ME 460/660, Mechanical Vibration   Exam 1, Spring 2002

Closed book, closed notes. Test booklets will be provided. Formula sheet from web must be turned in with exam.

1. Obtain the natural frequency, ω_n, damping ratio, ζ, and the damped natural frequency, ω_d for the following system:: $100\ddot{x} + 5\dot{x} + 10000x = 0$ where $x_0 = 1$ and $v_0 = 0$.

2. Prolonged exposure to 5×10^{-4} g floor oscillation (or above) is deemed intolerable for comfort. If the amplitude of the velocity is $0.01m/s^2$, what frequency of the motion would cause discomfort $(g = 9.8m/s^2)$?

3. Estimate the damping ratio of the system with the response shown below using log decrement:

4. Derive the equation of motion of the system shown below using Lagrange's equation. Assume no damping, and don't forget to include gravity. Assume no damping or other energy loss mechanisms.
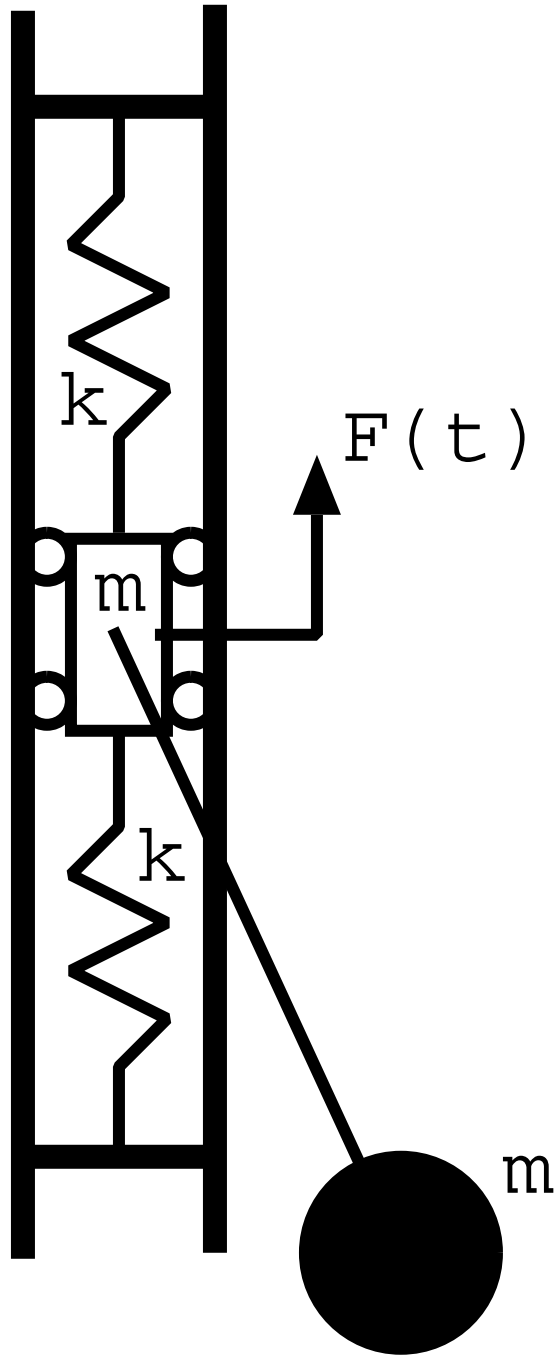
5. *Grad student/bonus* Determine the natural frequencies and mode shapes for a clamped-free bar. The equation of motion of a bar is $\left(\frac{E}{\rho}\right)\frac{\partial^2 w(x,t)}{\partial x^2} = \frac{\partial^2 w(x,t)}{\partial t^2}$. (20% of other points)