1. **DT Fourier Series.** Consider the following discrete-time periodic signal

\[ x[n] = \begin{cases} 
-1 & n = -1 + 7\ell \\
1 & n = 0 + 7\ell \\
-1 & n = 1 + 7\ell \\
0 & \text{Otherwise}
\end{cases} \]

where \( \ell \) is any integer.

a. What is the fundamental period of this signal.

b. Does the signal have even or odd symmetry?

c. Plot four fundamental periods of the signal.

d. Plot the real and imaginary parts of the Fourier series coefficients \( X[k] \).

e. Plot the magnitude and phase of the Fourier series coefficients \( X[k] \).

f. How are real, negative coefficients represented in polar (magnitude & phase) form?

g. What type of symmetry do the coefficients have?

h. What is the fundamental period of the coefficients?

i. Plot the real and imaginary parts of the DT sinusoids that comprise the discrete-time signal.
j. Plot the real and imaginary parts of the sum of the DT sinusoids that comprise the discrete-time signal.

k. How does the sum of the complex sinusoids compare to the original signal?

2. **CT Fourier Series.** Consider the following continuous-time periodic signal

\[
x(t) = \begin{cases} 
  t + 7\ell & -1 \leq t + 7\ell \leq 1 \\
  0 & \text{Otherwise}
\end{cases}
\]

where \( \ell \) is any integer.

a. What is the fundamental period of this signal.

b. Does the signal have even or odd symmetry?

c. Plot four fundamental periods of the signal.

d. Solve for the Fourier series coefficients. Simplify your expression as much as possible.

\[
\text{Hint: } \int te^{at} \, dt = \frac{1}{a^2}e^{at}(at - 1) + C.
\]

e. Plot the real and imaginary parts of the Fourier series coefficients \( X[k] \).

f. Plot the magnitude and phase of the Fourier series coefficients \( X[k] \).

g. What type of symmetry do the coefficients have?

h. What is the fundamental period of the coefficients?

i. Plot the real and imaginary parts of the CT complex sinusoids that comprise the continuous-time signal for \( k = -5 \) to \( k = 5 \).

j. Plot the partial sums of the analysis equation,

\[
\hat{x}_K(t) = \sum_{k=-K}^{K} X[k]e^{jk\omega t}
\]

of the CT complex sinusoids that comprise the continuous-time signal for \( K = 1, 2, 3, 4, 5, 25, 50, 100 \).
k. Plot the mean square error of the partial sums for $K = 0, \ldots, 100$.

l. How do the partial sums of the complex sinusoids compare to the original signal?

m. In the limit, does the following equality hold?

$$\lim_{K \to \infty} \hat{x}_K(t) = x(t)$$