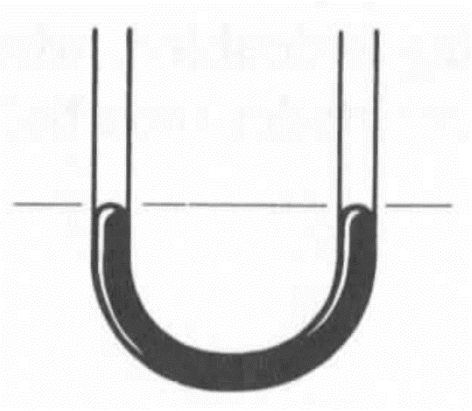
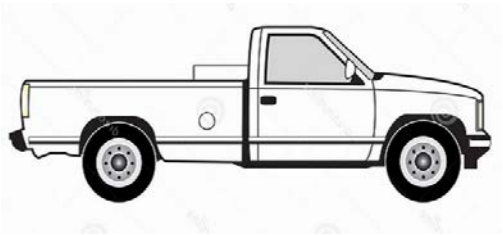
MECH 463 -- Homework 2

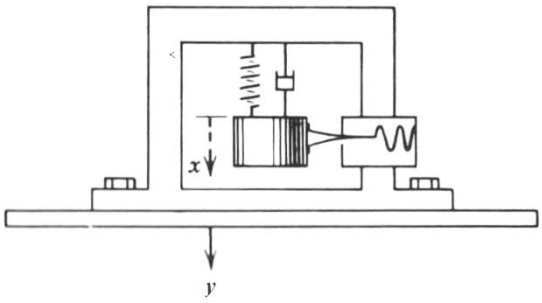
1. A manometer tube 15mm in diameter is filled with oil to a length ℓ = 250mm. The specific gravity of the oil is 0.8 and its dynamic viscosity μ is 0.035 Pa.s. When the oil is displaced from its equilibrium position it oscillates with decaying amplitude. Determine the equivalent quantities m, c and k for the oil in the manometer and hence determine the damping factor ζ and damped natural frequency ω_d. *(Hint: Poisseuille's Law for the steady-state flow through a circular tube is* $v_{avg} = \Delta p\, A / (8\pi\mu\ell)$*, where* Δp *is the pressure differential across the length of the liquid).*



2. A student of mass 75kg stepped onto the back of a small pickup truck, causing a steady state displacement of the truck body of 2.5cm. The student then stepped off and the truck body started to oscillate with a frequency of 1.0Hz around the original position it had before the student stepped on. The first overshoot (in the opposite direction of the 2.5cm) was measured to be 1.5cm. What are the equivalent quantities m, c and k for the truck body ? *(Hint: the logarithmic decrement concept may be useful).*



3. The seismic vibrometer schematically shown in the diagram has a mass m = 1 kg, a spring of stiffness k = 2 N/m and a damper that provides a damping factor ζ = 0.1. An earthquake occurs where the dominant frequency of vibration is 0.5Hz. If the peak-to-peak vibration indicated by the vibrometer is 10mm, what is the peak-to-peak vibration of the ground ?



4. A machine of total mass M contains a rotor of mass m and eccentricity e. It is supported on springs of combined stiffness k and has a damper of rate c. Derive a formula for the vibration response of the machine as a function of rotation frequency.