



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Automation and Robotics

Subject Code : DI04041031

Subject Name : Signals and Systems

w. e. f. Academic Year:	2025-26
Semester:	4 <sup>th</sup>
Category of the Course:	PCC

<b>Prerequisite:</b>	Differential equations and difference equations, Laplace Transform, Electrical circuits and networks.
<b>Rationale:</b>	<p>This course helps students develop a strong understanding of signals and systems, which forms the base for subjects like communication and signal processing. It introduces the concepts of continuous-time and discrete-time signals and systems, and explains how they are analyzed using different mathematical transforms.</p> <p>Students will learn how to represent and classify signals, study system behavior in time and frequency domains, and apply discrete Fourier transform and Z-transforms for analysis. The course also covers the concept of sampling and its effect on the signal spectrum.</p> <p>By the end, students will gain analytical skills needed for advanced studies in electronics, communication, and control engineering.</p>

## Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	Identify different types of signals and systems.	R
2	Explain the behavior of linear time-invariant (LTI) systems using convolution and system properties.	U
3	Compute the Discrete-Time Fourier Transform (DTFT) of signals and apply its properties for frequency-domain analysis.	A
4	Explain discrete-time signals using the Discrete Fourier Transform (DFT).	U
5	Use Z-Transform for the analysis of discrete-time signals and systems in the frequency domain.	A

\*Revised Bloom's Taxonomy (RBT)



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### Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE(E)	PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150

### Course Content

Unit	Topics and Sub-topics	No. Of Hrs.	% Weightage
<b>Unit – I Introduction to signals and Systems</b>	1.1 Basic concepts of signals 1.1.1 Continuous time (CT) and Discrete time (DT) 1.1.2 Multichannel and multidimensional signals 1.1.3 Periodic and non-periodic signals 1.1.4 Deterministic and random signals 1.1.5 Energy and power signals 1.1.6 Even and odd signals 1.2 Standard Test Signals 1.2.1 Impulse signal 1.2.2 Step signal 1.2.3 Ramp signal 1.2.4 Parabolic signal 1.2.5 Sinusoidal signal 1.3 Basic operations on signals 1.3.1 Time shifting operation 1.3.2 Time reversal (inversion) 1.3.3 Signal Addition 1.3.4 Signal Multiplication 1.3.5 Time scaling operation 1.3.6 Amplitude scaling operation 1.4 Introduction to Systems 1.5 Classification of systems 1.5.1 Continuous Time system (CT) & Discrete Time system (DT) 1.5.2 Static system & Dynamic system 1.5.3 Linear system & Nonlinear system 1.5.4 Causal system & non-causal system 1.5.5 Time invariant system & Time variant system 1.5.6 Stable system & Unstable system	9	20



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<b>Unit – II Discrete time LTI systems</b>	2.1 Introduction to Linear-Time-Invariant (LTI) Systems 2.2 Characterization of Linear-Time-Invariant (LTI) Systems 2.3 The Continuous-Time Unit-Impulse Response and the Convolution Integral 2.4 Convolution Sum for Discrete-Time LTI Systems 2.5 Properties of Linear-Time-Invariant (LTI) Systems 2.5.1 Commutative Property 2.5.2 Distributive Property 2.5.3 Associative Property 2.5.4 Static and Dynamic LTI Systems 2.5.5 Invertibility of LTI Systems 2.5.6 Causality for LTI Systems 2.5.7 Stability for LTI Systems 2.6 Unit-Step Response of an LTI System 2.7 Basic Building Blocks of Continuous-Time and Discrete-Time Systems	9	20
<b>Unit – III Frequency Analysis of Discrete Time Fourier Transform(DTF T)</b>	3.1 Introduction 3.2 The Discrete-Time Fourier Transform: Representation of Aperiodic Signals 3.3 Properties of DTFT 3.3.1 Periodicity 3.3.2 Time-Shifting Property 3.3.3 Frequency-Shifting Property 3.3.4 Linearity 3.3.5 Multiplication by n: Frequency Differentiation 3.3.6 Time Reversal 3.3.7 Convolution 3.3.8 Correlation 3.3.8 Scaling 3.4 Discrete time LTI systems characterized by Linear constant-co-efficient difference equation	9	20
<b>Unit – IV Discrete Fourier Transform (DFT) and its Application</b>	4.1 Introduction 4.2 Frequency Domain Sampling: The Discrete Fourier Transform 4.2.1 Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals 4.2.2 Derivation of an Interpolation Formula for $X(\omega)$	10	20



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	4.3 The Discrete Fourier Transform (DFT) 4.4 The Inverse Discrete Fourier Transform (DFT) 4.4 The DFT as a Linear Transformation 4.5 Comparison of DTFT and DFT 4.6 Discrete Fourier Transform (DFT) of Standard Signals 4.7 Detailed Explanation of Cyclic Property of Twiddle Factor 4.8 Properties of Discrete Fourier Transform (DFT) 4.8.1 Periodicity 4.8.2 Linearity 4.8.3 Circular Symmetries of a Sequence 4.8.4 Symmetry Properties of DFT 4.8.5 Duality Property 4.8.6 Multiplication of Two DFTs and Circular Convolution 4.9 Frequency Analysis of Signals Using the DFT 4.9.1 Linear Convolution Using DFT 4.9.2 Steps to Calculate Linear Filtering Using DFT		
<b>Unit – V Z-Transform</b>	5.1 Introduction to The z-Transform 5.2 Region of Convergence (ROC) 5.3 Properties of z-Transform 5.4.1 Linearity Property 5.4.2 Time Reversal 5.4.3 Time Shifting Property 5.4.4 Scaling 5.4.5 Differentiation Property 5.4.6 Convolution Property 5.4.7 Correlation Property 5.5 Introduction to The Inverse z-Transform 5.6 Methods for Inverse z-Transform 5.6.1 Long Division Method 5.6.2 Partial Fraction Expansion Method 5.6.3 Residue Method	8	20
	<b>Total</b>	<b>45</b>	<b>100</b>



