Homework #5
Due Tu. 3/6

1. Matlab Basics
   Get familiar with the Matlab environment. There are a number of tutorials online that will help as well as extensive documentation in Matlab itself. The Matlab documentation is very good. Information about a function can be easily found using the command line for the function *func_name*

   - `>> help` *func_name* - command window documentation
   - `>> doc` *func_name* - interactive documentation in new window

   The interactive documentation viewer allows you to search for topics. This is very helpful if you want to check for a specific functionality but you do not know the Matlab function name. The command line prompt will be indicated using the `>>` symbol through the rest of this assignment.

   The following website links present Matlab tutorials

   - MIT Day1: Introduction to using Matlab - Matlab basics
   - Mathworks Interactive Signal Processing Tutorial - more advanced signal processing specific tutorials by makers of Matlab (Most of this will is beyond our current point in the book).

2. Continuous Signal Basics
   This problem explores the basics of signal creation an manipulation in Matlab.

   (a) Plot

   $$x(t) = \sin(\omega_0 t) \qquad \omega_0 = \frac{\pi}{3} \tag{1}$$

   In order to plot the signal, a time interval must be specified. Create a vector of time values a
   `>> t = -5:0.01:5;`
   How many elements are in in `t`?
   Define the fundamental frequency and find the fundamental period. What is `T`?
   `>> w0 = pi/3;`
   `>> T = 2*pi / w0` % notice the ; is not included so that the value of `T` is printed on screen. Calculate $x(t)$ using the `sin` function
   `>> x = sin(w0 * t);`
   Plot $x(t)$. Note: It is good practice to label your axis and title your figures.

   ```
   >> h=figure;
   >> plot(t,x);
   >> xlabel('time [sec]');
   >> xlabel('x(t)');
   >> title('x(t) = sin(\omega_0 t)');
   >> grid on
   ```

   (b) Plot the the two real exponentials on the same figure with different color lines.

   $$x(t) = Ce^{at} \qquad C = \frac{1}{2} \qquad a = \frac{1}{2}, = -\frac{1}{2} \tag{2}$$

   Hint: `legend`, `plot`, `.^`, `exp`, `hold`

(c) Plot the periodic complex exponential where $a = j\omega_0$ in equation (3). What happens when you plot $x(t)$? Plot the i) real-part, ii) imaginary-part, iii) magnitude, and iv) phase of $x(t)$.
Hint: `real`, `imag`, `abs`, `angle`, `subplot`

3. Discrete Signal Basics

   (a) Plot the discrete version of $x(t) = \sin(\omega_0 t)$ from 1(a) where $x[n] = x(n)$ for $n \in \mathbb{Z}$. First plot the continuous signal $x(t)$ and overlay the discrete version $x[n]$ on top.
   Hint: `stem`, `=` comparison operator

   (b) Plot the the two real discrete exponentials on the same figure with different color lines.

$$x[n] = C\alpha^n \qquad C = \frac{1}{2} \qquad \alpha = \frac{1}{2}, = -\frac{1}{2} \tag{3}$$

   (c) Recreate Figure 1.27 of the book by plotting $x[n] = \cos(\omega n)$ for $\omega =$ `0:pi/8:2*pi`. Take note of how the the frequency changes and how the low frequency $\pi/8$ cosine is the same as the high frequency $15\pi/8$ cosine.
   Hint: `for` loop

4. (1.22 a-f)
   Use Matlab to plot the results. Do not just redefine the signal $y[n] = f(x[n])$, try to manipulate the the time index where appropriate.

5. Convolution

   (a) If $x(t)$ and $y(t)$ are bounded signals as shown in Figure 1, what are the bounds on the convolution $z(t) = x(t) * y(t)$ when $B_{xh} = -B_{xl} = B_x$ and $B_{yh} = -B_{yl} = B_y$. You must find the lower bound B_{zl} and upper bound B_{zh} in terms of B_x and B_y.

   (b) Repeat (a) for the discrete convolution $z[n] = x[n] * y[n]$.

   (c) Now generalize the previous results for case of arbitrary boundaries, B_{xh} and B_{xl}. This will be useful to know when using Matlab to compute convolutions.

   (d) (OW 2.4) Plot the convolution. Be sure to use the full convolution (check the help).
   Hint: `conv`

6. More Convolution

   (a) (OW 2.10a) Do for $\alpha = 0.2$ and $\alpha = 1$.

   (b) (OW 2.21) Use $\alpha = \frac{1}{2}$, $\beta = \frac{1}{3}$. You may plot beteween $-10 \leq n \leq 10$.

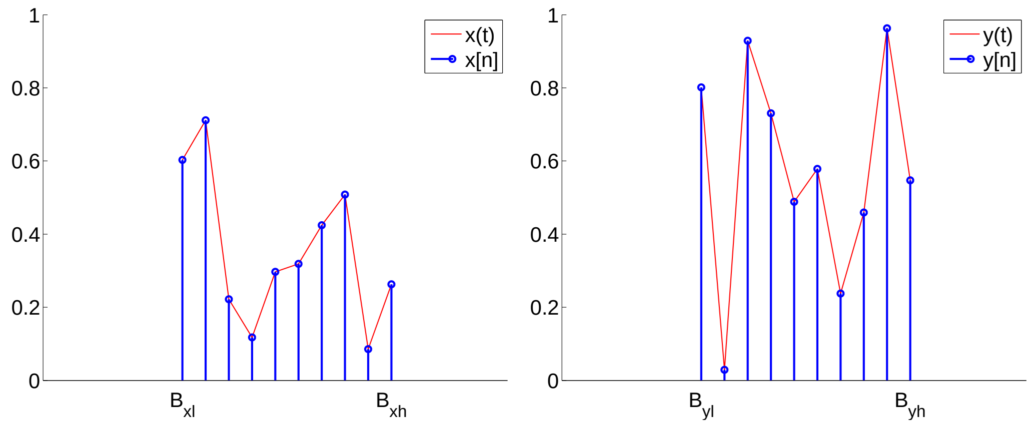
7. Fourier Series

   (a) (OW 3.21) Plot the Fouier Series coefficients (remember this is a discrete signal so should be done with stem) and plot the corresponding signal $x(t)$.

   (b) (OW Example 3.5) Recreate Figure 3.7 by ploting the FS coefficients given by the sinc function

$$a_k = \frac{\sin(k\omega_0 T_1)}{k\pi} \tag{4}$$

   Hint: `sinc`



(a) (b)

Figure 1: Time bounded signals.