# EC8091 ADVANCED DIGITAL SIGNAL PROCESSING

DETAILED SYLLABUS

## OBJECTIVES:

- To learn and understand the concepts of stationary and non-stationary random signals and analysis & characterization of discrete-time random processes
- To enunciate the significance of estimation of power spectral density of random processes
- To introduce the principles of optimum filters such as Wiener and Kalman filters
- To introduce the principles of adaptive filters and their applications to communication engineering
- To introduce the concepts of multi-resolution analysis

## UNIT I DISCRETE-TIME RANDOM PROCESSES

Random variables - ensemble averages a review, random processes - ensemble averages, autocorrelation and autocovariance matrices, ergodic random process, white noise, filtering random processes, spectral factorization, special types of random processes - AR, MA, ARMA

## UNIT II SPECTRUM ESTIMATION

Bias and consistency, Non-parametric methods - Periodogram, modified-Periodogram - performance analysis. Bartlett's method, Welch's method, Blackman-Tukey method. Performance comparison. Parametric methods - autoregressive (AR) spectrum estimation – autocorrelation method, Prony's method, solution using Levinson Durbin recursion.

## UNIT III OPTIMUM FILTERS

Wiener filters - FIR Wiener filter - discrete Wiener Hopf equation, Applications - filtering, linear prediction. IIR Wiener filter - causal and non-causal filters. Recursive estimators - discrete Kalman filter.

## UNIT IV ADAPTIVE FILTERS

Principles and properties of adaptive filters - FIR adaptive filters. Adaptive algorithms – steepest descent algorithm, the LMS algorithm - convergence. Applications of adaptive filtering – noise cancellation, channel equalization.

## UNIT V MULTIRESOLUTION ANALYSIS

Short-time Fourier transform - Heisenberg uncertainty principle. Principles of multi-resolution analysis - sub-band coding, the continuous and discrete wavelet transform - properties. Applications of wavelet transform - noise reduction, image compression.

## TEXT BOOKS

1. Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and Sons Inc. New York, Indian reprint 2008. (UNIT I-IV)

2. P. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc. 1993 (UNIT V)

**REFERENCES:**

1. John G. Proakis & Dimitris G. Manolakis, —Digital Signal Processing – Principles, Algorithms & Applications‖, Fourth Edition, Pearson Education / Prentice Hall, 2007.

2. Sophoncles J. Orfanidis, "Optimum signal processing", McGraw Hill, 2000