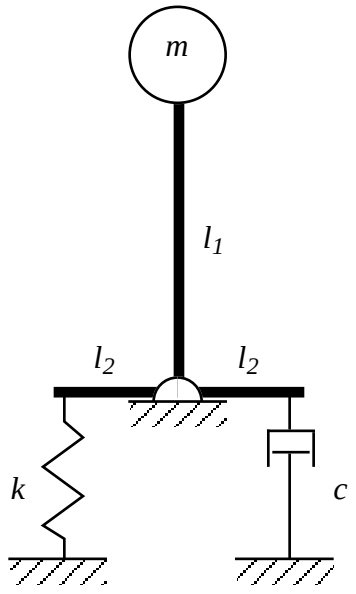
ME 460/660, Mechanical Vibration — Exam 2, Fall 1999

Closed book, closed notes. Use one $8\frac{1}{2} \times 11$ formula sheet, front and back. Test books will be provided.

1. Determine the Fourier Series representation of the function shown below. (25 points)

2. Derive the equation of motion of the inverted pendulum-like system shown below. The system is comprised of two massless rigid bars welded together in an inverted "T" formation pinned at the bottom center. The mass of the spherical ball is $m = 10$ kg, the dashpot coefficient is $c = 1$ kg/sec, and the spring's stiffness is given by $k = 100$ N/m. The lengths are $l_1 = 1$ m and $l_2 = .2$ m. (25 points)



3. A system is governed by the equation $m\ddot{x} + c\dot{x} + kx = c\dot{y}$. Find the frequency response function $\frac{X(j\omega)}{Y(j\omega)}$. Sketch the frequency response function showing the what happens for low, medium and high values of r, and for low and high values of ζ. (25 points)

4. A vibrating mass of 300 kg, mounted on a massless support by a spring of stiffness 40,000 N/m and a damper of unknown damping coefficient, is observed to vibrate with a 100-mm amplitude while the support vibration has a maximum amplitude of only 2.5 mm at resonance. (25 points)

   (a) Calculate the damping coefficient approximately.

   (b) Calculate the force on the base.

5. *Grad student/bonus* Determine the natural frequencies and mode shapes for a clamped-clamped 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)