SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

B. Tech. Semester VI

Subject Name: **Introduction to Adaptive Signal Processing** **Subject Code: BTEC15603**

Type of course: OE

Prerequisite: Probability theory and Linear algebra

Rationale: This course aims to develop a foundation of linear adaptive filters. Adaptation is accomplished by adjusting the free parameters of a filter according to the input data to achieve the desired output. Such adaptive algorithms are frequently encountered in many signal processing and machine learning algorithms. The adaptive signal processing course provides a treatment of signal processing algorithms for designing optimum and linear filters; designing, implementing, and analysing adaptive filters applied to system identification, inverse modelling (deconvolution), adaptive control, and interference cancellation; and some selected emerging topics in signal processing.

Teaching and Examination Scheme:

Teaching Scheme				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	100
3	0	0	3	60	25	15	-	-	

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 and Systems:** Representation of Discrete-Time signals, Elementary Discrete-time signals, Basic operations on Discrete-time signals, Classification of Discrete-time signals, Review of Discrete-time systems, , Classification of Discrete-time systems, Discrete time Convolution and Correlation	6	10
2.	**Introduction to Transforms:** DTFT, difference between DTFT and Z, Z-Transform and its advantages, Convergence of z-Transform, Properties of z-Transform, Inverse z-Transform, Solution of Difference equations using z-Transform.	5	10
3.	**Introduction to Adaptive Systems and Statistical Signal Processing** – Definition and characteristics – Properties –	5	15

	Applications and examples of an adaptive system. Correlation; ergodicity; means, variances; stationarity; wide sense stationarity; periodogramme; frequency response vs. power spectrum. Stochastic Processes and Models: Characterization – Mean Ergodic theorem – Correlation matrix –Power spectral density – Properties of power spectral Density – Linear transformations		
4.	**Wiener filters** – normal equations; error performance surfaces; orthogonality; minimum mean square errors, Linear optimum filtering – Minimum mean-square error – Wiener- Hopf equations – Multiple linear regression model – Steepest-descent algorithm – Linear prediction – Forward linear prediction, Levinson-Durbin algorithm. Kalman filter – Extended Kalman filter	8	20
5.	**Least-Mean-Square (LMS) adaptive filters** –formulation; convergence; stability criteria. Algorithm variations: normalized algorithm, sign error algorithm, sign data algorithm, leaky algorithm, filtered-X algorithm, variable step-size algorithm. LMS adaptation algorithm – applications. Method of Least Squares – Data windowing, Normal equations and linear least square filters, Applications of the LMS	8	20
6.	**Recursive LMS-IIR Algorithms**: output error formulation; equation error formulation; full gradient, simplified gradient, applications of recursive LMS algorithms.	8	15
7.	**Application Examples**: Examples for the use and performance of adaptive filters are given and demonstrated by audio demonstrations.	5	10

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	25	25	20	10	10

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 above table.

Reference Text Books:

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

			like ISBN		
1.	Adaptive Filter Theory	Simon Haykins	Pearson Education	2013.	5th
2.	Adaptive Signal Processing	Bernard Widrow Samuel. D. Stearns	Pearson	2001	Latest
3.	Theory and Design of Adaptive Filters	John. R. Triechler, C. Richard Johnson (Jr)	Prentice Hall India Private Limited	2004	Latest
4.	Statistical and Adaptive Signal Processing	D.G.Manolakis,V. K. Ingle and S.M.Kogon	McGraw Hill	2000	Latest

Course Outcome:

Sr. No.	CO Statement After learning this subject students will be able to	Marks % weightage
CO-1	Describe various types of signals and systems, classify them, analyse them, and perform various operations.	25
CO-2	Apply Discrete Time Transforms in analysis of signals and system.	25
CO-3	Devise adaptive filtering solutions by optimising the cost function	25
CO-4	Evaluate the performance of various methods for designing adaptive filters	25

Mapping with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	-	1	1	2	-	-	-	2	-	-	2
CO-2	2	3	2	2	2	3	-	-	1	-	-	-
CO-3	1	1	2	3	2	2	1	1	2	2	2	2
CO-4	2	3	3	3	3	3	-	-	-	2	-	-

List of Open Source/learning website:

- https://nptel.ac.in/courses/117105075- NPTEL course on Introduction to Adaptive Filters