

**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**  
**Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)**  
**Semester - IV**  
**Course Title: Signals and Systems**  
**(Course Code: 4344104)**

<b>Diploma programme in which this course is offered</b>	<b>Semester in which offered</b>
AUTOMATION & ROBOTICS	FOURTH

### 1. RATIONALE

Signals and Systems is a crucial subject that helps to predict the behavior of systems when subjected to different input signals. It also helps to design electrical circuits or algorithms that will operate on signals to get the desired output. The subject provides the foundation for many advanced courses like Digital Signal Processing, Control Systems, Communication Systems, etc. The importance of Signals and Systems is not restricted only to respective core engineering but is also applicable to all other engineering disciplines and other seemingly unrelated fields.

### 2. COMPETENCY

The aim of this course is to help the student to attain the following industry-identified competency through various teaching-learning experiences:

- Use Fourier series, Fourier transforms and Z transforms to demonstrate in signals and systems.

### 3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills should be taught to acquire different learning outcomes in cognitive, psychomotor and affective domain for the achievement of the following CO's:

CO1: Summarize basic concepts and classification of signals and systems.

CO2: Identify continuous and discrete time Fourier series.

CO3: Explain continuous and discrete time Fourier transforms.

CO4: Apply Z transforms to demonstrate concepts of signals and systems.

### 4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(\*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

**Legends:** *L* - Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* - Practical; *C* – Credit, *CA* - Continuous Assessment; *ESE* - End Semester Examination.

## 5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the subcomponents of the Course Outcomes (Cos). Some of the **PrOs** marked ‘\*’ are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Generate standard test signals waveforms (impulse, step, ramp, parabolic, e.g.) in continuous and discrete domain.	I	2
2	Generate sinusoidal waveforms of different frequencies in continuous and discrete domain.	I	2
3	Generate growing exponential, decaying exponential and exponentially damped sinusoidal signals.	I	2
4	Perform basic operations on signals.	I	2
5	Find the output of the system with given input.	II	2
6	Obtain the impulse response $h[n]$ of the systems.	II	2
7	Check different properties of given systems.	II	2
8	Generate continuous/discrete time periodic waveforms.	III	2
9	Generate Fourier series of a Square Wave	III	2
10	Generate continuous/discrete time aperiodic waveforms.	IV	2
11	Find the discrete/continuous convolution between two sequences/signals.	IV	2
12	Compute FT and DTFT of the continuous time signals and discrete time sequences.	IV	2
13	Calculate and plot Z transform of a given signal.	V	2
14	Find the power series expansion of the given inverse z-transform.	V	2
15	Find the partial fraction expansion of the given inverse z-transform.	V	2

### Note

- i. 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.
- ii. 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	Understanding of Concepts	20
2	Approach of Solving Programs	20
3	Preparation of Programs.	20
4	Execution of Programs.	20
5	Interpretation of Results and Conclusion.	20
<b>Total</b>		<b>100</b>

\* Weightage of particular PrO may vary as per experiments.

## 6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to use in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer (Latest Version)	1 to 15
2	Simulation Software/ Tools e.g. MATLAB/ Scilab	1 to 15

## 7. 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 fulfill the development of this course competency.

- a. Work as a leader/a team member.
- b. Follow safety practices while using electrical appliances.
- c. Practice environmentally friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- a. 'Valuing Level' in 1<sup>st</sup> year.
- b. 'Organization Level' in 2<sup>nd</sup> year.
- c. 'Characterization Level' in 3<sup>rd</sup> year.

**8. UNDERPINNING THEORY**

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for the development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on the attainment of COs and competency.

