THE UNIVERSITY OF TEXAS AT AUSTIN
Dept. of Electrical and Computer Engineering

EE313 Linear Systems and Signals
Problem Set #1: Introduction to Signals and Systems

Prof. Brian L. Evans

Date assigned:	August 26, 2010
Date due:	September 2, 2010

Homework is due at 11:00 am sharp in class. Late homework will not be accepted.

Reading: *Signals and Systems*, Chapters 1 and 2, and Appendix B

You may use any computer program to help you solve these problems, check answers, etc.

As stated on the course descriptor, "Discussion of homework questions is encouraged. Please be absolutely sure to submit your own independent homework solution."

The office hours in ENS 433B for Prof. Evans follow:

- Tuesdays 12:15pm–1:00pm (right after lecture)
- Wednesdays 12:30pm–2:00pm
- Thursdays 12:15pm–1:00pm (right after lecture)
- Fridays 9:30am–11:00am

In addition, Prof. Evans holds coffee hours on Fridays 1:30–2:30pm at a nearby café. Prof. Evans can be reached at `bevans@ece.utexas.edu`.

The teaching assistant is Mr. Jackson Massey. His office hours will be on Wednesdays 4:00pm–7:00pm in ENS 138. Mr. Massey can be reached at `jackson.massey@gmail.com`.

The ECE Department has traditionally offered tutoring sessions for all basic sequence ECE courses, including EE 313, on Sundays through Thursdays, 7:00–10:00 pm, in ENS 637. These tutoring sessions will begin shortly after Labor Day (Sept. 6th).

Matlab's strength is in performing matrix-vector calculations which are convenient for computing signals and testing signal processing algorithms. In Matlab, the complex number $1 + 2j$ is represented as `1 + 2*j`. For more information about using Matlab, please see Handout D in the course reader

http://users.ece.utexas.edu/~bevans/courses/ee313/handouts/matlab/matlab.pdf and Appendix B in Roberts' *Signals and Systems* book.

Problem 1.1 Properties of Complex Numbers

Part I: Given that $z_1 = r_1\, e^{j\theta_1}$ and $z_2 = r_2\, e^{j\theta_2}$, express the following operations in terms of r_1, θ_1, r_2, and θ_2 and simplify as much as possible.

(a) z_1^*	(b) z_2^2	(c) $z_1 + z_1^*$
(d) $z_1 - j z_1^*$	(e) z_1/z_2	(f) $z_1 z_1^*$

Part II: Double check your simplifications by using $z_1 = 3 - 4j$ and $z_2 = 1 + 2j$. This might be a good opportunity to write a Matlab script to compare the original expression with the simplified expression for each case above. In comparing numeric calculations for the original o and simplified s expressions, you can consider them equal if $\frac{|o-s|}{|o|} < 10^{-10}$, i.e., that the relative error is less than 10^{-10}.

Hint: Be careful when converting a complex number in Cartesian form to polar form. Getting the right quadrant of the angle is important. In order to compute the angle for a complex number $x + jy$, you could use atan2(y, x) in Matlab. When writing a number in polar form, one format is to use $Ae^{j\theta}$ where θ is in radians and A is the amplitude of the complex number. The reason for the units of radians for θ is

$$exp(j\theta) = cos(\theta) + j sin(\theta)$$

*To specify a complex number, use -4 + j*3 in Matlab. Other useful functions in Matlab include:*

- *Conjugation: conj(z1)*
- *Exponentiation: exp(z2)*

Problem 1.2 Using Matlab to Plot Signals

Roberts, Chapter 2, Problem 26, parts (a), (c), (d), and (g). Submit the Matlab plots for each part.

The problem asks to plot a sinusoid as a function of time t on the interval $0 < t < 10$. The code below will plot the sinusoid on the interval $0 \le t \le 10$ by evaluating $x(t)$ at uniformly spaced samples of $t \in [0, 10]$. Here is sample Matlab code to solve this problem except that you have to define Δt on the first line of the program:

```
dt = ??;                %%% time increment - depends on part
tt = 0 : dt : 10;       %%% vector [0, dt, 2dt, ..., 10-dt, 10]
xx = sin(2*pi*tt);
subplot(2,1,1);
plot(tt, xx), grid      %%% time-domain plot
title( 'Section of a sinusoid' ), xlabel('time (sec)')
```

Problem 1.3 More Plotting of Continuous-Time Signals

Roberts, Chapter 2, Problem 30, parts (a), (b), (e) and (m). We will use these particular signals through the semester.

Problem 1.4 Transformations

Roberts, Chapter 2, Problem 34, both parts.

Problem 1.5 Plotting of Discrete-Time Signals

Roberts, Chapter 2, Problem 60, parts (a), (c) and (f).