

UNIT 4 Exercises: Optimal filtering

**4.1** Given an 2<sup>nd</sup> order FIR filter:

- a) Draw the block diagram of the filter.
- b) Write the expression of  $y[0]$ ,  $y[1]$  and  $y[2]$  ( $y[n]$  is the output of the filter), given that the initial values for the delays are all zero. Provide the general expression and particularize for the following values of  $x[n]$ :  
 $x(0)=0.1$   
 $x(1)=0.8$   
 $x(2)=0.2$

**4.2** Check that  $\vec{w}^T \overrightarrow{R_{XD}} = \overrightarrow{R_{XD}}^T \vec{w}$  for  $M=3$ .

**4.3.** Design a 2-coefficient optimal filter given the following statistics:

$$\begin{aligned} R_{XX}(-2) &= 0.24649 \\ R_{XX}(-1) &= 0.24671 \\ R_{XX}(0) &= 0.27136 \\ R_{XX}(1) &= 0.24671 \\ R_{XX}(2) &= 0.24649 \end{aligned}$$

$$\begin{aligned} R_{XD}(-2) &= 0.24616 \\ R_{XD}(-1) &= 0.24634 \\ R_{XD}(0) &= 0.24640 \\ R_{XD}(1) &= 0.24634 \\ R_{XD}(2) &= 0.24616 \end{aligned}$$

**4.4.** Check that  $\frac{d(\vec{w}^T \overrightarrow{R_{XD}})}{d\vec{w}} = \overrightarrow{R_{XD}}$  for  $M=3$ .

**4.5.** Prove that  $E[\vec{x}(n)d(n)] = E[d(n)\vec{x}(n)^T] = \overrightarrow{R_{XD}}$



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