**Department of Electronics & Communication Engineering**

**Indian Institute of Technology Roorkee**

**ECN 614 – Adaptive Signal Processing Techniques**

**Tutorial #1**

1. Show that the product is an analytic function of the complex tap weight *wk*but is not an analytic function.
2. A second-order autoregressive process is defined by the difference equation

where {*w*[*n*]} is a zero-mean white-noise process with variance . Determine the autocorrelation function values *rxx*(0), *rxx*(1) and *rxx*(2).

1. Consider a Wiener filtering problem characterized as follows: The correlation matrix of the tap-input vector **x**[*n*] is

and the cross-correlation vector between the tap-input vector **x**[*n*] and the desired response *d*[*n*] is

.

* 1. Evaluate the tap weights of the Wiener filter.
  2. What is the minimum mean-square error produced by this Wiener filter?
  3. Formulate a representation of the Wiener filter in terms of the eigenvalues of the matrix **R**xx and associated eigenvalues.

1. The tap-input vector of a transversal filter is defined by

,

where

and

The complex amplitude of the sinusoidal vector is a random variable with zero mean and variance .

* 1. Determine the correlation matrix of the tap-input vector .
  2. Suppose that the desired response *d*[*n*] is uncorrelated with What is the value of the tap-weight vector of the corresponding Wiener filter?
  3. Suppose that the variance is zero and the desired response is defined by , where 0 ≤ *k* ≤ *M* – 1. What is the new value of the tap-weight vector of the Wiener filter?
  4. Determine the tap-weight vector of the Wiener filter for a desired response defined by , where *τ* is a prescribed delay.

1. Consider a signal , where is an autoregressive process that satisfies the difference equation

where is a zero-mean white-noise sequence with variance and is another zero-mean white-noise sequence with variance . The processes and are uncorrelated.

* 1. Determine the autocorrelation sequences { *rss*(*m*) } and { *rxx*(*m*) }.
  2. Design a Wiener filter of length *M* = 2 to estimate .
  3. Repeat Part (b) above for *M* = 3.
  4. Compare the minimum mean-square errors produced by the filters in Part (b) and Part (c) above and comment on the difference.

1. The figure below shows the autoregressive model of the transmitted signal *d*[*n*] and the model of a noisy communication channel over which the signal is transmitted. is a white-noise process of zero-mean with variance is another white-noise source of zero-mean with variance . The two noise sources and are statistically independent.



A Wiener filter of length two is employed at the receiver to estimate the transmitted signal *d*[*n*]. Determine the optimum weight vector of the Wiener filter and the minimum mean-square error produced by the filter.