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](image_url)

From the plot estimate the:
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 $x(t) = A \cos(\omega t + \theta)$ 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 $f_1(t)$, $f_2(t)$, and $f_3(t)$ 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 $f_1$ and $f_2$ (the magnitudes of $f_1$ and $f_2$ are determined by the chosen key). The signal repeats itself over any interval of time $T$ such that

$$T = \frac{n1}{f1} = \frac{n2}{f2}$$

where both $n_1$ and $n_2$ 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 $T_6$, $T_7$, and $T_8$ produced by the keys 6, 7, and 8, respectively.