ME 318 – Summer 2013 – Homework 8

1. Find the eigenvalues and eigenvectors for the system below.

![Diagram of a two-mass system with spring connections]

2. Find the natural frequencies and mode shapes for the system below.

![Diagram of a three-mass system with spring connections]

3. Complete the analysis of the first example worked in this section on the eigenvalue problem. Find the modal matrix, the weighted modal matrix, the generalized masses, the initial conditions in principal coordinates, and \(x_1(t)\) and \(x_2(t)\), using the procedure laid out in Thompson with the coordinate transformation. Use for the initial conditions, \(x_1(0) = 0\) and \(x_2(0) = 3^\circ\). Beware of units! This is the problem that is like 1 above except that the masses are both \(1/3 \text{ lb} \cdot \text{s}^2/\text{ft}\) and \(k_{12} = k_2 = 60 \text{ lb/ft}\) (the left-hand mass is connected through a spring to a wall).

4. For the coupled pendulum experiment in the lab, find the eigenvalues and eigenvectors. Use \(k = 4 \text{ N/m}\), \(m = 0.612 \text{ kg}\), \(\ell = 0.76 \text{ m}\), \(a = \ell/2\), \(g = 9.81 \text{ m/sec}^2\).

![Diagram of a coupled pendulum system]

The equations of motion for this system are

\[
m \cdot l^2 \cdot \ddot{\theta}_1 + m \cdot g \cdot l \cdot \theta_1 + k \cdot a^2 \cdot (\theta_1 - \theta_2) = 0
\]

\[
m \cdot l^2 \cdot \ddot{\theta}_2 + m \cdot g \cdot l \cdot \theta_2 - k \cdot a^2 \cdot (\theta_1 - \theta_2) = 0
\]