GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 2025 Spring 2006
Problem Set #3

Assigned: 20-Jan-06
Due Date: Week of 30-Jan-06

Quiz #1 will be held in lecture on Friday 10-Feb-06. It will cover material from Chapters 2 and 3, as represented in Problem Sets #1, #2, #3 and #4.
Closed book, calculators permitted, and one hand-written formula sheet ($8\frac{1}{2}'' \times 11''$, both sides)

Reading: In *SP First*, Chapter 3: *Spectrum Representation,* Sections 3-1, 3-2 and 3-3.

There are two web sites for the *SP First* text: `www.ece.gatech.edu/~spfirst` or `www.rose-hulman.edu/DSPFirst` Use these to find old problems with solutions.

$\Longrightarrow$ **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 3.1*:

The two-sided spectrum of a signal $x(t)$ is given in the following table:

Frequency (rad/sec)	Complex Amplitude
$-\omega_2$	$42e^{-j3\pi/4}$
-7π	X_{-1}
0	B
ω_1	$\sqrt{32} - j\sqrt{32}$
21π	X_2

(a) If $x(t)$ is a *real* signal, determine the numerical values of the parameters: X_{-1}, X_2, ω_1 and ω_2.

(b) Write an expression for $x(t)$ involving only real numbers, cosine functions and the unknown B.

(c) Determine the value for B so that the maximum value of the signal $x(t)$ is 100.
Hint: what is the maximum value of $x(t)$ when B is zero?

PROBLEM 3.2*:

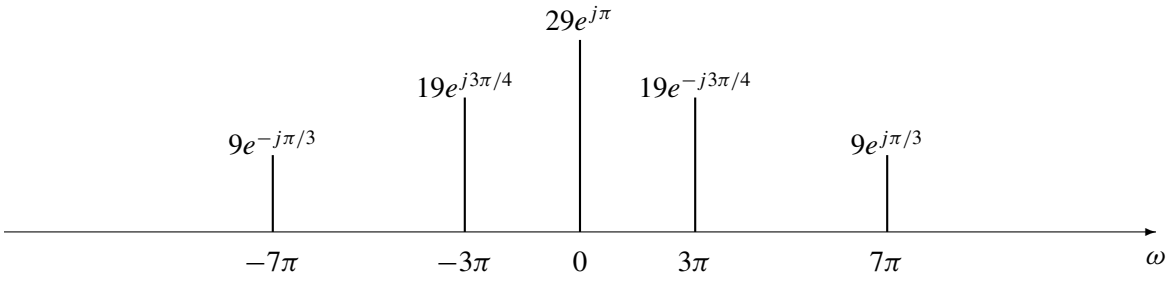
Determine the spectrum for each of the following signals. Give your answer as a plot.

(a) $x(t) = \cos^3(7\pi t) - 7$

(b) $y(t) = \cos^3(7\pi t)\sin(33\pi t)$

PROBLEM 3.3*:

A real signal $x(t)$ has the following two-sided spectrum:



(a) Write an equation for $x(t)$ as a sum of cosines.

(b) Plot the spectrum of the signal $y(t) = x(t - \frac{1}{2})$.

(c) Determine the period (in secs.) of the signal $z(t) = 8x(t - 1) + 13$.

PROBLEM 3.4*:

In AM radio, the transmitted signal is voice (or music) mixed with a *carrier signal.* The carrier is a sinusoid at the assigned broadcast frequency of the AM station. For example, WCNN in Atlanta has a *carrier frequency* of 680 kHz. If we use the notation $v(t)$ to denote the voice/music signal, then the actual transmitted signal for WCNN might be:

$$x(t) = (v(t) + A)\cos(2\pi(680 \times 10^3)t)$$

where A is a constant.
Note: The constant A is introduced to make the AM receiver design easier, in which case A must be chosen so that $(v(t) + A) > 0$.

(a) Voice-band signals tend to contain frequencies less than 4000 Hz (4 kHz). Suppose that $v(t)$ is a 3300 Hz sinusoid, $v(t) = \cos(2\pi(3300)t + 0.1\pi)$. Draw the spectrum for $v(t)$.

(b) Now draw the spectrum for $x(t)$, assuming a carrier frequency of 1000 kHz. Use $v(t)$ from part (a) and assume that $A = 2$. *Hint: Substitute for $v(t)$ and expand $x(t)$ into a sum of cosine terms of three different frequencies.*

PROBLEM 3.5*:

Signal Processing First, Chapter **3**, Problem **P-3.19**, page 69–70. (Match spectra to time signals)
Explain your answers by deriving the a time signal formula from each of the spectrum plots.