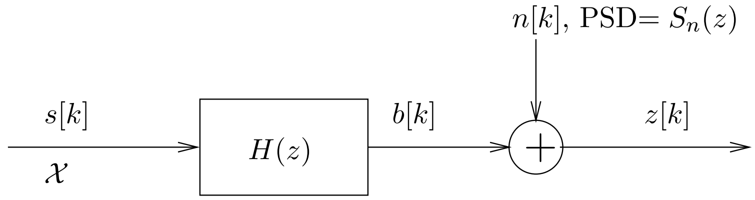
Problem Set 7

EE419: Digital Communication Systems

Consider the general ISI model shown below for all problems in this assignment. The equalizers work with the sequence $z[k]$. Assume $\mathcal{X} = \{-1, 1\}$ wherever necessary.



1. Let $H(z) = c$ (c is a complex number) and $S_n(z) = N_0$. Derive the MMSE linear equalizer $C(z) = \sum_{m=-P}^{P} c_m z^{-m}$ of order $N = 2P + 1$ for $N = 1, 3, 5$. Determine the MSE in each case. Use $c = e^{j\pi/4}$ if numerical evaluation is necessary.

2. Let $H(z) = 1 + cz^{-1}$ (c is a complex number) and $S_n(z) = N_0$. Derive the MMSE linear equalizer $C(z) = \sum_{m=-P}^{P} c_m z^{-m}$ of order $N = 2P + 1$ for $N = 1, 3, 5$. Determine the MSE in each case. Use $c = 1/2$ and $N_0 = 0.1$ if numerical evaluation is necessary.

3. Let $H(z) = \dfrac{1}{1 + cz^{-1}}$ (c is a complex number) and $S_n(z) = N_0$. Derive the MMSE linear equalizer $C(z) = \sum_{m=-P}^{P} c_m z^{-m}$ of order $N = 2P + 1$ for $N = 1, 3, 5$. Determine the MSE in each case. Use $c = 1/2$ and $N_0 = 0.1$ if numerical evaluation is necessary.

4. *Constrained ZF-LE*: Determine the set of equations to be solved for finding an order-$N (= 2P + 1)$ zero-forcing linear equalizer $C(z) = \sum_{m=-P}^{P} c_m z^{-m}$. Assume a suitable $H(z)$ and $S_n(z)$, if necessary. Determine the MSE, if possible.

5. *Constrained ZF-DFE*: Determine the set of equations to be solved for finding a zero-forcing DFE i.e. a precursor $C(z) = \sum_{m=-P}^{0} c_m z^{-m}$ and a postcursor $D(z) = \sum_{m=1}^{P'} d_m z^{-m}$. Assume a suitable $H(z)$ and $S_n(z)$, if necessary. Determine the MSE, if possible.

6. *Constrained MMSE-DFE*: Determine the set of equations to be solved for finding a MMSE DFE i.e. a precursor $C(z) = \sum_{m=-P}^{0} c_m z^{-m}$ and a postcursor $D(z) = \sum_{m=1}^{P'} d_m z^{-m}$. Assume a suitable $H(z)$ and $S_n(z)$, if necessary. Determine the MSE, if possible.

7. Let $H(z) = \dfrac{1}{1 + cz^{-1}}$ (c is a complex number) and $S_n(z) = N_0$. Derive the MMSE DFE i.e. a precursor $C(z) = \sum_{m=-P}^{0} c_m z^{-m}$ and a postcursor $D(z) = \sum_{m=1}^{P'} d_m z^{-m}$ for combinations of $P = 0, 1, 2$ and $P' = 1, 2, 3$. Use $c = 1/2$ and $N_0 = 0.1$ if numerical evaluation is necessary.