1. For the system in Problem 1a of HW#3 (copy attached).

a) add an offset of 0.2 to the output of the channel. What happens to the MSE in steady state? Show a plot of MSE.

b) now add a DC-offset-cancellation tap to the equalizer. Plot MSE vs time. Plot the DC coeff value vs time.

c) for the system in (b), let's assume we're using analog d-t integrators in the adaptive loops, and that each integrator has an input-referred offset:

\[ C_i[n+1] = C_i[n] + \mu(e[n]x[n-c] + offset_i) \]

Assume all the offset_i's are equal, and simulate with offset_i = 0.01, 0.1 and 0.2.
What happens to the MSE and the coeffs as the offset increases? Explain.

\[ a(n) \xrightarrow{G(z)} a[n] + z \hat{a} \]

2. a) Let \( G(z) = 1 - 0.3z^{-1} - 0.1z^{-2} \). Use an adaptive 2-tap DFE. Plot the coeffs and MSE vs time.
b) Try a 3-tap DFE. What happens?

3. Derive the LMS update equation for the DFE coeffs:

\[ d_i[n+1] = d_i[n] + \beta e[n] \hat{a}[n-i] \]

as we did in class for the FIR equalizer coeffs.
4. A channel has been equalized so that the total response is

\[ G(z) \cdot E_g(z) = (1 - z^{-1})(1 + z^{-1} + z^{-2}). \]

If the binary data transmitted is \( \pm 1 = a[n] \), what levels will appear at the output of the equalizer?

5. Decide if the following c-t channels satisfy the Nyquist criterion for transmission at a rate \( \frac{1}{T} \) w/o ISI.

- **a**)

  ![Diagram a](image)

- **b**)

  ![Diagram b](image)

- **c**)

  ![Diagram c](image)
6. \[ x[n] \]
\[ \rightarrow \]
\[ z^{-1} \]
\[ \rightarrow \]
\[ z^{-1} \]
\[ \rightarrow \]
\[ c \]
\[ \rightarrow \]
\[ y[n] \]

a) For the equalizer above (called a "cosine equalizer"), find \( E_g(z) = \frac{Y(z)}{X(z)} \).

b) Let \( z = e^{j\omega T} \) and show that the equalizer has linear phase and a magnitude response that is a fn of \( \cos(\omega T) \).

c) If \( x[n] \) = white noise w/ \( \sigma_x^2 = E(x^2) \). What is the noise power in \( y \)? Is it bigger or smaller than \( \sigma_x^2 \)?
Let \( G(z) = 1 - z^{-1} \). What FIR equalizer coefficients would be required to equalize this channel? How many taps?
Fig. 1

\[ Eq(z) = \text{adaptive FIR equalizer} \]

1. a) In Fig. 1, let \( G_{ch}(z) = \frac{K}{1 - 0.6z^{-1}} \), \( K = 0.4 \).

   Use the LMS algorithm to adapt a 2-tap FIR equalizer. Use \( \beta = 0.01 \).

   a) Use the equalizer coefs so \( Eq(z) = 1 + 0z^{-1} \), initially. Plot the coefs versus time.

   Also plot \( MSE(n) \approx \frac{1}{20} \sum_{i=0}^{10} e^2[n-i] \).

   Show 2000 samples.

   b) Repeat (a) using a 4-tap FIR equalizer. What do you notice?

   c) Repeat (a) using \( \mu = 0.001 \). Compare (a) and (c).