**Department of Electronics & Communication Engineering**

**Indian Institute of Technology Roorkee**

**ECN 614 – Adaptive Signal Processing Techniques**

**Tutorial #2**

1. The sampled form of the transmitted radar signal is where is the angular frequency and is the transmitted complex amplitude. The signal received is given as

where and differs from by virtue of Doppler shift produced by the motion of the target of interest, and is a sample of white noise.

The time-series is applied to an *M*-tap Wiener filter with cross-correlation vector between and the desired response preset to , where and . Derive expression for the tap-weight vector of the Wiener filter.

1. Derive the augmented Wiener-Hopf equations of a forward prediction-error filter by
   1. Formulate the expression for the mean-square value of the forward prediction error in terms of the tap-weight vector of the forward prediction-error filter.
   2. Minimize this mean-square prediction error, subject to the constraint that the first tap-weight (fed with the current sample ) is equal to unity.
2. Consider the linear prediction of a stationary autoregressive process generated from the difference equation

where {} is a zero-mean white-noise process with unit variance. Determine the tap weights of the forward prediction-error filter.

1. Consider the filtering structure described in the figure below, where the delay Δ is an integer greater than unity.



Find the optimum value of the weight-vector **w**[*n*] so as to minimize the estimation error *e*[*n*].

1. A process consists of a single sinusoidal process of complex amplitude α and angular frequency Ω in additive white noise of zero mean and variance , as given by

where and . Determine the tap weights of the forward prediction-error filter of order *M* and the final value of the prediction-error power.

1. Consider a wide-sense stationary process whose auto-correlation function has the following values for different lags:
   1. Use the Levinson-Durbin recursion to evaluate the tap weights of the forward prediction-error filter of order three and the final value of the prediction-error power.
   2. Based on the Levinson-Durbin recursion, determine the transfer function of the forward prediction-error filter and check your result with that in Part (a) above.
2. A second-order autoregressive process is defined by the difference equation

where {} is a zero-mean white-noise process with variance .

* 1. Find the average power of .
  2. Find the reflection coefficients *κ*1 and *κ*2.
  3. Using the results obtained in Part (a) and Part (b) above, compute the autocorrelation function values *r*(1) and *r*(2), and the average prediction-error powers *P*1 and *P*2.