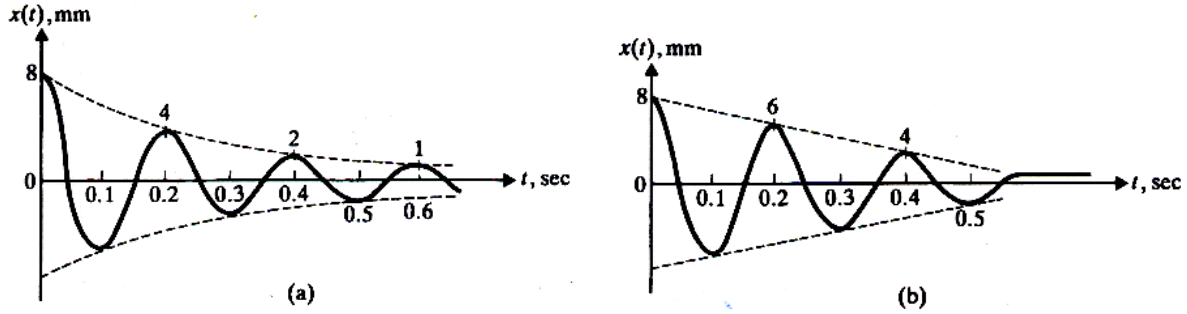
Homework for Lecture 5

Problem 5.1 – (modified from *Mechanical Vibrations* by Rao)
The free vibration response of an electric motor of weight 400 N mounted on different types of foundation are shown in figures (a) and (b) below.

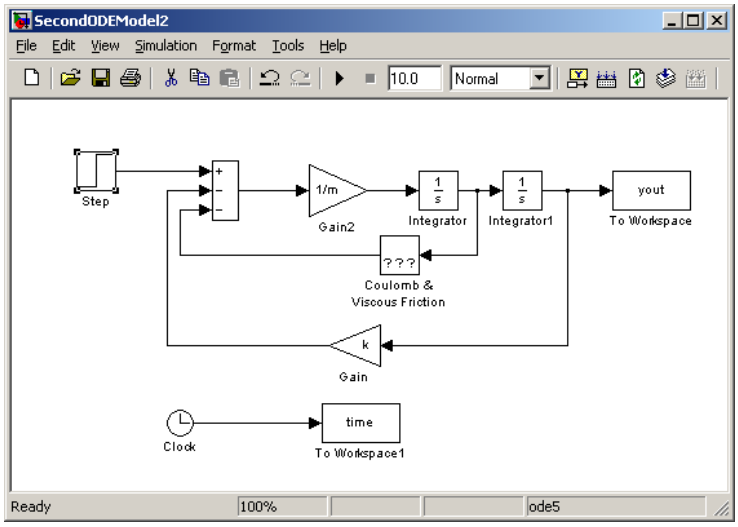


Identify the following in each case:

(i) The nature of damping provided by the foundations;

(ii) The spring stiffness and damping coefficient of the foundation, that is, the coefficient of kinetic friction if it has Coulomb damping and the viscous damping coefficient if the system has viscous damping.

(iii) Using Simulink and the parameters you determined in (ii) and (iii) create a model of each system. How does the response from Simulink compare to the responses given? You model should look the model given in class (shown below) except there is no step input (just set the input = 0) and you should have an initial conditions for the integrators.



Problem 5.2 - See next page.

Problem 5.2

As mentioned in class, one method of determining the type of damping is to plot the decay envelope using a semilog plot. A data file, data.mat, has been put on the web that contains the free response of two mechanical systems. The URL is:
http://www.rose-hulman.edu/~cornwell/courses/em406/homework/data.mat.

This data file contains three 10,000 element vectors: time, y1 and y2. One convenient way to determine the decay envelope is to use the Hilbert transform. For this problem, load the data into Matlab, apply a Hilbert transform to y1 and y2, plot the magnitude of the Hilbert transform on semilog axes and determine the type of damping. To be more specific, I would like the following plots:

1. y1 vs time and abs(h1) vs time (on the same plot)
2. y2 vs time and abs(h2) vs time (on the same plot)
3. abs(h1) vs. time for time = 1 to 7 seconds on semilog axes.
4. abs(h2) vs. time for time = 1 to 7 seconds on semilog axes.

Identify the type of damping for y1 and y2 and comment on your results. How good was the Hilbert transform at isolating the decay envelope? What problems did it have?

Hints: The following Matlab commands will be useful for this problem:

- "load data" – this will load the data file. Make sure that you are currently in the directory that has the data file.
- "h1 = hilbert(y1);" – this will take the Hilbert transform of y1 and put the result in h1. Note that h1 is a complex quantity which is why we need to use "abs(h1)" to obtain the magnitude.
- "plot(time,y1,time,abs(h1));" – this will plot y1 and abs(h1) versus time on the same plot.
- "semilogy(time(1001:7001),abs(h1(1001:7001));" – this will make a semilog plot of abs(h1) verses time for time = 1 to 7 seconds.