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## SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the PrOs marked “\*” are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.*

S.No.	Practical Outcomes (PrOs)	Approx. Hrs. required
1	Study the simulation software for simulation of signals and system.	2Hrs
2	Classify CT/DT signals as energy/power, periodic/aperiodic, and even/odd based on mathematical definitions.	2Hrs
3	Generate standard test signals (impulse, step, ramp, parabolic, sinusoidal) using analytical or simulation tools.	2Hrs
4	Perform basic signal operations such as time shifting, scaling, and time reversal and observe their effects on signal shape.	4Hrs
5	Classify systems as linear/nonlinear, causal/non-causal, stable/unstable, and time-invariant/time-variant using given input-output relationships.	2Hrs
6	Compute the response of CT LTI systems using convolution integral.	2Hrs
7	Compute the response of DT LTI systems using convolution sum.	2Hrs
8	Verify LTI system properties such as linearity, time invariance, commutativity, associativity, and distributivity.	4Hrs
9	Determine the unit step response and derive system output using impulse response relationships.	2Hrs
10	Compute the DTFT of a discrete-time sequence and interpret its magnitude and phase spectrum.	4Hrs
11	Verify DTFT properties such as time-shifting, frequency-shifting, scaling, and time reversal using example signals.	4Hrs
12	Compute DFT and IDFT of sequences and interpret spectral	2Hrs
13	Verify DFT properties including periodicity, linearity, symmetry, and perform circular convolution.	4Hrs
14	Perform linear convolution using the DFT method.	2Hrs
15	Perform frequency-domain analysis of signals using DFT to extract magnitude and phase information.	2Hrs
16	Compute z-transform of standard signals and identify their regions of convergence (ROC).	2Hrs
17	Verify key properties of z-transform such as linearity, shifting, scaling, convolution, and differentiation.	4Hrs



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S.No.	Practical Outcomes (PrOs)	Approx. Hrs. required
18	Compute the inverse z-transform using Partial Fraction Expansion methods.	2Hrs
	Total	48

### Note

- More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Ability to Apply Theoretical Concepts	20
2	Accuracy of Computation / Simulation	20
3	Use of Tools and Techniques	20
4	Record observations correctly	20
5	Interpret the result and conclude	20
	<b>Total</b>	<b>100</b>

### MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	PC / Laptop with Required Software Minimum recommended specs: 8 GB RAM i3 processor or above Windows / Linux / macOS	1,3,4,6 to18
2	MATLAB (with Signal Processing Toolbox)	1,3,4,6 to18



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3	Function Generator	1,3,4,6 to18
4	Digital Signal Processor (DSP) Kits	1,3,4,6 to18
5	Digital Storage Oscilloscope (DSO)	1,3,4,6 to18

## AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

- Demonstrates Discipline and Regularity
- Shows Responsibility and Safety Awareness
- Works Cooperatively in Teams
- Demonstrates Ethical Use of Software and Data
- Develop gradually the engineering mindset in day-to-day observation.

## SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare a Summary Sheet of Signal Types.
- Flipped-Classroom Presentation on LTI properties and DFT properties.
- Create a Concept Map of Transforms of DTFT, DFT and Z-transform.
- Case Study on Real-world applications of z-transform

## SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Following Sample strategies teacher can use to accelerate the attainment of the various outcomes in this course:

- Inspire Student to read books on digital signal processing, instruct them to take notes in form of summary
- Prepare a short note on applications of digital signal processing in industry.
- Guide students to make presentation on applications of DFT.
- List out various properties used in DFT along with their advantages and limitations.
- Guide students to make presentation on Sampling and reconstruction.



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## SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Digital Signal Processing, Principles, algorithms & applications	Proakis J. G. , Manolakis D. G	Pearson Education
2	Signals and Systems	Alan V. Oppenheim, Alan S. Willsky, S. Hamid	Prentice Hall (1996)
3	Digital Signal Processing	N. G. Palan	Tech-Max Publications, Pune
4	Digital Signal Processing including matlab programs	Sanjay Sharma	S. K. Kataria and Sons, New Delhi (Latest edition)
5	Linear Systems and Signals	B. P. Lathi	Oxford University Press

## SUGGESTED LEARNING WEBSITES

- i. NPTEL Videos
  - a. <https://nptel.ac.in/courses/117102060>
  - b. <https://nptel.ac.in/courses/108101174>
  - c. <https://nptel.ac.in/courses/108106151>
- ii. MIT open course ware website (<https://ocw.mit.edu>)
- iii. [www.scilab.org](http://www.scilab.org)
- iv. [www.mathworks.com](http://www.mathworks.com)
- v. <https://octave-online.net>
- vi. GaussianWaves – Signal Processing for Communication Systems

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