Lab Assignments #1A

What to do ?

- Write Matlab code plot results (label axis and titles)
- Create a short report including plots

Unit-impulse and unit-step function

In the first problem, you will use Matlab to generate and plot the discrete-time signal *δ[n]* and unit step function *u[n]*. Matlab provides two built-in functions that will be useful.

The call `zeros(m,n)` returns an array of zeros with *m* rows and *n* columns. Similarly, `ones(m,n)` returns an *m x n* array of ones.

Our first problem is that Matlab array indexing starts at one, but for plotting δ[n] and *u[n]* we will want to have the time variable *n* start at some negative integer.

So we will have to use one array (call it *n*) to hold the values of n and another array to hold the values of the signal.

Unit-impulse function

1. Consider the following Matlab code, which generates the signal *δ[n]* and plots it:

```
%-----------------------------------------------------
% P1a
%
% generate the signal \delta[n] and plot it
%
n = -10:10;           % values of the time variable
delta_n = [zeros(1,10) 1 zeros(1,10)];
stem(n,delta_n);
axis([-10 10 0 1.5]);
title('Unit Sample Function');
xlabel('Time index n');
ylabel('\delta[n]');
```

(a) Type in the code and run it. You can type it in line-by-line at the command prompt or you can create an *m*-file (see page 1).

(b) Modify the code above to generate and plot $\delta[n-2]$ for $-10 \le n \le 10$.

(c) Use the Matlab functions `ones` and `zeros` to generate and plot the signal $u[n]$ for $-10 \le n \le 10$.

(d) Generate and plot $u[-n-3]$ for $-10 \le n \le 10$.

Cosine signal (discrete-time)

2. Consider the following Matlab code, which generates a discrete-time cosine signal *x[n]* and plots it:

```
%-----------------------------------------------------------------------
% P2a
%
% generate and plot a discrete-time cosine signal
%
n = 0:40;                               % values of the time variable
w = 0.1*2*pi;                           % frequency of the sinusoid.
phi = 0;                                % phase offset.
A = 1.5;                                % amplitude.
xn = A * cos(w*n - phi);
stem(n,xn);
axis([0 40 -2 2]);
grid;
title('Discrete Time Sinusoid');
xlabel('Time index n');
ylabel('x[n]');
```

(a) Type in this code and run it.

(b) What is the length of the signal $x[n]$?

(c) What is the fundamental period of $x[n]$?

(d) What is the purpose of the `grid` command?

Sine signal (discrete-time)

3. Use Matlab to generate and plot the discrete-time signal x[n] = sin(ω_0n) for the following values of ω_0 :

$$\frac{-29\pi}{8}, \frac{-3\pi}{8}, \frac{-\pi}{8}, \frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{9\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}, \frac{33\pi}{8}, \text{ and } \frac{21\pi}{8}.$$

- Plot each signal for 0 ≤ n ≤ 63.
- Label each graph with the frequency.
- Use the subplot function to plot four graphs per figure.

Example:

```
n = 0:63;
k = -29;
w = k * pi/8;
xn = sin(w*n);
subplot(4,1,1);
stem(n,xn);
title('-29\pi/8');
```

- Are any of the graphs from the above part identical to one another? *Explain.*
- 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.*

Complex signal (continuous-time)

4. Consider the Matlab code below which generates a continuous-time complex exponential signal and then graphs the real and imaginary parts in one figure and the magnitude and phase in another figure.

```
% generate and plot a continous-time complex sinusoid
%
t = -4:0.01:4;                          % values of the time variable
w = 2.2;                                % frequency of the sinusoid.
xt = exp(j*w*t);
xtR = real(xt);
xtI = imag(xt);
figure(1);              % make Fig 1 active
plot(t,xtR,'-b');       % '-b' means 'solid blue line'
axis([-4 4 -1.0 2.0]);
grid;
hold on;               % add more curves to the same graph
plot(t,xtI,'-r');                  % 'r' = red
title('Real and Imaginary parts');
xlabel('Time t');
ylabel('x(t)');
legend('Re[x(t)]','Im[x(t)]');
hold off;
```

Complex signal *(cont)*

Plot magnitude and phase in figure(2).

```
mag = abs(xt);
phase = angle(xt);
figure(2);                % make Fig 2 active
plot(t,mag,'-g');         % '-' = solid line; 'g' = green
grid;
hold on;                  % add more curves to the graph
plot(t,phase,'-r');                % 'r' = red
title('Magnitude and Phase');
legend('|x(t)|','arg[x(t)]');
xlabel('Time t');
ylabel('x(t)');
hold off;
```

- Type and run this code
- Use similar Matlab statements to generate the continuous-time damped exponential signal

  $$x(t) = 3e^{-t/2}e^{j8t}$$

  for 0 ≥ t ≥ 4.
- Plot magnitude and phase.