

CE 573 – Structural Dynamics

Homework #6

due 23 October 2009, Friday, 1:30pm

- 1) On 17 January 1994, a magnitude 6.7 earthquake hit the Los Angeles metropolitan area. The epicenter of the earthquake was in Northridge, CA.

As engineers, you are asked to comment on the “destructiveness” of the Northridge earthquake based on one of the ground acceleration records obtained near the Olive View Hospital in Sylmar, CA. The ground motion data is on the CE573 website (<http://cobweb.ecn.purdue.edu/~ce573>).

Your assignment is to prepare a technical memo to summarize your opinion about the shaking at the Sylmar station.

- Graph acceleration, and estimated velocity and displacement time-histories experienced at the Sylmar station.
- To guesstimate how various structures with different periods and damping ratios around that station e might have responded to the ground shaking, find and graph the response spectra (absolute acceleration, relative velocity, and relative displacement) for the Sylmar record.

Specifically, generate the response spectra curves using spectrum points at eight periods, namely, 0.1 sec, 0.2 sec, 0.4 sec, 0.5 sec, 1 sec, 2 sec, 3 sec, and 4 sec and with two damping ratios, 2% and 5% of the critical. Plot the 2% and 5% results on the same graph for each type of spectra so that you can compare the effect of damping.

Please use your numerical solution approach from Homeworks #1 (you can update it with Newmark- β method, if you like). You may want to compare your results with those from linear spectrum generator programs such as BiSpec or Phantom2. Course website has links to both programs.

- Using Sd (spectral displacement spectra) data from part b) generate the PSv (pseudo-velocity response spectra) and PSa (pseudo-acceleration response spectra) graphs. Compare with Sv and Sa graphs.
 - Summarize your observations. What kind of structures do you think would have had the worst shaking and possibly worst performance?
- 2) An undamped SDOF system with natural period T_n is excited by a periodic external force $f(t)$ with period T_o and amplitude f_o , as shown below.
- Express the forcing function as a Fourier series.
 - Find the steady-state displacement response of the system. For what value(s) of T_o does the response become unbounded?
 - For $T_o/T_n = 2$, determine and graph the displacement response to individual terms in the Fourier series.
 - How many terms are necessary to obtain reasonable convergence of the series solution?

