Using the FFT

When using a digital computer, spectral analysis means using a Fast Fourier Transform (FFT). This necessitates that we spend some time becoming familiar with using the FFT to study the spectral contents of a sequence.

1. **MATLAB function FFT**

   In this problem you will learn how to use the MATLAB command FFT. First, use the HELP feature in MATLAB to learn the syntax of the FFT function. The FFT function determines the Discrete Fourier Transform (DFT) of a sequence. In general the FFT of a sequence will be a complex function so you will need to look at the magnitude and phase separately. The MATLAB commands ABS and ANGLE are useful for obtaining the magnitude and phase of a complex valued sequence. If you are not familiar with these commands, type HELP. You can plot a discrete signal using the STEM command.

   Plot magnitude and phase of the FFT of the following sequences. The FFT outputs over the range $0 \leq \omega \leq 2\pi$ so label the axis accordingly.

   (a) $x[n] = 5\sin(2\pi f n)$ where $f = 0.65$ and $0 \leq n \leq 127$.

   (b) $x[n] = 5(1 + \cos(2\pi f n))$ where $f = 0.65$ and $0 \leq n \leq 127$.

   Describe what the magnitude plots show. Don't hand in these plots. You are probably more familiar with seeing the spectrum plotted over the range $-\pi \leq \omega \leq \pi$. The FFTSHIFT function can be used for this purpose. Hand in plots of the following sequences and their respective magnitude and phase plots. Make sure the magnitude and phase plots are over the range $-\pi \leq \omega \leq \pi$.

   (a) $x[n] = sinc(f[n - 64])$ where $f = 0.4$ and $0 \leq n \leq 127$.
   Note: sinc is the function `sinc.m` that generates the sinc function – it is on the web page.

   (b) $x[n] = sinc(f[n - 64])cos(2\pi f n)$ where $f = 0.4$ and $0 \leq n \leq 127$.

What type of signals are these (low pass, high pass, etc.)?

What important electrical engineering property is taking place with the second signal above? (Hint: compare with the spectrum of the first signal).