GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 2025 Fall 2009
Problem Set #2

Assigned: 24-Aug-09
Due Date: Week of 31-Aug-09

Reading: In *SP First*: App. A on *Complex Numbers,* pp. 430–451; and Ch. 2 on *Sinusoids,* pp. 8–43.

The web site for the course uses **`t-square`**: `https://t-square.gatech.edu`
The login for **`t-square`** is your GT login.

$\Longrightarrow$ Please check **`t-square`** daily. All official course announcements will be posted there.

Turn in all **STARRED** problems. Some subset of these problems will be randomly selected for grading.

Some of the problems have solutions that are similar to those found on the SP-First CD-ROM. After this assignment is handed in by everyone, solutions will be posted to the web.

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.

Two-Part Format for HW Solutions: For each homework problem, two distinct pieces of information are required for a complete solution:

(a) *Approach:* Write a clear explanation of ***how*** you are going to solve the problem. Write in complete sentences. This explanation should be written with little or no mathematical formulas, and it should also be written so that it is independent of the specific numerical values in the problem.

(b) *Details:* Carry out the solution of the particular problem. Details mean getting the algebra correct, making precise plots, and doing the numerical calculations are the key.

PROBLEM 2.1*:
For each of the following signals: (i) use the phasor addition theorem to determine numerical values for amplitude A and phase ϕ in the simplified equivalent form $x(t) - A\cos(\omega t + \phi)$; (ii) sketch a vector diagram in the complex plane to visualize the phasor addition and check the feasibility of your answer.

(a) $x_1(t) = 5\cos(777t - 0.2\pi) + 4\cos(777t + 0.4\pi)$

(b) $x_2(t) = 7\cos(\pi t - 3\pi/8) + 4\cos(\pi t - 7\pi/8) + 3\cos(\pi t + 9\pi/8)$

(c) $x_3(t) = \sqrt{5}\cos(6\pi(t-7)) - \sqrt{4}\cos(6\pi(t-10)) + \sqrt{3}\cos(6\pi(t-12))$

PROBLEM 2.2*:
Two sinusoidal signals are defined as

$$x_1(t) = \sqrt{5}\cos(7t - \pi/3)$$
$$x_2(t) = \sqrt{5}\cos(7t + \pi)$$

and their sum is denoted by $x(t) = x_1(t) + x_2(t)$.

1. Find a complex-valued signal $z_1(t)$ such that $x_1(t) = \Re e\{z_1(t)\}$.
2. Find a complex-valued signal $z_2(t)$ such that $x_2(t) = \Re e\{z_2(t)\}$.
3. Find a complex-valued signal $z(t)$ such that $x(t) = \Re e\{z(t)\}$.

PROBLEM 2.3*:
Signal Processing First, Chapter **2**, Problem **19**, page 34.

PROBLEM 2.4*:
Solve the following simultaneous equations by using complex amplitudes. Show how to convert the sinusoidal equations into complex-number equations. If we assume that the amplitudes are positive, will the answers for A_1 and A_2 be unique? How about ϕ_1 and ϕ_2; are there other answers for the phases?

$$\begin{aligned} 3\cos(\omega_0 t + 2\pi/3) &= A_1\cos(\omega_0 t + \phi_1) + A_2\cos(\omega_0 t + \phi_2) \\ 3\cos(\omega_0 t - \pi/3) &= A_1\cos(\omega_0 t + \phi_1) - A_2\cos(\omega_0 t + \phi_2) \end{aligned}$$

PROBLEM 2.5*:
Suppose that MATLAB is used to plot a sinusoidal signal. The following MATLAB code generates the signal and makes the plot. Derive a formula for the signal; then draw a sketch of the plot that will be done by MATLAB.

```
dt = 1/1000;
tt = -0.15 : dt : 0.15;
Fo = 7;
zz = 15*exp(j*(2*pi*Fo*(tt + 0.875)));
xx = real( zz );
%
plot( tt, xx ), grid on
title( 'SECTION of a SINUSOID' )
xlabel('TIME   (sec)')
```

Note that the following problems are not "starred" and do not have to be turned in. They are only suggested as extra practice.

PROBLEM 2.6:
Signal Processing First, Chapter **2**, Problem **4**, page 32.

PROBLEM 2.7:
Signal Processing First, Chapter **2**, Problem **11**, page 33.

PROBLEM 2.8:
Find all of the solutions for z when $z^5 = \sqrt{2}e^{j\pi/4}$.