25ECMJ206: Signals and Systems

w. e. f. Academic Year:		**2026-27**
Semester:		**3**
Category of the Course:		**Program Core Course** (PCC).
Prerequisite:	Engineering Mathematics (specifically Calculus, Differential Equations, and Complex Numbers) and Basic Electrical Circuit Analysis.	
Rationale:	To provide a solid mathematical foundation for analyzing continuous-time and discrete-time signals and systems which is essential for designing modern electronic and communication equipment.	

Course Outcomes:

After Completion of the Course, Student will able to:

	Course Outcome (CO)	**RBT Level (Cognitive Domain)**	**Marks % Weightage (Approx.)**
CO1	Classify and perform basic operations on signals and systems.	Understand(L2)	20%
CO2	Evaluate the time-domain response of LTI systems using convolution.	Apply(L3)	20%
CO3	Analyze periodic and aperiodic signals in the frequency domain.	Analyze(L4)	25%
CO4	Analyze system stability and causality using transform techniques.	Analyze(L4)	20%
CO5	Apply signal processing techniques to real-world applications including filtering, modulation, and communication systems.	Apply (L3)	15%

Teaching and Evaluation Scheme:

Teaching Scheme					**Examination Scheme**				
L	**T**	**P**	**C**	**Hrs/Week**	**IE**	**Theory**	**CIA**	**Practical**	**Total Marks**
3	0	2	4	5	40	60	30	20	150

IE: Internal Evaluation
Theory: Theory Exam (End Semester)
CIA: Continuous Internal Assessment
Practical: Practical Exam (End Semester)

Detailed Syllabus:

Topic		Hrs.	% of Weightage (Approx.)
UNIT: 1	**Fundamentals of Signals & Systems**	**09**	**20%**
Signal Analysis: Classification (Continuous/Discrete, Periodic, Energy/Power); Basic operations; Standard signals (Step, Impulse). **System Analysis:** Linearity, Time-invariance, Causality, and Stability.			
UNIT: 2	**Time Domain Analysis (LTI Systems)**	**08**	**20%**
Convolution: Analysis of LTI systems using the Convolution Integral (CT) and Convolution Sum (DT).			
UNIT: 3	**Frequency Domain Analysis (Fourier)**	**12**	**25%**
Fourier Transform: CTFT and DTFT properties; Frequency response of LTI systems; Sampling theorem and Aliasing			
UNIT: 4	**Transform Domain Analysis (Laplace & Z)**	**08**	**20%**
Transform Domain Analysis & System Realization: Laplace Transform: ROC and S-plane analysis. Z-Transform: ROC and Unit Circle.			
UNIT: 5	**System Realization & Applications:**	**08**	**15%**
System Realization: Direct Form I & II, Cascade and Parallel realizations; Applications: Transfer function of RLC circuits; Stability analysis of feedback systems; Introduction to Filtering and Modulation basics in communication systems**.**			
		45	**100%**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks in Percentage					
Remember	Understand	Apply	Analyze	Evaluate	Create
-	20	35	45	-	-

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.

List of Practical:

Topic	**Hrs**
1. To write a program to generate and plot Unit Step, Unit Impulse, Ramp, and Exponential signals.	2
2. To generate sinusoidal signals and determine their periodicity numerically and graphically.	2
3. To implement Time Shifting, Time Scaling (up sampling/down sampling), and Time Reversal of a sequence.	2
4. To decompose a given signal into its even and odd components and verify the reconstruction.	2

5. To perform the convolution of two discrete sequences and verify the commutative property.	2
6. To compute the Auto-correlation of a signal and Cross-correlation between two different signals.	2
7. To demonstrate the Sampling Theorem and visualize the effect of under-sampling (Aliasing effect).	2
8. To check a given system for Linearity, Time-Invariance, and Causality using Scilab scripts.	2
9. To synthesize a square wave or triangular wave using the summation of its Fourier harmonics.	2
10. To compute the N-point DFT and IDFT of a sequence and plot the Magnitude and Phase spectra.	2
11. To implement circular convolution using the DFT/IDFT method and compare it with linear convolution.	2
12. To find the Z-transform of a signal and determine system stability by plotting Poles and Zeros.	2
13. To analyze continuous-time systems by plotting the Pole-Zero map in the s-domain.	2
14. To find the Z-Transform of a DT sequence and visualize the ROC in relation to the Unit Circle.	2
15. To find and plot the Magnitude and Phase response of a system given its differential equation.	2
Total Hours	**30**

TEXT/REFERENCE BOOKS:

TEXT BOOKS:

