SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

B. Tech. Semester IV

Subject Name: **Signals and Systems** **Subject Code: BTEC13401**
Type of course: **PCC**
Prerequisite: Differential equations and difference equations, Laplace Transform
Rationale: The course will create a strong foundation on signals and systems which will be useful for studying analog and digital communication and signal processing. The students will learn basic continuous-time and discrete-time signals and systems. Students will learn the application of various transforms for the analysis of signals and systems both continuous-time and discrete-time. Students will also explore the effect of sampling on the spectrum of a signal.

Teaching and Examination Scheme:

Teaching Scheme				Theory Marks			Practical Marks		Total
L	**T**	**P**	**C**	**TEE**	**CA1**	**CA2**	**TEP**	**CA3**	150
3	0	2	4	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. no.	Topics	Teaching Hrs.	Module % Weightage
1.	**Introduction to Signals & Systems:** Basic definitions of signals, Basic elementary signals, Classification of signals, Basic operations on signals, Overview of a Case study of different signals. Basic definitions of systems, Classification of systems, Basic system properties, Overview of a Case study of different systems.	8	15
2.	**Review of Continuous-time Transforms (Fourier Series, Fourier Transform and Laplace transform):** Fourier Series Representation of Periodic Signals, Waveform Symmetries, Calculation of Fourier Coefficients. The frequency spectrum of aperiodic signals, Fourier Transform, Relation between Laplace Transform and Fourier	8	10

	Transform, Properties of Fourier transform, Examples of Fourier transform, Properties of Continuous-Time Fourier transform. Limitations of Fourier transform, Laplace transforms, Relation between Laplace Transform and Fourier Transform, Properties of Laplace transform, Examples of Laplace transform.		
3.	**Signal Transmission through Linear Systems:** Properties of LTI systems, convolution, and correlation of signals, transfer function, signal bandwidth.	6	15
4.	**Discrete-Time Fourier Transform (DTFT):** Introduction to DTFT, Relation between DTFT and FT, Properties of DTFT, examples of DTFT.	4	10
5.	**Z Transform:** The z-Transform, Convergence of z-Transform, Properties of z-Transform, Inverse z-Transform, LTI System analysis from Linear Constant Coefficient Difference Equations using z-Transform.	10	20
6.	**Analysis of Continuous-time (CT)& Discrete-Time(DT) Linear Time-Invariant (LTI) Systems:** Impulse response characterization and convolution for CT- LTI and DT-LTI systems, Properties of LTI systems, LTI systems characterized by Differential and difference equations.	6	20
7.	**Sampling & Reconstruction:** Representation of digital signals, The Sampling Theorem, Sampling with a zero-order hold, Reconstruction of a signal from its samples using interpolation, Aliasing and its effects.	3	10

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	20	20	20	20	5

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **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 the above table.

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition

1.	Signal and Systems	Anand Kumar	PHI	2012	2nd
2.	Signal and Systems	Alan V. Oppenheim, Alan S. Wilsky and Nawab	Prentice Hall	1983	2nd
3.	Signals and Systems	Simon Haykin and Bary Van Veen	Wiley-India Publications	2002	2nd
4.	Digital Signal Processing Fundamentals and Applications	Li Tan	Elsevier, Academic Press	2013	2nd
5.	Digital Signal Processing	Anand Kumar	PHI	2012	2nd

Course Outcome:

Sr. No.	CO Statement After learning this subject students will be able to,	Marks % weightage
CO-1	Explain types of signals, classification and perform various operations on them.	15
CO-2	Analyse linear time-invariant continuous and discrete-time systems.	15
CO-3	Apply transforms for the analysis of signals and systems.	30
CO-4	Carry simulation on signals and systems for observing effects of applying various properties and operations.	20
CO-5	Create a strong foundation of communication and signal processing.	20

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	2	1	3	3	1	1	1	1	1	2	1	3	1	2
CO-2	3	2	1	3	3	1	1	1	1	1	2	1	3	1	2
CO-3	3	3	1	3	3	1	1	1	2	1	2	1	3	1	2
CO-4	3	3	2	3	3	2	1	1	2	1	2	1	3	1	2
CO-5	3	2	2	3	3	1	1	1	2	1	2	1	2	1	2

List of practical:

1. Introduction to MATLAB as a language/tool and Signal & Systems.
   a) Enter two variables and find the arithmetic operation between them.
   b) Write a generalized MATLAB program for Matrix operations.
   c) Define two variables and Comparison of two variables are equal, greater, or lesser.

(Using If else)

2. a) Write a MATLAB program to generate and plot different types of continuous and discrete-time signals like Sine, Cosine, Square, Rectangular pulse (using a square function), Sawtooth, and Triangular pulse. The time axis span should be 0 to 200 ms and the amplitude axis between -2 to 2.

b) Write a MATLAB program to generate and plot continuous-time signals like the Sinc function and Signum function. The time axis span should be -10 to 20 ms and the amplitude axis between -1 to 1.

Note: Use the subplot command to display CT and DT signals (Two) windows on the same graph.

3. a) Write a MATLAB program to generate and plot basic continuous and discrete-time signals like Impulse, Unit Step, and Unit Ramp signals. The time axis span should be -10 to 10 and the amplitude axis between -1 to 1.

Note: Use the subplot to display CT and DT signals (Two) windows on the same graph.

4. Plot the signals in the interval $o \leq n \leq 2\pi$ using 80 data points.

$y(n) = \sin^2 n$, $z = \cos^2 n$, $w = \sin^2 n * \cos^2 n$, $v = \sin^2 n/(0.1+\cos^2 n)$

Use the subplot command to display these functions as four windows on the same graph.

