GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 2025 Spring 2004
Problem Set #2

Assigned: 12-Jan-04
Due Date: Week of 20-Jan-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*:

Each of the following signals may be simplified, and expressed as one or two sinusoids of the form: $A\cos(\omega t + \phi)$. For each part work the problem in two different ways:

- Draw a vector diagram of the complex amplitudes (phasors), and use vector addition to ***estimate*** the amplitude(s) A and phase(s) ϕ of the resultant sinusoid(s). Avoid doing a numerical calculation for this method.
- Use the phasor addition theorem to find the exact values for A and ϕ. Do a numerical calculation here.

(a) $x_a(t) = 24\cos(100\pi t - 3\pi/4) + 10\cos(100\pi t + 3\pi/4)$

(b) $x_b(t) = 50\cos(71\pi t + 71\pi) + 20\sqrt{2}\cos(71\pi t - 71.75\pi) + 20\sqrt{2}\cos(71\pi t + 71.75\pi)$

(c) $x_c(t) = \sum_{k=0}^{4} |k-2|\cos(3\times 10^6 t - 2\pi k/4)$

PROBLEM 2.2*:

Complex exponentials obey the expected rules of algebra when doing integrals and derivatives. Consider the complex signal $z(t) = -j3\, e^{j(\pi/20)(t-5)}$.

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

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

Simplify your answer (via Euler's formula) to obtain a value that is a real number.
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:

$$\int_0^{u} z(t)\, dt = 0 \;\; ?$$

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 2.3*:

Signal Processing First, Chapter **2**, Problem **P-2.8**, page 32.
(Relate MATLAB code to mathematical formula for a sinusoid)

PROBLEM 2.4*:

Signal Processing First, Chapter **2**, Problem **P-2.18**, page 34.
(Simultaneous equations with phasors)

PROBLEM 2.5*:

Signal Processing First, Chapter **2**, Problem **P-2.20**, page 34.
(Adding complex exponentials expressed as a sequence)