1. Oppenheim A. V. & Schafer R. W., Signals and Systems, Pearson Education
2. Proakis J. G. & Manolakis D. G., Digital Signal Processing, Principles, algorithms & applications, Pearson Education.
3. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
4. Signals and Systems by Tarun Rawat Pub: Oxford

REFERENCE BOOKS:

1. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, 1998.
2. Simon Haykin & Barry Van Veen, Signals and Systems, Wiley-India.
3. D. Ganesh Rao & Satish Tunga, Signals and Systems, Sanguine Technical Publishers
4. Roy Choudhury, Networks & Systems, New Age International publishers
5. S. Palani , Signals and Systems, Ane Books Pvt. Ltd

Teaching Learning Method:

- **Interactive Chalk-and-Talk Lectures**: Traditional lectures focused on deriving fundamental mathematical models, such as the Fourier and Laplace transforms, to ensure a solid theoretical foundation.

- **Simulation-Based Laboratory Sessions**: Hands-on sessions using tools like Scilab or MATLAB to visualize signal operations, sampling effects, and system stability, directly supporting the practical list.
- **Problem-Based Learning (PBL)**: Assigning real-world engineering problems such as noise removal from an audio signal where students must design a filter using Z-transform techniques to meet specific criteria.
- **Collaborative Flip-Classrooms**: Providing recorded snippets or hand-outs on standard signals and operations before class, then using class time for group peer-evaluations of complex convolution or transformation problems.
- **Application-Oriented Projects**: Small-scale projects where students synthesize concepts from Unit 3 and Unit 4 to model basic communication blocks.

Course Outcomes Mapping:

CO No.	Course Outcome (CO)	POs/ PSOs Mapped	Cognitive Level (RBT)	Knowledge Category	Class Sessions (Lecture)
CO1	Classify and perform basic operations on signals and systems.	PO1, PO2, PSO1	Understand (L2)	Conceptual	09
CO2	Evaluate the time-domain response of LTI systems using convolution.	PO1, PO2, PO4, PSO1	Apply (L3)	Procedural	08
CO3	Analyze periodic and aperiodic signals in the frequency domain.	PO1, PO2, PO3, PSO1	Analyze (L4)	Procedural	12
CO4	Analyze system stability and causality using transform techniques.	PO1, PO2, PO4, PSO1	Analyze (L4)	Conceptual / Procedural	08
CO5	Apply signal processing techniques to real-world applications including filtering, modulation, and communication systems.	PO1, PO3, PO5, PSO2	Apply (L3)	Procedural	08

Mapping of COs with POs & PSOs:

CO	PO											PSO	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	3	3	0	0	0	0	0	0	0	0	0	3	0
CO2	3	3	0	2	0	0	0	0	0	0	0	3	0
CO3	3	3	2	0	0	0	0	0	0	0	0	3	0

CO4	3	3	0	2	0	0	0	0	0	0	0	3	0
CO5	3	0	2	0	1	0	0	0	0	0	0	0	1

3: High, 2: Medium, 1: Low

Sustainable Development Goals (SDG) Integration:

The course on Signals and Systems supports SDG 4 (Quality Education) by strengthening analytical and problem-solving skills in signal analysis. It contributes to SDG 9 (Industry, Innovation and Infrastructure) through the design and analysis of efficient communication and electronic systems. The application of signal processing in real-world domains like filtering and modulation also aligns with SDG 11 (Sustainable Cities and Communities) by enabling smart and reliable communication technologies. Additionally, it has relevance to SDG 7 (Affordable and Clean Energy) through its role in modern energy monitoring and smart grid systems.

SDG Mapping with Course Outcomes:

CO	Course Outcome	Relevant SDGs	Justification
CO1	Classify and perform basic operations on signals and systems.	SDG 4	Builds strong foundational knowledge in signal analysis, supporting technical education and lifelong learning in engineering disciplines.
CO2	Evaluate the time-domain response of LTI systems using convolution.	SDG 9	Enables understanding of system behavior essential for designing reliable electronic and communication infrastructure systems.
CO3	Analyze periodic and aperiodic signals in the frequency domain.	SDG 9	Supports innovation in signal processing applications such as telecommunications, audio processing, and spectrum analysis.
CO4	Analyze system stability and causality using transform techniques.	SDG 9	Ensures development of stable and efficient systems used in critical infrastructure like control systems, communication networks, and automation.
CO5	Apply signal processing techniques to real-world applications including filtering, modulation, and communication systems.	SDG 9, SDG 11	Contributes to development of smart communication systems, efficient signal transmission, and technologies used in smart cities (e.g., wireless networks, IoT systems).