5. a) Using the MATLAB plot the function defined by (Consider t= -20 to +20)

g(t) = 0 for t<=-5
= 10+2t for -5<=t<=-2
=12+3t for -2<=t<=2
=22-2t for 2<=t<=11
= 0 for t>=11

b) Using the MATLAB stem the function defined by (Consider n= -20 to +20)

x(n) = -4-2n for n [-2:0]
= -4+3n for n [0:4]
= 16 -2n for n [4:8]

6. For above g(t) signal, plot the transformed function g(-t), 3g (t), -2g(t), g(3/2*t), g(2/3*t).

7. a)From practical 5, take x(n) as input. Make user-defined Matlab code for the delay and advance shift of the signal.

b)Using the MATLAB stem the signal x[n] = [4 5 -4 -3 1 2 -5 6 3], x[0]=1. Using If else instruction makes user-defined code for delay and advance of the signal. Also verify time scaling operation.

8. Over a range of: $-50 < n < 50$. Is x (n) periodic or non-periodic? If periodic then find period theoretically and practically.

a) $x(n) = 10\, e(-n/4) \sin(3\pi n/16)\, u(n)$.
b) $x(n) = 2 * \cos(2\pi n/3) - 3 * \sin(\pi n/4)$

9. Using MATLAB find the signal energy for $x(n) = e^{|n/10|} * \sin(2\pi n/4)$.

10. Write a MATLAB code to make your function file. Which compares two variables and display two variables are equal, greater, or lesser? (Use char inbuilt function to display) (Function name is mycompare)

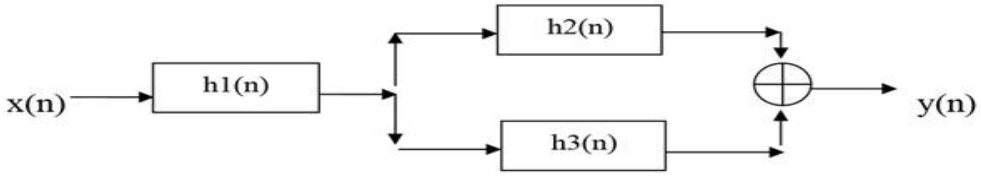
a) Write a MATLAB code to arrange the array in ascending order.
(Function name is myascend)
b) Write a MATLAB code to make your own function file.

Function z = f(x,y), x = f(t) and y = f(t), where
t = 0:0.1:10

x = -1*sin(t)
y = 2*cos(t)
z =2*x+2*y
Plot (t,x,t,y,t,z). (Function name is myfunc2)

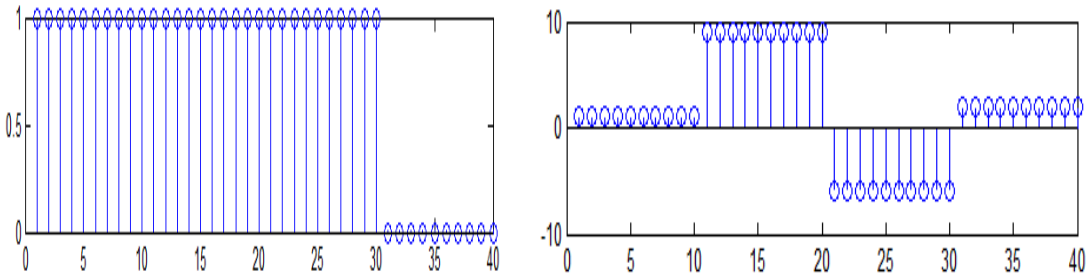
11. For the signals,
$h_1(t) = \text{Sin}(3\pi t/16)$
$h_2(t) = 2\cos(9\pi t/4)$
$h_3(t) = (4/5)*t*u(t)$
(Consider t= -20 to +20)
Verify the different properties of convolution using the "conv" function.
a) Commutative - h1 (t) * h2 (t) = h2 (t) * h1 (t)
b) Distributive - h1 (t) * [h2 (t) + h3 (t)] = h1 (t) * h2 (t) + h1 (t) * h3 (t)
c) Associative - $h_1(t) * [h_2(t) * h_3(t)] = [h_1(t) * h_2(t)] * h_3(t)$

12. An inter-connection of LTI system is shown. The impulse responses are:
$h_1(n) = (2/3)^n [u(n)-u(n-6)]$, $h_2(n) = \sin(n)*u(n)$ and $h_3(n) = u(n+3)-u(n-3)$ as shown in figure. Let the impulse response of the over-all system from x (n) to y (n) be denoted as h (n). Find the impulse response of the over-all system. by (Consider n= -20 to +20)



figure

13. Find convolution of following signal with "conv" function.
$y(n) = x_1(n) * x_2(n)$



$x_1(n)$ $x_2(n)$

14. a) Find convolution of $x_1(n)$ = [4 3 5 2 1 5] and $x_2(n)$ = [3 6 2 4 5] using "conv" function. (Verify theoretically and practically).
b) Find convolution of user defined signals without "conv" function and compare with "conv".
$y(n) = x_1(n) * x_2(n)$

15. Discretization using different sampling rates and observing aliasing effect. Observing the effects of lower sampling rate and higher sampling rate on the signal.

16. Determine the transfer function H(S) and Impulse response h(t) of the system when,

$y(t) = e^{-t} - 2e^{-2t} + e^{-3t}$ and $x(t) = e^{-0.5t}$

17. To determine the Z transform of different discrete-time signals.

List of Open Source/learning websites:

- https://nptel.ac.in/courses/117/101/117101055/
  entire syllabus
- https://www.youtube.com/playlist?list=PLC6210462711083C4
  entire syllabus (Video Lecture Series by IIT professors (Not Available in NPTEL) – "Signals and Systems" by Prof. S.C. Dutta Roy)
- https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/
  entire syllabus

List of Open Sources of software

- SCILAB