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. \[
   \begin{bmatrix}
   -1/2 & 3/2 & 0 \\
   0 & -1/2 & 3/2 \\
   0 & 3/2 & -1/2 \\
   \end{bmatrix}
   \]

   b. \[
   \begin{bmatrix}
   3/2 & -1/2 & 0 \\
   0 & 3/2 & -1/2 \\
   \end{bmatrix}
   \]

   c. \[
   \begin{bmatrix}
   3/2 & -1/2 & 0 \\
   0 & 3/2 & -1/2 \\
   \end{bmatrix}^T
   \]

   d. \[
   \begin{bmatrix}
   3/2 & -1/2 & 0 \\
   0 & 3/2 & -1/2 \\
   \end{bmatrix}
   \]

   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 \( x(k), v(k) \) respectively for this scenario

   a. \( 10I_{3x3}, 2I_{3x2} \)

   b. \( 10I_{3x3}, 3I_{3x2} \)

   c. \( 10I_{3x2}, 2I_{3x3} \)

   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 \( y(k) = \frac{3}{2} x(k) - \frac{1}{2} x(k-1) + \nu(k) \). 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 \( P_d = 10 \text{ dB} \) and dB noise variance \( \sigma^2 = 3 \text{ dB} \). 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 \( y(k) = \frac{3}{2} x(k) - \frac{1}{2} x(k-1) + \nu(k) \). 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 \( P_d = 10 \text{ dB} \) and dB noise variance \( \sigma^2 = 3 \text{ dB} \). 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 \( y(k) = \frac{3}{2} x(k) - \frac{1}{2} x(k-1) + \nu(k) \). 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 \( P_d = 10 \text{ dB} \) and dB noise variance \( \sigma^2 = 3 \text{ dB} \). 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. \( \begin{bmatrix} 0.602 \\ 0.507 \end{bmatrix} \) 
   d. None of the above 
   Ans (a)

7. Consider an Inter Symbol Interference channel \( y(k) = \frac{3}{2} x(k) - \frac{1}{2} x(k-1) + \nu(k) \). 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 \( P_d = 10 \text{ dB} \) and dB noise variance \( \sigma^2 = 3 \text{ dB} \). What is the MSE of LMMSE equalization?
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