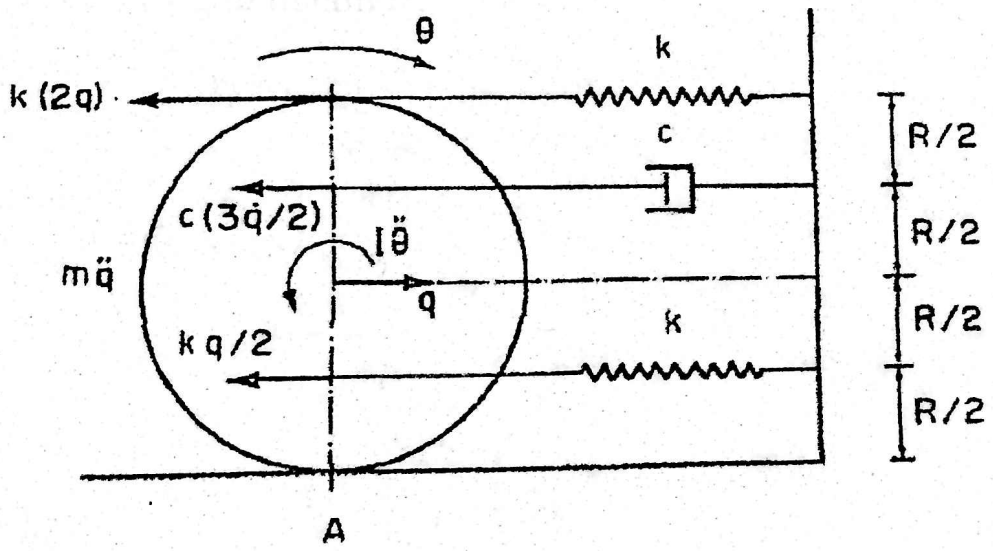
# MAE 576 MIDTERM 1, FALL 2014

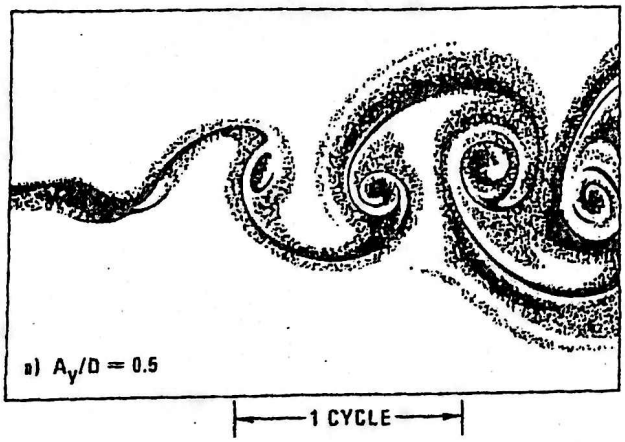
1) The disk shown has a total mass m distributed uniformly throughout. It contacts the point A on the flat surface without slipping. Assuming small displacements: a) write the equation of motion for the disk, b) neglect damping and calculate the circular frequency of the system in terms of k, and m c) for c=0.1, calculate damping ratio, damped frequency, logarithmic decrement, and amplitude ratio after 5 cycles of free vibrations ($I=mR^2/2$)

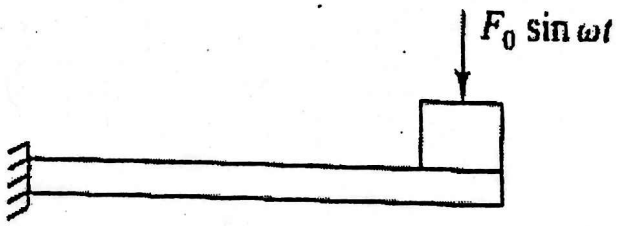


2) It is proposed to build a 6-m smokestack on the top of a 60-m factory. The smokestack will be made of steel ($\rho$=7850kg/m$^3$) and will have an inner radius of 40cm and an outer radius of 45cm. a) What is the maximum amplitude of vibration due to vortex shedding and at what wind speed will it occur b) What is the **steady state** amplitude of oscillation due to vortex shedding of the smokestack if the wind speed is 22mph?

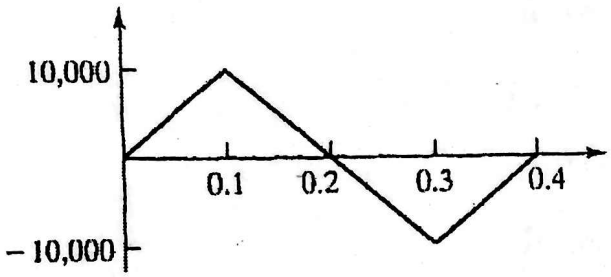
Use a one degree of freedom model for the smokestack with a concentrated mass at its end to account for inertia effects. Use $\zeta$=0.05. Just model the stack as a beam with a concentrated mass at the end, with a force applied at the end in the form of $F_o$Sin($\omega$t). Use the following to obtain $F_o$.

$C_d = Fo/(0.5\ \rho\ v^2\ D\ L)$ $C_d$ = drag coefficient = 1.0
$S= \omega D/(2\pi v)$ S= Strouhal number = 0.2
D=diameter
L=length of smokestack.



3) During operation a 100 kg press is subjected to the periodic excitations shown. The press is mounted on an elastic foundation of stiffness 1.6x105 N/m and damping ratio 0.2. Determine the steady-state response of the press and approximate its maximum displacement from equilibrium. Each excitation is shown over one period.



4) A vehicle traveling over a bridge is idealized by the system shown in the figure below. The bridge profile irregularities are represented by a sine function. Assuming that the vehicle travels with a uniform velocity V=constant, calculate the response q(t) and the force transmitted to the vehicle. Also calculate the steady-state vertical motion of the vehicle using the following numerical data:

$$W = 20 \text{ kN}$$

$$k = 2500 \text{ N/cm}$$

$$y_0 = 3 \text{ cm}$$

$$L = 12 \text{ m}$$

$$V = 70 \text{ km/h}$$

$$\zeta = 40\% \text{ of critical damping}$$