<b>Unit</b>	<b>Unit Outcomes (UOs)</b> (4 to 6 UOs at different levels)	<b>Topics and Sub-topics</b>
<b>Unit I</b> <b>Introduction</b> <b>to</b> <b>Signals</b>	1a. Define signals. 1b. Classify signals. 1c. Compare various concepts of signals. 1d. Identify standard test signals. 1e. Apply basic operations of signals. (as per 1.3) 1f. Represent signals with functions.	1.1 Basic concepts of signals <ol style="list-style-type: none"> <li>i. Continuous time (CT) and Discrete time (DT)</li> <li>ii. Periodic and non-periodic signals</li> <li>iii. Even and odd signals</li> <li>iv. Energy and power signals</li> <li>v. Deterministic and random signals</li> <li>vi. Multichannel and multidimensional signals</li> </ol> 1.2 Standard Test Signals <ol style="list-style-type: none"> <li>i. Impulse signal</li> <li>ii. Step signal</li> <li>iii. Ramp signal</li> <li>iv. Parabolic signal</li> <li>v. Sinusoidal signal</li> </ol> 1.3 Basic operations on signals <ol style="list-style-type: none"> <li>i. Time shifting operation</li> <li>ii. Time reversal (inversion)</li> <li>iii. Signal Addition</li> <li>iv. Signal Multiplication</li> <li>v. Time scaling operation</li> <li>vi. Amplitude scaling operation</li> </ol>
<b>Unit II</b> <b>Introduction</b> <b>to</b> <b>Systems</b>	2a. Define systems. 2b. Classify systems. 2c. Compare various categories of systems. 2d. Explain properties of systems.	2.1 Introduction to Systems 2.2 Classification of systems <ol style="list-style-type: none"> <li>i. Continuous Time system (CT) &amp; Discrete Time system (DT)</li> <li>ii. Linear system &amp; Nonlinear system</li> <li>iii. Static system &amp; Dynamic system</li> <li>iv. Time invariant system &amp; Time variant system</li> <li>v. Causal system &amp; non-causal system</li> <li>vi. Stable system &amp; Unstable system</li> </ol> 2.3 Properties of systems <ol style="list-style-type: none"> <li>i. Linearity</li> <li>ii. Homogeneity or additivity</li> <li>iii. Causality</li> <li>iv. Time invariance and Time variance</li> </ol>

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
<b>Unit-III Fourier Series</b>	3a. State steps to represent continuous time periodic signal for Fourier series. 3b. Explain properties of continuous time Fourier series. 3c. State steps to represent discrete time periodic signal for Fourier series. 3d. Explain properties of discrete time Fourier series.	3.1 Introduction 3.2 Fourier Series Representation of Continuous-Time periodic signal 3.3 Properties of Continuous time Fourier Series 3.4 Fourier Series Representation of Discrete-Time periodic signal 3.5 Properties of Discrete time Fourier Series
<b>Unit-IV Fourier Transform</b>	4a. State steps to represent periodic and aperiodic signals. (CT and DT) 4b. Explain properties of CT Fourier transform. 4c. Explain properties of DT Fourier transform. 4d. List out Convolution Property of CT and DT.	4.1 Representation of aperiodic signals (Continuous time and Discrete time) 4.2 Fourier Transform for Periodic Signals (Continuous time and Discrete time) 4.3 Properties of the Continuous-Time (CTFT) and Discrete time Fourier Transform (DTFT) 4.4 Convolution Property of Continuous-Time and Discrete time
<b>Unit V Z Transform</b>	5a. Define Z transform. 5b. Enlist advantages of Z transform. 5c. Represent standard test signals using Z transform. 5d. Explain properties of Z transform. 5e. Define Inverse Z transform. 5f. Explain methods to find inverse Z transform.	5.1 Introduction to Z transform 5.2 Advantages of Z transform 5.3 Z transform of Standard Sequences <ol style="list-style-type: none"> <li>i. unit impulse</li> <li>ii. unit step</li> <li>iii. unit ramp</li> <li>iv. right-handed exponential sequence</li> <li>v. left-handed exponential sequence</li> </ol> 5.4 Properties of Z transform <ol style="list-style-type: none"> <li>i. Linearity</li> <li>ii. Time shifting</li> <li>iii. Scaling</li> <li>iv. Time reversal</li> <li>v. Differentiation</li> <li>vi. Convolution</li> </ol> 5.5 Introduction to Inverse Z transform 5.6 Method of obtaining Inverse Z transform <ol style="list-style-type: none"> <li>i. Power series expansion</li> <li>ii. Partial Fraction Expansion</li> <li>iii. Residue Method</li> </ol>

