Math 2250–4
Earthquake project
Due April 22, 2011

Your assignment is to first carefully (and slowly) read pages 444–445 of your text, for the section 7.4 application. Understand the derivation and discussion for the seven story shaking building. I've posted some further explanation of "inertial force" discussion leading to acceleration term

$$E \cdot \omega^2 \cdot \cos(\omega \cdot t) \cdot [1, 1, 1, 1, 1, 1, 1]^T$$

in equation (2) page 445, on our homework page.

There are four warm–up problems at the end of pages 444–445, which you are not required to do. Instead, we will focus on the paragraph immediately preceding those problems, which I reproduce here for your convenience:

For your personal seven–story building to investigate, let the weight (in tons) of each story equal the largest digit of your student ID number and let k (in tons/ft) equal the smallest nonzero digit. Produce numercial and graphical results like those illustrated in Figs. 7.4.17 and 7.4.18. Is your building susceptible to likely damage from and earthquake with period in the 2– to 3– second range?

I've broken your assignment into 6 steps. You should hand in a hard copy which has been titled, includes your name and UID, and which answers each step mathematically and with explanations as appropriate. I recommend starting with this Maple document, quakeproj.mw, and modifying it....recall you can insert Math fields by inserting the math prompts [> from the menu bar, and enter multi–line commands by holding down the shift key while you hit the return/enter key.

There is helpful **sample code** related to every problem below, in the Maple notes I wrote for Friday April 15. These notes are linked from our lecture page and homework page, and you can download them using the "open URL" option under the "File" menu item. Or you might be able to use the URL directly:

> http://www.math.utah.edu/~korevaar/2250spring11/apr15maple.mw

1) Use your student number to construct your building, following the directions in the paragraph I copied from the text. Deduce the mass of each floor (in slugs), and then use Maple define the mass and spring constant values for your building.

2) Define the "A" matrix as in equation (1) page 444. One way to do this is to define the mass matrix M for this system, the spring constant matrix K, and define "A" as the inverse of M times K...or you can work out the values in the *A* matrix by hand. Use $32 \, \dfrac{ft}{\sec^2}$ for the acceleration of gravity, rather than any more accurate decimal approximation. This way your *A* matrix will have fraction or integer (rather than floating point decimal) entries.

3) Find the natural angular frequencies (the omegas) for your seven story building, as well as the corresponding periods. Make sure to leave the original Maple commands and output in your file, so we can check your work! Exhibit this data in a table like figure 7.4.17 on page 444. (Maple can make tables.)

4) Study practical resonance as we did in class, i.e. by studying the (undetermined coefficients) particular solution to (2), page 445, for your building. (This is NOT exactly the same equation we studied on April 15, or in the text pages 440–441, but it's close. So you won't be using exactly the same commands.) Choose forcing amplitude $E = 3$ *inches* in Equation (2) page 445. For the given earthquake wave angular frequency ω find the vector $c(\omega)$ amplitudes so that $c(\omega) \cdot \cos(\omega \cdot t)$ solves equation (2). Do not display the very complicated and long formulas for $c(\omega)$ when you hand in your project report.

5) Create an approximate resonance picture like Figure 7.4.18, for your building. Note that in this graph you are to compute the maximal amplitude of the **c**–vector as a function of period, not of angular frequency.

6) Is your particular building susceptible to likely damage from an earthquake having its period in the 2 to 3 second range? Explain.