SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

B. Tech. Semester VI

Subject Name: **Adaptive Signal Processing** **Subject Code: BTEC14604**
Type of course: PEC
Prerequisite: Probability theory, digital signal processing, and linear algebra.
Rationale: The primary aim is to develop a mathematical theory 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. It provides a comprehensive treatment of mathematical signal processing algorithms for designing optimum and linear filters.

Teaching and Examination Scheme:

Teaching Scheme				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
2	0	2	3	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 Adaptive Systems** Definition and characteristics, Properties Applications and examples of an adaptive system. Correlation; ergodicity; means, variances; stationarity; wide sense stationarity; periodogram; frequency response vs. power spectrum.	4	15
2.	**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	7	20
3.	**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	7	20

	of Least Squares – Data windowing, Normal equations and linear least square filters, Applications of the LMS such as : System identification; inverse system modelling; modems, telecommunications adaptive equalization, echo cancelling; adaptive beamforming (radar, sonar, hearing aids, listening devices) etc.		
4.	**Recursive LMS-IIR Algorithms**: Output error formulation; equation error formulation; full gradient, simplified gradient, applications of recursive LMS algorithms.	5	15
5.	**Comparative Analysis**: Wiener; LMS-FIR, LMS-IIR; RLS, lattice; frequency domain and neural networks for adaptive signal processing applications	4	15
6.	**Implementation of Adaptive Filters**: DSP microprocessor implementation; software; custom hardware.	3	15

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	15	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 like ISBN	Year of publication	Publication Edition
1.	Adaptive Filter Theory	Simon Haykins	Pearson Education	2013	5th
2.	Adaptive Signal Processing	Bernard Widrow Samuel. D.	Pearson Education	2001	3rd
3.	Theory and Design of Adaptive Filters	John. R. Triechler C. Richard Johnson (Jr), Michael. G.	Prentice Hall India Private Limited	2004	Latest
4.	Statistical and Adaptive Signal Processing	D.G.Manolakis,V.K. Ingle and .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 properties and applications of Adaptive Systems	15
CO-2	Apply linear filters to solve linear prediction problems	25
CO-3	Solve engineering problems using LMS /RLS based algorithms	20
CO-4	Evaluate the performance of various methods for designing adaptive filters through estimation of different parameters of stationary random process	25
CO-5	Implement adaptive filters on digital signal processing kits	15

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	-	1	2	2	3	2	-	-	2	2	1	-	-	-	2
CO-2	2	3	2	2	2	3	-	-	1	-	-	-	2	2	2
CO-3	2	3	2	2	2	1	-	-	2	-	2	-	1	2	2
CO-4	2	3	3	3	3	3	-	-	-	2	-	-	2	2	2
CO-5	1	1	2	3	2	2	1	1	2	2	2	2	2	2	2

List of practical:

1. Estimate means, variances, frequency response vs. power spectrum.
2. To compute auto correlation and cross correlation between signals and sequences.
3. Designing IIR Filters.
4. Designing FIR Filters.
5. Design Wiener filter.
6. Noise Reduction by Wiener Filter.
7. Design Kalman filter.
8. Compute output, error, and weights of LMS adaptive filter.
9. Recursive LMS-IIR Algorithms.

List of Open Source/learning websites:

- https:// https://nptel.ac.in/courses/117105075- Adaptive Signal Processing

List of Open Source software:

- SCILAB