Sheet 6
Two Degree of Freedom Modal Analysis

1. Consider the system of Figure 1 consisting of two pendulums coupled by a spring. Determine the natural frequency and mode shapes. Plot the mode shapes as well as the solution to an initial condition consisting of the first mode shape for k = 20 N/m, l = 0.5 m and m1 = m2 = 10 kg, a = 0.1 m along the pendulum.

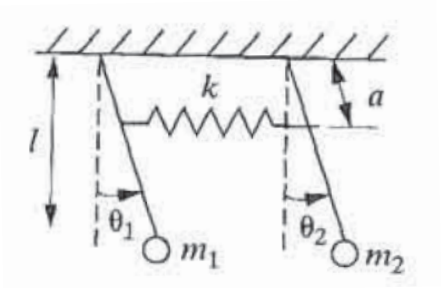

Figure 1. Two Pendulums of the same length connected by a spring used to model a machine part.

2. Find the response of the system shown in Figure 2 by modal analysis for the case where the rods have equal stiffness (i.e., $k_1 = k_2$), $J_1 = 3J_2$, and the initial conditions are $x(0) = [0\ 1]^T$ and $\dot{x}(0) = 0$.

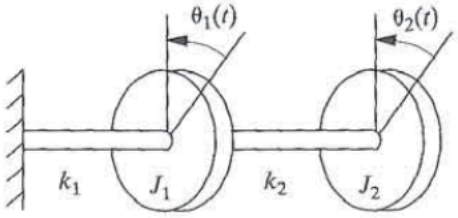

Figure 2.

3. A slightly more sophisticated model of a vehicle suspension system is given in Figure 3 Calculate the natural frequencies for k1 =103 N/m, k2 = 104 N/m, m2 = 50 kg, and m1 = 2000 kg. Suppose that the tire hits a bump which corresponds to an initial condition of x(0) =[0 0.01]T and $\dot{x}(0) = 0$. Use modal analysis to calculate the response of the car x1(t). Plot the response for three cycles.

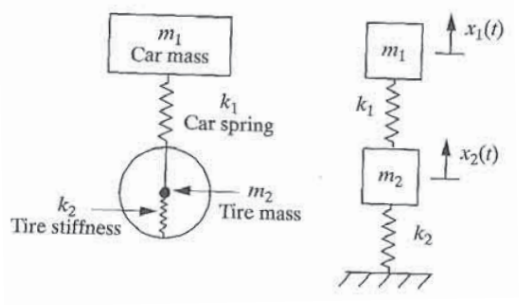

Figure 3.