ME 460/660, Mechanical Vibration — Midterm, Fall 2006

Closed book, closed notes. Test booklets will be provided. Formula sheet must be turned in with the exam. Formula sheet must be exactly the same as that posted on the web site. Problem 5 is required for graduate students.

1. A person sitting on the earth in a gravitational field is subject to a vibration test in which the amplitude of vibration is ± 0.25g with frequencies ranging from 2.4-9.5 Hz. Their ability to complete an assigned visual task accurately was worst at 3.4 Hz and 4.8Hz, but the time to completion was worst at 4.8 Hz.[1]

   (a) What was the maximum displacement amplitude the person was subjected to?

   (b) What was the displacement amplitude corresponding to the worst performance?

2. A linear system is governed by the following equation of motion:

$$m\ddot{x} + c\dot{x} + kx = ky + c\dot{y}$$

   where $y(t) = Y\sin(\omega_b t)$. Given $m = 10$kg, $c = 0.01$kg/s, and $k = 10,000$kg/s^2.

   (a) Sketch the FRF $\frac{X(j\omega)}{Y(j\omega)}$ for $0 < \frac{\omega_b}{\omega_n} < 3$. Use decibels ($20\log_{10}$) for the magnitude. *label limit values*

   (b) Fill in the following table (*beware of units!*):

Y (m)	f_b (Hz)	$\lvert X\rvert$ (m)	$\measuredangle X$ (deg)
10	10		
2	33		
1	64		

3. The log decrement value determined from test results shows values of 0.01 for high amplitudes, 0.015 for moderate amplitudes, and 0.02 at low amplitudes.

   (a) What can be concluded decisively about the damping in the system?

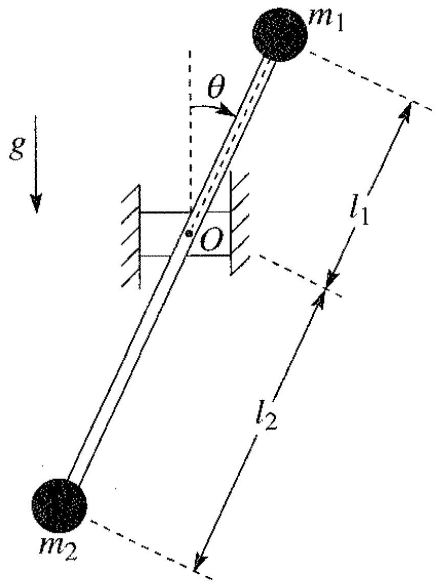
   (b) What is the most likely reasonable cause for this result?

4. For the system following

   (a) determine the equation of motion in terms of θ.

   (b) determine the natural frequency.

[1] (Guignard and Living, 1960- p314 Bioastronautics data book)



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)