Student Code Number:_____

Ph.D. Qualifying Exam

Dynamics and Vibrations

January, 2007

B. F. Feeny and A. G. Haddow

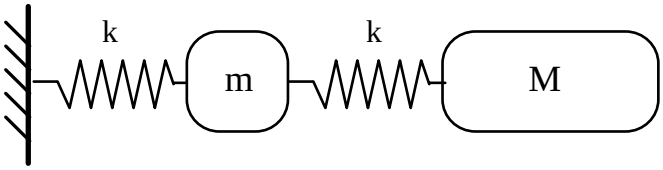
<u>Directions</u>: Work all four problems.
Note that the problems are EVENLY WEIGHTED.
You may use two books and two pages of notes for reference.

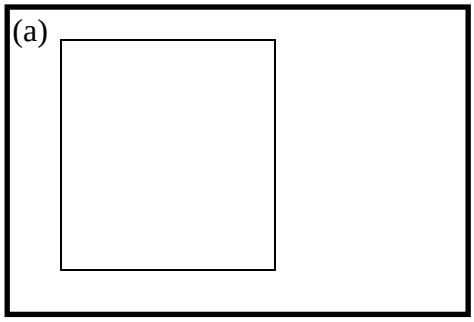
1. A sensitive instrument of mass 5 kg is mounted on a spring to help isolate it from the table it is mounted on (see below). Measurements indicate that the table vibrates sinusoidally with a maximum amplitude of 0.4 mm somewhere in the frequency range of 20 to 30 Hz. Determine the spring constant, *k*, so that the amplitude of the vibration of the instrument will be limited to 0.02mm over the frequency range indicated. State and justify any simplifying assumptions.

2. NOTE you do not have to complete a detailed mathematical analysis of this problem to answer either part of this question, but you may do so if it will help you.

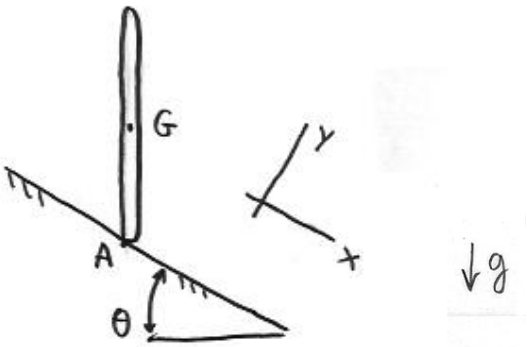
A two degree of freedom system has two masses *m* and *M*, as shown below.

(a) What are the two natural frequencies of the system if the mass *M* is extremely large compared to *m*? Justify your answer.
(b) Discuss the physical interpretation of the motion of the system if the only non zero initial condition is that the large mass *M* has an initial velocity. *M* is assumed to be very large compared to *m*.





3. A bar of length L and mass m is in a vertical position, with its lower end (point A) in contact with an inclined plane at an angle θ. The bar is released from rest. Find the angular acceleration of the bar at the instant of release for the case of $\theta = 45^{o}$. (Note that the bar slides without friction on the incline.) Use $I_G = \frac{1}{12}mL^2$ for the bar.



4. A particle of mass *m* is at rest, spring loaded in a launch tube. The linear spring constant is *k* = 2000 N/m and the deformation is δ = 0.2 m. The particle is released and travels without friction before it meets the end of a uniform slender rod of mass *m* and length *L* pinned at point O and initially at rest. On impact, the particle sticks to the end of the rod. How much energy is lost when the particle meets the rod? Neglect gravity (horizontal plane), and note that the rod is free to rotate about the fixed axis at O.