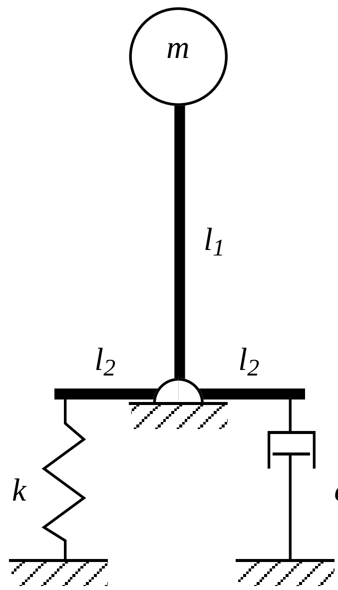
ME 460/660, Mechanical Vibration — Exam 2, Fall 1997

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.

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 $m\ddot{x} + c\dot{x} + kx = F\sin(\omega_{dr}t)$. At what frequency/ies will the system oscillate? Assuming $c > 0$, will there be a time after which, for all practical purposes, your answer would change? Why or why not? (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. Consider a system with rotating unbalance. The deflection at resonance is 0.05 m, and the damping ratio is measured to be $\zeta = 0.01$. The unbalance is estimated to be 10% of the total mass. Estimate the location of the unbalance e. (25 points)

BONUS: By applying the principle of impulse and momentum, the effect of a single impulse on a system can be represented instead as what (in two words)? (10 points)