03/31/07 CIVL-558 Earthquake And Wind Engineering - CJ Roberts
Homework Assignment #3

3.1) A building has been determined to have a damped natural frequency of 1.0 Hz and damping of 5.0% of critical. The structure responds with free vibrations to the initial conditions shown below. Plot approximately the first three cycles of the structure's displacement response, x(t).

xo = 1.0 in.
vo = 5.0 in./sec.

Free Vibrations Response to Initial Conditions for x(t)

$$x = Ae^{-\xi\omega\tau}\cos(\omega\delta\tau - \phi)$$

$A = (C1^2 + C2^2)^{\wedge}1/2$

$\phi =$ arctan(C2/C1)

C1 = xo (given)

$C2 = (vo + \xi\omega\, xo)/\omega\delta$

find: $\omega\delta$, ω fd = 1.0 Hz (given)

$\omega\delta = 2\pi fd =$ 6.283 rad/sec

$\omega = \omega\delta/\sqrt{(1-\xi^2)}$ where; $\xi =$ 0.05 (given)

$\omega =$ 6.291 rad/sec

calc: C2 C2 = 0.8458

calc: A A = 1.3097

calc: ϕ $\phi =$ 0.7021

Using the equation for x(t) and a spreadsheet, plot the results for the equation for values of t ranging from 1 to 4 seconds at 0.01 second intervals. As a check, find x(t) at t = 0.

x = 1.0000