NPTEL MOOC Estimation: Assignment #7

1. Consider an Inter Symbol Interference channel $y(k)=\frac{3}{2}x(k)-\frac{1}{2}x(k-1)+v(k)$. Let an r = 2 tap channel equalizer be designed for this scenario based on symbols $y(k+1)$, $y(k)$ to detect $x(k)$. Let symbols x(k) be IID zero-mean with dB Power P_d = 10 dB and dB noise variance \sigma^2 = 3 dB. What is the effective channel matrix **H** for this scenario
   a. $\begin{bmatrix} -1/2 & 3/2 & 0 \\ 0 & -1/2 & 3/2 \end{bmatrix}$
   b. $\begin{bmatrix} 3/2 & -1/2 & 0 \\ 0 & 3/2 & -1/2 \end{bmatrix}$
   c. $\begin{bmatrix} 3/2 & -1/2 & 0 \\ 3/2 & -1/2 & 0 \end{bmatrix}$
   d. $\begin{bmatrix} 3/2 & -1/2 & 0 \\ 0 & 3/2 & -1/2 \end{bmatrix}^T$

   Ans (b)

2. Consider an Inter Symbol Interference channel $y(k)=\frac{3}{2}x(k)-\frac{1}{2}x(k-1)+v(k)$. Let an r = 2 tap channel equalizer be designed for this scenario based on symbols $y(k+1)$, $y(k)$ to detect $x(k)$. Let symbols x(k) be IID zero-mean with dB Power P_d = 10 dB and dB noise variance \sigma^2 = 3 dB. What are the covariance matrices of the input, noise vectors $\mathbf{x}(k)$, $\mathbf{v}(k)$ respectively for this scenario
   a. $10\mathbf{I}_{3X3}, 2\mathbf{I}_{2X2}$
   b. $10\mathbf{I}_{3X3}, 3\mathbf{I}_{2X2}$
   c. $10\mathbf{I}_{2X2}, 2\mathbf{I}_{3X3}$
   d. None of these

   Ans (a)

3. Consider an Inter Symbol Interference channel $y(k)=\frac{3}{2}x(k)-\frac{1}{2}x(k-1)+v(k)$. Let an r = 2 tap channel equalizer be designed for this scenario based on symbols $y(k+1)$, $y(k)$ to detect $x(k)$. Let symbols x(k) be IID zero-mean with dB Power P_d = 10 dB and dB noise variance \sigma^2 = 3 dB. What is the LMMSE equalizer vector **c** ?
   a. $\begin{bmatrix} 0.3344 \\ 5.463 \end{bmatrix}$
   b. $\begin{bmatrix} 0.04497 \\ 0.6347 \end{bmatrix}$
   c. $\begin{bmatrix} 0.03344 \\ 0.5463 \end{bmatrix}$
   d. $\begin{bmatrix} 0.4497 \\ 6.347 \end{bmatrix}$

   Ans(c)

4. Consider an Inter Symbol Interference channel $y(k)=\frac{3}{2}x(k)-\frac{1}{2}x(k-1)+v(k)$. Let an r = 2 tap channel equalizer be designed for this scenario based on symbols $y(k+1)$, $y(k)$ to detect $x(k)$. Let symbols x(k) be IID zero-mean with dB Power P_d = 10 dB and dB noise variance \sigma^2 = 3 dB. What is the resulting LMMSE equalizer ?
   a. $\frac{-90}{2001}y(k+1)+\frac{1270}{2001}y(k)$
   b. $\frac{-9}{2001}\ y(k+1)+\frac{127}{2001}y(k)$
   c. $\frac{-9}{2691}\ y(k+1)+\frac{127}{2691}y(k)$
   d. $\frac{-90}{2691}\ y(k+1)+\frac{1270}{2691}y(k)$

   Ans(d)
5. Consider an Inter Symbol Interference channel $y(k)=\frac{3}{2}x(k)-\frac{1}{2}x(k-1)+v(k)$. Let an r = 2 tap channel equalizer be designed for this scenario based on symbols $y(k+1)$, $y(k)$ to detect $x(k)$. Let symbols x(k) be IID zero-mean with dB Power P_d = 10 dB and dB noise variance \sigma^2 = 3 dB. What is the MSE of LMMSE equalization ?
   a. 1.638
   b. 2
   c. 1.75
   d. None of these

   Ans (a)
6. Consider an Inter Symbol Interference channel $y(k)=\frac{3}{2}x(k)-\frac{1}{2}x(k-1)+v(k)$. Let an r = 2 tap channel equalizer be designed for this scenario based on symbols $y(k+1)$, $y(k)$ to detect $x(k+1)$ **instead of** $x(k)$. Let symbols x(k) be IID zero-mean with dB Power P_d = 10 dB and dB noise variance \sigma^2 = 3 dB. What is the LMMSE equalizer vector **c** ?
   a. $\begin{bmatrix} 0.602 \\ 0.1672 \end{bmatrix}$
   b. $\begin{bmatrix} 0.0602 \\ 0.01825 \end{bmatrix}$
   c. $\begin{bmatrix} 6.062 \\ 0.507 \end{bmatrix}$
   d. None of the above

   Ans (a)
7. Consider an Inter Symbol Interference channel $y(k)=\frac{3}{2}x(k)-\frac{1}{2}x(k-1)+v(k)$. Let an r = 2 tap channel equalizer be designed for this scenario based on symbols $y(k+1)$, $y(k)$ to detect $x(k+1)$ **instead of** $x(k)$. Let symbols x(k) be IID zero-mean with dB Power P_d = 10 dB and dB noise variance \sigma^2 = 3 dB. What is the MSE of LMMSE equalization?

   a. 0.875
   b. 1.75
   c. 0.9699
   d. 0.75

   Ans (c)

8. OFDM is a technology which is used in
   a. 4G LTE
   b. 3G HSDPA
   c. 2G GSM
   d. All of the above

   Ans a

9. The acronym OFDM stands for
   a. Optimal Frequency Diversity Module
   b. Orthogonal Fourier Dispersion Module
   c. Optimal Fourier Duplex Multiplexing
   d. Orthogonal Frequency Division Multiplexing

   Ans d

10. For an L-tap channel, what is the minimum length of cyclic prefix needed to lead to a circular convolution of the channel and input at the receiver?
    a. L
    b. L-1
    c. L+1
    d. $\left\lceil \frac{L}{2} \right\rceil$

    Ans b