GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 2025 Fall 2004
Problem Set #2

Assigned: 20-Aug-04
Due Date: Week of 30-Aug-04

Reading: In *SP First*, all of Ch. 2, and start reading in Chapter 3: *Spectrum Representation,* Section 3-1.

The *SP First* Toolbox for MATLAB has been posted on WebCT under the "Lab Assignments" link. You can install it to get some useful functions and GUIs for manipulating complex numbers.

$\Longrightarrow$ **Please check the "Bulletin Board" often. All official course announcements are posted there.**

ALL of the **STARRED** problems will have to be turned in for grading. A solution will be posted to the web. Some problems have solutions similar to those found on the CD-ROM.

Your homework is due in recitation at the beginning of class. After the beginning of your assigned recitation time, the homework is considered late and will be given a zero.
Please follow the format guidelines (cover page, etc.) for homework.

PROBLEM 2.1*:

Signal Processing First, Chapter **2**, Problem **P-2.17**, page 34.
(addition of sinusoids using phasors)

PROBLEM 2.2*:

Suppose that MATLAB is used to plot a sinusoidal signal. The following MATLAB code generates the signal and makes the plot. Draw a sketch of the plot that will be done by MATLAB. Determine the amplitude (A), phase (ϕ), and period of the sinusoid and label the period on your plot.

```
Fo = 50;td=.005
dt = 0.0001;
tt = -.01 : dt : .04;
Z =20;
xx = real( Z*exp( j*2*pi*Fo*(tt - td) ) );
%
plot( tt, xx ),   grid
title( 'SECTION of a SINUSOID' ),    xlabel('TIME   (sec)')
```

PROBLEM 2.3*:

Complex exponentials obey the expected rules of algebra when doing integrals and derivatives. Consider the complex signal $z(t) = j4\,e^{j(-\pi/12)(t-4)}$.

(a) Evaluate the definite integral of $z(t)$ over the range $0 \le t \le 30$:

$$\int_0^{30} z(t)\,dt = ?$$

Simplify your answer (via Euler's formula) to obtain a complex constant and express the answer in polar form.
Note: integrating a complex quantity follows the expected rules of algebra: you could integrate the real and imaginary parts separately, but you can also *use the integration formula for an exponential* directly on $z(t)$.

(b) Determine all possible values of the upper limit u for which the definite integral of $z(t)$ is zero:

$$\int_3^{u} z(t)\,dt = 0 \quad ?$$

where $u > 0$.

(c) Recall that the magnitude magnitude squared $|z|^2$ of a complex number z is equal to $(z^*)z$ where z^* is the conjugate of z. Evaluate the following definite integral:

$$\int_0^{30} z^*(t)z(t)\,dt = ?$$

Since the magnitude-squared is purely real, the answer should be a real number.

PROBLEM 2.4*:

Signal Processing First, Chapter **2**, Problem **P-2.19**, page 34.
(Solving equations using phasors)

PROBLEM 2.5*:

A real signal $x(t)$ can be represented with a two-sided spectrum by using the inverse Euler formula

$$\cos(\omega t + \phi) = \tfrac{1}{2}e^{j\phi}e^{j\omega t} + \tfrac{1}{2}e^{-j\phi}e^{-j\omega t}$$

(a) For the signal $x(t) = -6 + 8\cos(10\pi t + \pi/3) + 2\cos(30\pi t - \pi/4)$, determine a formula for $x(t)$ in terms of complex exponentials.

(b) Plot the spectrum representation for $x(t)$ in a form like that shown on the axis below.