Name: _____

EE354 Homework #1: EE322 Refresher

Last semester in EE322, complex numbers were introduced when working with Fourier analysis. This semester again, we will use complex numbers, but now phase will play a more important role in the course. Work through the following complex number problems first by hand:

1. Each row of the following table contains a complex number in its rectangular format, along with its magnitude and phase (which are the polar format components).

a. Complete the table. Use your calculator if needed.

Rectangular Format	**Magnitude**	**Phase (convert answers to degrees)**
7 – 3j		
	15	**45°**
–1 + 2j		
1 – 2j		
– 1 – 2j		
–12		
	4	**115°**

b. Now use the MATLAB *abs( )* and *angle( )* functions to check your answers. Note that the *angle( )* function gives angle in radians, not degrees.

2. Three complex functions are given in the following table.

a. Find their magnitude and phase and fill in the following table.

Function	**Magnitude Function**	**Phase Function**
$Z(f) = 5f + j12f$		
$Z(f) = 2e^{-f} + j\cos(2\pi f)$		
$Z(f) = 5e^{-j2\pi f}$		

b. Use MATLAB to plot the magnitude and phase of these functions. Plot these for $-2 \le f \le 2$, with small step sizes (such as Δf=0.001). Use the subplot(2,1,1) and subplot(2,1,2) commands to plot the magnitude and phase in the same figure window. Your phase plots should have the y-axis in degrees, but the MATLAB *angle( )* function gives phase in radians…convert to degrees by multiplying radians by 180°/π .

3. Given the following signal:

$$s(t)=\begin{cases} 0 & -\frac{T}{2}\le t\le -\frac{T}{10} \\ -1 & -\frac{T}{10}\le t\le 0 \\ +1 & 0\le t\le \frac{T}{10} \\ 0 & \frac{T}{10}\le t\le \frac{T}{2} \end{cases}$$

Find:

(a) The exponential and trigonometric Fourier Series formulas for the a_n's, b_n's, and c_n's.
(b) Calculate the a_n, b_n, and c_n values for n = 0, 1, 2, and 3.
(c) Using Matlab, plot the Fourier Series for the first 1, 3, 5, and 11 terms and compare it with the original function.

4. Given the following signal:

$$s(t)=\begin{cases} 3 & -2\le t\le -1 \\ 4 & 1\le t\le 2 \\ 0 & elsewhere \end{cases}$$

(a) Find the Fourier Transform of *s(t)* evaluated at *f = 0*.
(b) Determine the total energy contained in *s(t)*.

5. Given the following three signals:

$$s_1(t)=e^{-at}u(t)$$
$$s_2(t)=\cos(2t)u(t)$$
$$s_3(t)=te^{-at}u(t)$$

Find the Fourier Transform of each signal.

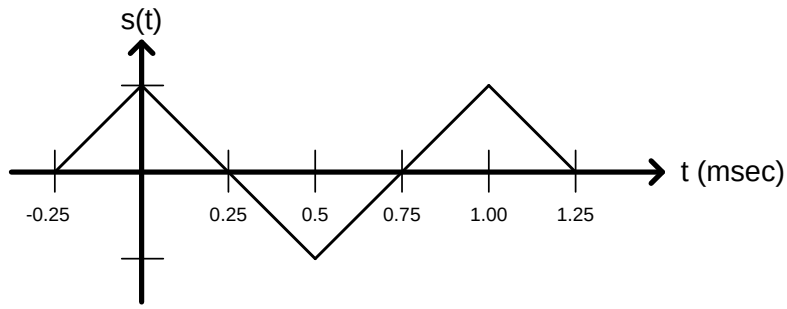
6. Evaluate the following convolution integrals:

(a) $e^{-t^2}*\delta(t-1)$
(b) $u(t)*u(t)$

7. A triangle wave with amplitude of 1V and frequency of 1 kHz (shown below) is input to a filter with the following transfer function:

$$H(f) = \begin{cases} 1 - \left|\frac{f}{f_0}\right|, & \text{for} \left|\frac{f}{f_0}\right| < 1 \\ 0, & \text{for} \left|\frac{f}{f_0}\right| > 1 \end{cases}$$

where f_0 = 6.5 kHz



(a) Determine the time-domain output of this filter (Hint: use Fourier Series).
(b) Use Matlab to plot the input and filtered signals and compare them.