1. (a) Use Matlab to plot the discrete-time signal
\[ x[n] = \sin(\omega_0 n) \]
for the following values of \( \omega_0 \):

\[-\frac{29\pi}{8}, -\frac{3\pi}{8}, -\frac{\pi}{8}, \frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{9\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}, \frac{33\pi}{8}, \frac{21\pi}{8}. \]

→ Use the subplot function to plot four graphs per page.
→ Label each graph with the frequency.
→ Use the plotting function stem to make the graphs look like the ones in the Book.
→ Plot each signal for \( 0 \leq n \leq 63 \).

Ex:
\[
k = [0:1:63];
n = -3;
w = n \times \pi/8;
y = \sin(w \times k);
subplot(4,1,1);
stem(k,y);
title('-3 pi/8');
\]

(b) Are any of the graphs from part (a) identical to one another? Explain.
(c) How are the graphs of \( x[n] = \sin(\omega_0 n) \) for \( \omega_0 = \frac{7\pi}{8} \) and \( \omega_0 = \frac{9\pi}{8} \) related? Explain.

2. Consider the continuous-time \( 2\pi \) periodic square wave signal shown below:
We will expand $x(t)$ in a Fourier series using Eq. (3.38) and (3.39) on page 191 of the book. Plugging into the equations gives the series:

$$x(t) = \frac{4}{\pi} \left( \frac{\sin t}{1} + \frac{\sin 3t}{3} + \frac{\sin 5t}{5} + \cdots \right).$$

(a) Graph the first term of the series.
(b) Graph the sum of the first two terms of the series, i.e.,
$$\frac{4}{\pi} \left( \frac{\sin t}{1} + \frac{\sin 3t}{3} \right),$$
(c) Graph the sum of the first eight terms.

Plot all of the above using 1000 points evenly spaced between zero and $2\pi$.

Ex:
$$t = [0:2*pi/1000:2*pi];$$
$$subplot(3,1,1);$$
$$y = 4/pi.*sin(t);$$
$$plot(t,y);$$

3. Consider a discrete-time system $H_1$ with impulse response
$$h_1[n] = \delta[n] + \delta[n-1] - \delta[n-2] - \delta[n-3],$$
a discrete-time system $H_2$ with impulse response
$$h_2[n] = \left( \frac{1}{2} \right)^n (u[n+3] - u[n-3]),$$
and a discrete-time signal
$$x[n] = \left( \frac{1}{4} \right)^n (u[n] - u[n-6]).$$

The signals $h_1[n]$, $h_2[n]$, and $x[n]$ are all defined for $-8<=n<=8$.

(a) Plot $h_1[n]$, $h_2[n]$, and $x[n]$ together using the subplot function.
(b) Consider a system $H$ formed from the series connection of $H_1$ and $H_2$, where $x[n]$ is input to $H_1$, the output $v[n]$ of $H_1$ is input to $H_2$, and the output of $H_2$ is $y[n]$. Use the `conv` function to find $v[n]$ and $y[n]$. Plot $v[n]$ and $y[n]$ using the subplot function.
(c) Now assume that the order of the systems is reversed, so that \( x[n] \) is input to H2, the output \( v[n] \) of H2 is input to H1, and \( y[n] \) is the output of H1. Plot \( v[n] \) and \( y[n] \). Briefly explain why \( v[n] \) is different in parts (b) and (c), whereas \( y[n] \) is the same in both parts.

Note: The first element of a Matlab array has index 1. Since the above signals are nonzero for negative values of the time index, you need to make another array, called \( n \) for example, to hold the values of the independent (time) variable when you make the plots in this problem. Then, e.g., \( y[n] \) can be plotted against the vector of times \( n \) using the command \texttt{stem(n,y)}. 