17ES013 ADAPTIVE SIGNAL PROCESSING

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	30	-	5	5	-

Course Objectives:

Adaptive signal processing concerns with processing of signals where the processing parameters are adjusted continuously to suit time varying signal environmental conditions. The study of adaptive signal processing involves development of various adaptation algorithms and assessing them in terms of convergence rate, computational complexity, robustness against noisy data, hardware complexity, numerical stability etc. This course demonstrates the design of important class of adaptive filters, LMS, RLS and Kalman filters.

Course Outcomes:

The student will be able to:

- Explain the importance of signal processing in non-stationary environment.
- Explain the role and importance of adaptive signal processing in communications signal processing
- List and apply the various mathematical models to adaptive signal processing.
- Understand the problem of finding the minimum error criteria.
- Use computer based simulation tools to understand the theoretical concepts of adaptive signal processing in various communication applications.

SKILLS :

- Able to analyze statistical properties of a signal.
- Able to design different adaptive filters for different applications.
- Able to use different algorithms such as LMS, NLMS, RLS for designing adaptive filters.

ACTIVITIES:

- Design of linear prediction filter using MATLAB
- Design of LMS filter using MATLAB
- Design of RLS filter using MATLAB
- Design of Kalman filter using MATLAB

UNIT – I

INTRODUCTION: The filtering problem, Adaptive filters, linear filter structures, approaches to the development of linear adaptive filter algorithms, real and complex forms of adaptive filters, non linear adaptive filters, Applications.

STATIONARY PROCESSES AND MODELS: Partial characterization of a discrete time stochastic process, mean ergodic theorem, correlation matrix, correlation matrix of sine wave plus noise, stochastic models, wold decomposition, asymptotic stationarity of an auto regressive process. Yule-Walker equations. Selecting the model order. Complex Gaussian process.

UNIT– II

WIENER FILTERS: Linear optimum filtering problem statement, principle of orthogonality, minimum mean squared error, wiener – hopf equations, error– performance surface. Channel equalization. Linearly constrained minimum variance filter , generalized side lobe cancellers.

UNIT – III

LINEAR PREDICTION: Forward Linear Prediction, backward Linear Prediction, Levinson-Durbin algorithm, properties of prediction error filters, Schur-Cohntest, auto regressive modeling of a stationary stochastic process, Cholesky factorization, lattice predictors, joint process estimation, block estimation.

Method of steepest descent: Steepest descent algorithm, stability of the Steepest descent algorithm.

UNIT– IV

LEAST MEAN SQUARE (LMS) ALGORITHM: Over view of the structure and operation of the Least Mean square Algorithm, Least Mean square adaptation Algorithm, stability and performance analysis of the LMS algorithm. Normalized Least Mean Square (NLMS) Algorithm, Concept of method of least squares,

RECURSIVE LEAST SQUARES (RLS) ALGORITHM: The matrix inversion lemma, the exponentially weighted RLS algorithm, update recursion for the sum of weighted error squares. Convergence analysis of the RLS algorithm.

UNIT - V

KALMAN FILTERS: Recursive minimum mean square estimation for scalar random variables, statement of the Kalman filtering problem, the innovations process, estimation of the state using the innovations process, filtering, initial conditions, variants of the Kalman filter, extended Kalman filtering.

TEXT BOOKS:

1. Adaptive Filter Theory, S. Haykin, Prentice-Hall, 4-th edition, 2001.
2. Fundamentals of Adaptive Filtering, Ali H. Sayed, John Wiley, 2003.

REFERENCE BOOKS:

1. Monson H. Hayes , “Statistical Digital Signal Processing And Modeling”, Wiley India, 2008.
2. John G. Proakis, Dimitris G.Manolakis, “Digital Signal Processing, Principles, Algorithms and Applications”, Pearson Education / PHI, 2007.
3. B. Farhang-Boroujen, “Adaptive Filters: Theory and Applications”, John Wiley and Sons, 2013.