1. For the following exercises on complex numbers, assume \( j = \sqrt{-1} \).

   a. Write simplified expressions for \( jj, jjj, \) and \( jjjj \).

   b. Draw a labeled plot of vector \( z \) where

      \[
      z = 3 + j4
      \]

      and the x-axis and y-axis correspond to the real and imaginary components, respectively. Be sure to include labels for the magnitude and phase (in degrees as opposed to radians) of \( z \).

   c. Calculate the magnitude, \( K \), and phase (in radians), \( \Phi \), of \( z \), where

      \[
      z = Ke^{j\Phi} = 1 + j2 + 2 + j2
      \]

   d. Calculate the real component, \( a \), and imaginary component, \( b \), for

      \[
      a + jb = 2e^{j\pi/2}3e^{j3\pi/6}
      \]

2. For the following exercises on Fourier Series, use only the complex exponential form of the Fourier Series:

   \[
   x(t) = \sum_{n=-\infty}^{\infty} \hat{X}_n e^{j\omega_n t}
   \]

   \[
   \hat{X}_n = \frac{1}{T} \int_{t_0}^{t_0+T} x(t) e^{-j\omega_n t} dt
   \]

   a. Calculate the Fourier Series \( \hat{X}_n \) for

      \[
      x(t) = \cos(\omega t) + 2\sin(3\omega t)
      \]

   b. Calculate the Fourier Series \( \hat{X}_n \) for the periodic waveform shown in Figure 1 below

      i. Express \( \hat{X}_n \) in terms of its real and imaginary components

      \[
      \hat{X}_n = A_n + jB_n
      \]
ii. Express $\hat{X}_n$ in terms of its magnitude and phase components

$$\hat{X}_n = |\hat{X}_n| e^{j\phi_n}$$

iii. Plot the magnitude of $\hat{X}_n$ over the index range of $n = -5$ to $n = 5$ assuming $T_p = T/4$.

3. For the following exercises on the Fourier Transform, assume the Fourier Transform definition given in class:

$$x(t) = \int_{-\infty}^{\infty} X(f)e^{j2\pi ft} df$$

$$X(f) = \int_{-\infty}^{\infty} x(t)e^{-j2\pi ft} dt$$

a. Calculate the Fourier Transform $X(f)$ for the non-periodic waveform shown in Figure 2 below.

i. Express $X(f)$ in terms of its real and imaginary components

$$X(f) = A(f) + jB(f)$$

ii. Express $X(f)$ in terms of its magnitude and phase components

$$X(f) = |X(f)| e^{j\Phi(f)}$$

iii. Plot the magnitude $X(f)$ of over a reasonable frequency range to see its key characteristics.