**EECS 210**
**Introduction to Electrical Engineering I**

Fall 2000

**Hwk Assignment 1**: Due Wed. Sept. 13, 2000

Reading:

1. Sections 16.1, 16.2 and 16.4 in your textbook.
2. Lab Lecture 1 which appears in your Lab Book.
3. Ch. 1 of EECS210 Additional Course Notes.
4. Chapter 1 of Appendix I(Matlab) which appears in your Lab Book.

Exercises:

1. Prove that for $A$ and $B$ positive

$$A\cos(t) + B\sin(t) = \sqrt{A^2 + B^2}\ \cos[t - \tan^{-1}(B/A)]$$

   Hint: $\cos(a-b) = \cos(a)\cos(b) + \sin(a)\sin(b)$.

2. Consider the following plot of a sinusoid.

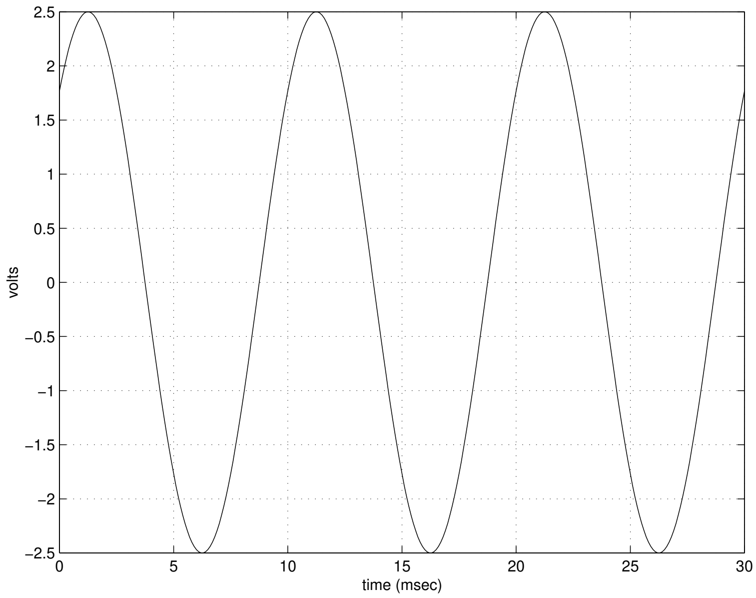


Figure 1:

   From the plot estimate the:

(a) period
(b) frequency
(c) phase
(d) peak amplitude
(e) peak-to-peak amplitude
(f) rms amplitude
(g) rms amplitude(relative to 1 V rms) in dBV.

3. Let $x(t)$ and $y(t)$ be the input and output, respectively, of a system. Assume that the following input/output relationship exists:

$$y(t) = x(t) - x(t-1)$$

(a) If $x(t) = A\cos(\omega_1 t + \theta)$ show that the output $y(t)$ can be written as $B\cos(\omega_2 t + \phi)$. Relate $B$, $\phi$ and $\omega_2$ to $A$, $\theta$ and $\omega_1$.
(b) Assume that the input $x(t)$ is periodic with period 4 and $x(t) = 1$ for $0 < t < 2$ and $x(t) = 0$ for $2 < t < 4$. Sketch $x(t)$ and $y(t)$.
(c) Comment on your results for parts (a) and (b).

4. Consider the following series

$$f_n(t) = \sum_{k=1}^{n} x_k(t)$$

where

$$x_k(t) = (-1)^{k+1}\frac{\sin(2\pi kt)}{k}$$

(a) Using Matlab compute and plot $f_1(t)$, $f_3(t)$, and $f_8(t)$ on the same graph using different line types for the three different functions. Also use legends, label the vertical axis "Signal(mV)", and the horizontal axis "Time (sec)". Include a copy of your program with your plot.
(b) What do you think $f_n(t)$ looks like for large $n$?

(Lab Question from A. Ganago) The period of a signal is defined as the minimal interval of time over which the signal repeats itself. Consider a signal produced with a telephone tone dialer, which is described in Lab 1 (see the Lab Book, Pre-Lab assignment for Experiment 1, p. 4). Such a signal consists of two sine waves at frequencies f1 and f2 (the magnitudes of f1 and f2 are determined by the chosen key). The signal repeats itself over any interval of time T such that

$$T = (n1/f1) = (n2/f2)$$

where both n1 and n2 are natural numbers (positive integers). The MINIMAL value of T is called the period (a signal which repeats itself every hour will repeat itself every week, but a week is not its period).

The signal of a tone dialer surely repeats itself over 1 second, because each of the sine waves has the frequency in Hz expressed as an integer number. However, 1 second is not the minimal interval of time over which the signal repeats itself, thus it is not the period of the tone dialer's signal. Determine the periods T6, T7, and T8 produced by the keys 6, 7, and 8, respectively.