Problem 3.1

(a) \( y[n] = x[n] - x[0] \) is linear.
(b) \( y[n] = x[n] - 1 \) is nonlinear (a system like this, nonlinear only because of the constant offset, is called “affine”). For example,

\[
\begin{align*}
  x_1[n] &= \cos \pi n \\
  y_1[n] &= \begin{cases} 0 & n \text{ even} \\ -2 & n \text{ odd} \end{cases} \\
  x_2[n] &= 1 \\
  y_2[n] &= 0 \\
  x_3[n] &= x_1[n] + x_2[n] \\
  y_3[n] &= \cos \pi n \neq y_1[n] + y_2[n]
\end{align*}
\]

Problem 3.2

(a) \( y[n] = x[n] - x[0] \) is time-varying. For example,

\[
\begin{align*}
  x_1[n] &= \cos \pi n \\
  y_1[n] &= \begin{cases} 0 & n \text{ even} \\ -2 & n \text{ odd} \end{cases} \\
  x_2[n] &= x_1[n] - 1 \\
  y_2[n] &= \begin{cases} 0 & n \text{ even} \\ 2 & n \text{ odd} \end{cases} \neq y_1[n - 1]
\end{align*}
\]

(b) \( y[n] = x[n] - 1 \) is time-invariant.

Problem 3.3

\[
y[n] = \begin{cases} 0 & n \leq -2, \, n \geq 4 \\ 0.5 & n = -1, \, 3 \\ 1.5 & n = 0, \, 2 \\ 2 & n = 1 \end{cases}
\]

Matlab Exercises
Problem 3.4