Basic Science

(Basic course for the foundation of signals and systems for control engineering.)

Prerequisite: Basic knowledge of integration, differentiation and complex numbers.

Rationale: This course will provide the students (i) understanding of the mathematical description of continuous and discrete time signals and systems, (ii) to classify signals into different categories, (iii) to analyze Linear Time Invariant (LTI) systems in time and transform domains, and (iv) to build foundation for understanding of courses such as control system and signal processing.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Classification of Signals and Systems** Introduction to signals and systems: Continuous Time (CT) and Discrete Time (DT) signals, Periodic and Aperiodic signals, Even and Odd signals, Energy and Power signals, Deterministic and Random signals. Standard signals: Impulse, Step, Ramp, Pulse, Real and Complex exponential and Sinusoidal. Classification of systems: CT and DT, Memory and Memoryless, Casual and Noncasual, Inverse, Stable and Unstable, Time-variant and Time-invariant, Linear and Non linear systems.	5
2	**Linear Time Invariant (LTI) systems** Discrete time LTI systems, Continuous time LTI systems, Properties of LTI systems**.**	7
3	**Fourier Series Representation of Periodic Signals** Introduction, A historical perspective, The response of LTI systems to complex exponentials, Fourier series representation of continuous time periodic signals and discrete time periodic signals, Properties of CT Fourier series and DT Fourier series, Fourier series and LTI systems, Filtering, Examples of CT filters described by differential equations.	9
4	**The Continuous Time Fourier Transform (CTFT)** Introduction, Representation of aperiodic signals – CTFT, Fourier transform for periodic	8

	signals, Properties of CTFT, Convolution property.	
5	**The Discrete Time Fourier Transform (DTFT)** Introduction, Representation of aperiodic signals, Fourier transform for periodic signals, Properties of DTFT, Convolution property.	**8**
6	**The Laplace Transform (Review)** Introduction, Definition, Region of convergence (ROC), Inverse Laplace transform, Properties of the Laplace transform, Analysis and characterization of LTI systems using the Laplace transform: Causality, Stability.	**3**
7	**The Z-Transform** Introduction, Definition, Region of convergence (ROC), Inverse z-transform, Geometric evaluation of the Fourier transform from the pole-zero plot of First order and Second order systems, Properties of the Z-transform, Analysis and characterization of LTI systems using Z-transform, System function algebra and block diagram representations.	**8**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
0 to 10	**10 to 21**	**21**	**14**	**14**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Signals & Systems, Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, Second Edition, PHI publications.
2. Signals and Sytems, Simon Haykin and Barry Van Veen, John Wiley and Sons, Second Edition, 2004.
3. Signal and Linear System Analysis, Gordon E. Carlson, Allied Publishers Limited.
4. Signals and Systems, A Anandkumar, PHI publications.
5. Signals and Systems, S Poornachandra and B Sasikala, McGraw Hill Education (India) Pvt. Ltd.

Course Outcomes:

Sr. No.	**CO statement**	**Marks % weightage**
	After successful completion of course students will be able to	

CO-1	classify various types of signals and systems, and perform various operations on them.	15
CO-2	analyze CT and DT systems in time domain using convolution.	20
CO-3	use transforms for the analysis of signals and systems in continuous and discrete time domain.	40
CO-4	analyze DT systems using z-transforms.	25

List of Experiments:

Write the programs in MATLAB/Scilab

1. Generate an impulse, step, and square waveforms in continuous and discrete domain.
2. Generate sinusoidal waveforms of different frequencies in continuous and discrete domain. Understand the difference between CT and DT waveforms.
3. Generate growing exponential, decaying exponential, and exponentially damped sinusoidal signals.
4. Find the discrete/continuous convolution between two sequences/signals. Verify the commutative, distributive and associative properties of convolution.
5. Perform folding, shifting and scaling on a given signal x(t) to obtain a signal of the form x(at+b).
6. Find the output of the system with given input (e.g. x[n]=2 {u[n+2] – u[n-12]}) and given impulse response (e.g. $h[n]= 0.9^n$ {u[n+2] – u[n-12] }.
7. Obtain the impulse response h[n] of the systems.
8. Compute FT and DTFT of the continuous time signals and discrete time sequences.
9. Find the partial fraction expansion of the given z-transform.
10. Given an LTI system with transfer function, plot its (i) pole-zero plot in the z-plane and (ii) frequency response.
11. Convert pole-zero gain form of z-transform to second order systems.

Major Equipment:
Computer Lab
MATLAB/Scilab software

List of Open Source Software/learning website:

1. MIT open courseware, Signals and Systems, Prof. Dennis Freeman https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/lecture-videos/

2. NPTEL lectures on signals and systems.