Due: Oct. 13 at beginning of class

Analyze the forced response of the pendulum. The forcing, as demonstrated in class, is the sinusoidal side to side movement of the attachment point.

Assume the lateral motion of the attachment point is of the form z = bcos(w t), where b is the maximum displacement and w is the frequency. The linearized dynamics about the equilibrium at theta = 0 are

dd(theta) + [c/(ml)] d(theta) + (g/l) theta = - (1/l) dd(z)

where d(theta) and dd(theta) denote the first and second derivatives of theta with respect to time.

1. Construct a physical pendulum. It can be as simple as the one I used in class, although a rigid rod would be preferable to an elastic one. Estimate the values of m, l and c and use these values in your calculations. l = length of the rod; m = mass of the pendulum bob;

c =damping coefficient

2. Determine the natural frequency and damping ratio of your pendulum.

3. Determine the general solution (homogeneous plus particular) for the linear pendulum model. You can use the result I gave in lecture if you know how to obtain it. If you don't know how to obtain it, this would be a good opportunity to learn how to.

4. Using the particular solution, construct the Bode plots theta (amplitude and phase angle as funtions of the forcing frequency w).

5. Experiment with forcing your pendulum at different frequencies and convince yourself that what you see corresponds to the predictions from the Bode plots.

6. If you move the attachment point according to

z = cos (w1 t) + cos (w2 t) + cos (w3 t),

where, relative to the natural frequency wn of the pendulum, w1 is much less than wn, w2 is close to wn, and w3 is greater than wn, describe qualitatively what the theta response will look like after the homogeneous solution has died out. Your answer should be based on theory not experiment.

Please turn in all your work except for your pendulum. Bring your pendulum to class if you want to show it off, but this is optional.