13-EC 535 STATISTICAL SIGNAL PROCESSING

SYLLABUS

Review of random variables Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonalit principle in estimation, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and autocovariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process. Random signal modelling: MA(q), AR(p) , ARMA(p,q) models. **Parameter Estimation Theory** Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties ; Baysean estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation. **Estimation of signal in presence of white Gaussian Noise** Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Noncausal IIR Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters. **Adaptive Filtering:** Principle and Application, Steepest Descent Algorithm Convergence characteristics; LMS algorithm, convergence, excess mean square error, Leaky LMS algorithm;Application of Adaptive filters ;RLS algorithm, derivation, Matrix inversion Lemma, Intialization, tracking of nonstationarity. **Kalman filtering:** State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter. **Spectral analysis:** Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Prametric method, AR(p) spectral estimation and detection of Harmonic signals, MUSIC algorithm.

TEXT BOOKS
1.Discrete Random Signals and Statistical Signal Processing, By Charles W. Therrien, Prentice Hall Signal Processing Series

REFERENCE TEXT BOOK
1.M. H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley & Sons, Inc.,
2.D.G. Manolakis, V.K. Ingle and S.M. Kogon: Statistical and Adaptive Signal Processing, McGraw Hill, 2000.
3.Monson H. Hayes, 'Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 2002
4.J. G. Proakis et. al., Algorithms for Statistical Signal Processing, Pearson Education, 2002.
5.Simon Haykin: Adaptive Filter Theory, Prentice Hall, 1996.

SIMULATION TEXT BOOKS
1.Statistical Digital Signal Processing and Modeling by Monson Hayes, John Wiley & Sons, Inc.,
2.Statistical Signal Processing Modelling and ESTIMATION BY Chonavel, T., Springer 2001