## 9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Signals	10	6	9	3	18
II	Introduction to Systems	08	3	9	3	15
III	Fourier Series	07	3	4	3	10
IV	Fourier Transform	07	3	4	3	10
V	Z Transform	10	4	9	4	17
<b>Total</b>		<b>42</b>	<b>19</b>	<b>35</b>	<b>16</b>	<b>70</b>

**Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

**Note:** This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

## 10. 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 perform following activities in group (or individual) and prepare reports of about 5 pages for each activity. They should also collect/record physical evidence for their (student's) portfolio which may be useful for their placement interviews:

- Present seminar on various topics from course content.
- Teachers guided self-learning activities through learning websites/ lab based mini projects, industrial visit etc.
- Prepare Internet based assignments which is relevant to field application of course content and also prepare learning materials using it.
- Visit library and collect information from various magazines on recent developments in simulation software used in Instrumentation & control engineering and its applications and then make report of that.
- Join various channels/ pages of simulation software used in Instrumentation & control engineering on social media and conduct group discussion on learned topics.

## 11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (**MOOCs**) may be used to teach various topics/subtopics.
- Guide student(s) in undertaking micro-projects.
- Co-relating the importance of content of this course with other practical application.
- Guide students on how to address issues on environment and sustainability.

## 12. SUGGESTED MICRO-PROJECTS

*Only one micro-project* is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should *not exceed three*.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **12-14 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. **Similar micro-projects could be added by the concerned course teacher:**

- Prepare presentation on given topics.
- Study of continuous time and discrete time system using simulation software.
- Develop a simple simulated linear control system using simulation software.

## 13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Signals and Systems	Alan V. Oppenheim, Alan S. Willsky, S. Hamid	Prentice Hall (1996)
2	Digital Signal Processing, Principles, algorithms & applications	Proakis J. G. , Manolakis D. G	Pearson Education
3	Digital Signal Processing	N. G. Palan	Tech-Max Publications, Pune
4	Signals and Systems	Ganesh Rao and SatishTunga,	Sanguine Technical Publishers
5	Linear Systems and Signals	B. P. Lathi,	Oxford University Press
6	Signals and Systems	A. Anandkumar	PHI Learning Pvt. Ltd, New Delhi

## 14. SOFTWARE/LEARNING WEBSITES

- NPTEL Videos
  - <https://nptel.ac.in/courses/117102060>
  - <https://nptel.ac.in/courses/108101174>
  - <https://nptel.ac.in/courses/108106151>
- MIT open course ware website (<https://ocw.mit.edu>)
- [www.scilab.org](http://www.scilab.org)
- [www.mathworks.com](http://www.mathworks.com)

**15. PO-COMPETENCY-CO MAPPING:**

SEMESTER IV	SIGNALS AND SYSTEMS (Course Code: 4344104)						
	POs						
Competency & Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
		Basic & Discipline specific knowledge	Problem Analysis	Design/ development of solution	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management
<b>Competency</b>	Use Fourier series, Fourier transforms and Z transforms to demonstrate in signals and systems.						
<b>CO1</b> Summarize basic concepts and classification of signals and systems.	2	-	-	1	1	1	2
<b>CO2</b> Identify continuous and discrete time Fourier series.	2	1	2	1	-	1	1
<b>CO3</b> Explain continuous and discrete time Fourier transforms.	2	1	1	-	-	1	-
<b>CO4</b> Apply Z transforms to demonstrate concepts of signals and systems.	2	1	1	2	1	1	-

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

**16. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Member – Board of Studies (GTU), Electrical and Allied branches**

**Prof. Suresh Z. Shyara**, IC Engineering, AVPTI, Rajkot.

**Prof. Mahesh J. Vadhvaniya**, IC Engineering, Government Polytechnic, Palanpur.

**Prof. Urvish P. Soni**, IC Engineering, Government Polytechnic, Ahmedabad

**Prof. Parth S. Thaker**, IC Engineering, Government Polytechnic, Gandhinagar

**Prof. Zankhana D. Mehta**, IC Engineering, Government Polytechnic, Ahmedabad

**GTU Resource Persons**

**Prof. M. A. Modi**, IC Engineering, Government Polytechnic, Ahmedabad.

**Prof. R. B. Gadhiya**, IC Engineering, Government Polytechnic, Gandhinagar.