Civil Engineering
USC

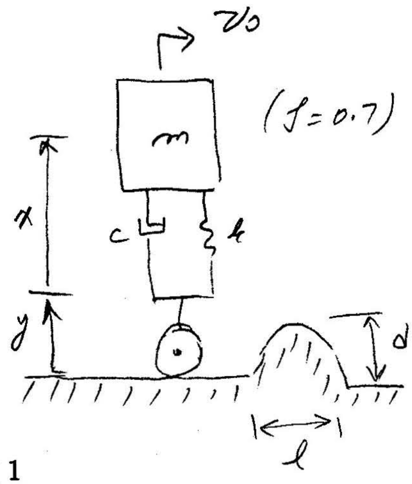
CE 541a - Computer Assignment No. 2

Use your computer program from assignment No. 1 to investigate the following problems:

1. Compute and plot the *free-vibration* response of a SDOF system with $\omega_n = 2\pi$ rad/s, $\zeta = 0.05$ and initial conditions $x(0) = 0$ and $\dot{x}(0) = -1$. Use a time step of DT = 0.05 and a total simulation time TMAX = 3.0.

2. Use the numbers generated above in 1 as "experimental data" to estimate the value of ζ from the "Log Decrement" method.

3. A SDOF model of a car traveling over a bump in a parking lot is shown. The model is governed by the equation:



$$\ddot{x} + 2\zeta\omega_n\dot{x} + \omega_n^2 x = -\ddot{y}(t)$$

where

$$\ddot{y}(t) = \begin{cases} -d(\frac{\pi\nu_o}{\ell})^2\sin(\frac{\pi\nu_o t}{\ell}) & ;\nu_o t \le \ell \\ 0 & \nu_o t > \ell \end{cases}$$

and where ν_o = velocity of the car.

In terms of the nondimensional variables:

$$\bar{x} \equiv \frac{x}{d} \qquad \text{and} \qquad \tau \equiv \frac{\nu_o t}{\ell}$$

we obtain

$$\frac{d^2\bar{x}}{d\tau^2} + 2\zeta\bar{\omega}_n\frac{d\bar{x}}{d\tau} + \bar{\omega}_n^2\bar{x} = \begin{cases} \pi^2\sin(\pi\tau) & ;0 \le \tau \le 1 \\ 0 & ;\tau > 1 \end{cases}$$

where

$$\bar{\omega}_n \equiv (\frac{\omega_n \ell}{\nu_o}).$$

The appropriate initial conditions are $\bar{x}(0) = \frac{d\bar{x}}{d\tau}(0) = 0$.

By computing the response of the system for various $\bar{\omega}_n$ values, determine the optimal speed ν_o which minimizes each of the following (also determine the corresponding minimum values):

1. peak deformation $\bar{x}$ during the motion
2. peak absolute acceleration $\frac{(\ddot{x}+\ddot{y})}{d\omega_n^2} = -(\bar{x} + \frac{2\zeta}{\bar{\omega}_n}\frac{d\bar{x}}{d\tau})$
3. peak absolute displacement $\bar{x} + \bar{y}$

Present your results in the form of graphs of peak values vs. $\bar{\omega}_n$. Explain the physical significance of each curve.

(Caution: In your investigation, be careful of the effects of different step size Δt on the accuracy of the solution).