CE 573 – Structural Dynamics
Homework #9
due 13 November 2009, Friday, 1:30pm

1) Prove that for a general stiffness, general mass 2-story structure (i.e., one with k_1, k_2, m_1, m_2 as the story stiffnesses and masses) the cross-coordinate (i.e., off-diagonal) inertia and stiffness coefficients in the modal space are zero.

2) For the 2-story building with fixed foundation conditions as shown below:

    a. Determine the natural vibration frequencies and modes; express the frequencies in terms of *m*, *E I*, and *h*.

    b. Verify that the modes satisfy the orthogonality properties.

    c. Normalize each mode so that the roof displacement is unity. Sketch the modes and identify the associated natural frequencies.

    d. Normalize each mode so that the modal mass matrix is a unity (identity) matrix. Compare these modes with those obtained in part (c) and comment on the differences.

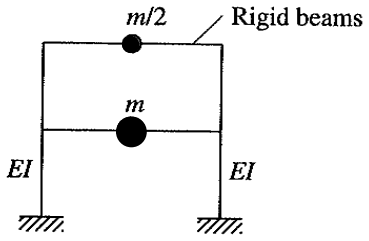
    e. Consider the following two cases:

        i. a constant force F_o is applied at first floor level quasi-statically to give an initial displaced shape, and the force is removed to start free-vibration response;

        ii. a constant force F_o is applied at second floor level quasi-statically to give an initial displaced shape, and the force is removed to start free-vibration response.

    In which case the relative contribution of the first mode to the total response is greater?

    f. Assume that the structure was turned sideways and gravity is turned on (quasi-statically). What would be the displacements?



3) The structure in problem 2 is modified so that the columns <u>are pinned at the foundation level</u>.

    a. Determine the natural vibration frequencies and modes of the modified system. Compare them with the vibration properties of the original "fixed-based" structure in problem 2. Comment on the effect of the support condition on the vibration properties.

    b. Assume that the structure was turned sideways and gravity is turned on (quasi-statically). What would be the displacements? Compare your findings with those from problem 2, part f?