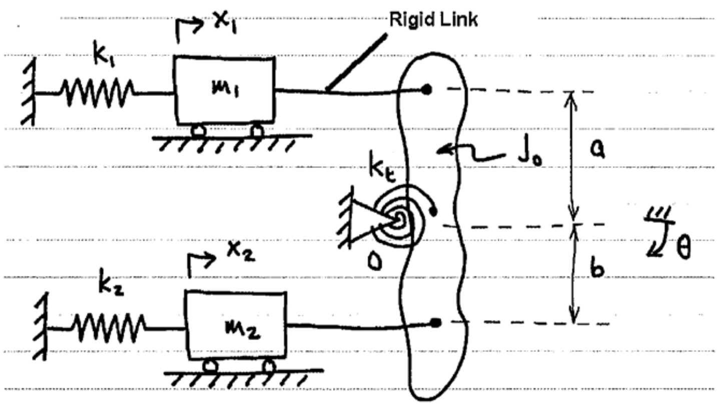
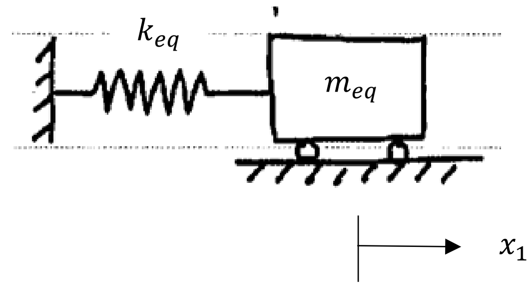
ME 370.1 Fall 2018 Name(s)

Homework 3
Due: *In class*, Friday 9/14

1. (10 pts) Examine the 1DOF system shown below. It may be reduced to a mass-spring model located at the location of m_1 as shown to the right of the system.





The equivalent mass, m_{eq}, of the model is given by:

a) $m_{eq} = m_1 + J_o + m_2$

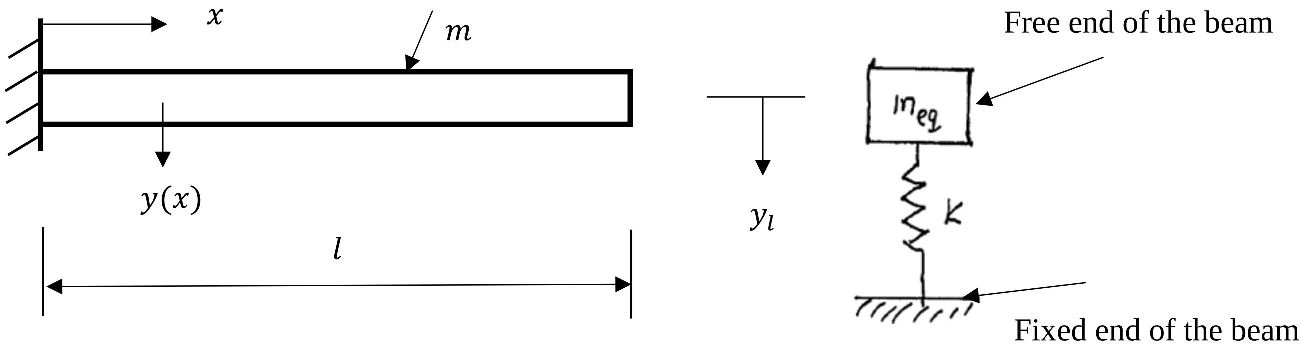
b) $m_{eq} = m_1 + \frac{J_o}{a} + \frac{b}{a} m_2$

c) $m_{eq} = m_1 + \frac{J_o}{b} + \frac{a}{b} m_2$

d) $m_{eq} = m_1 + \frac{J_o}{a^2} + \frac{b^2}{a^2} m_2$

e) $m_{eq} = m_1 + \frac{J_o}{b^2} + \frac{a^2}{b^2} m_2$

2. (10 pts) Consider a uniform-cross-section cantilever beam of mass m and length l shown below:



The shape of the beam deflection, $y(x)$, under a static downward force at the free end may be expressed in terms of its deflection displacement at the free end, y_l, by the following equation:

$$y(x) = \frac{3lx^2 - x^3}{2l^3} y_l$$

The beam may be approximated by a mass-spring model shown to the right of the beam. The equivalent mass, m_{eq}, of the model is given by:

a) $m_{eq} = 0.123m$

b) $m_{eq} = 0.236m$

c) $m_{eq} = 0.344m$

d) $m_{eq} = 0.457m$

e) $m_{eq} = 0.529m$

3. (14 pts) Refer to the figure below of three torsional dampers on geared shafts. The gear on shaft 1 has n_1 teeth, the gear on shaft 2 has n_2 teeth, and the gear on shaft 3 has n_3 teeth. Let $\omega_1, \omega_2, \omega_3$ be the angular velocities of the three shafts and J_1, J_2, J_3 be the moments of inertia of the three rotating bodies. The system may be modeled as one inertia and one torsional damper (J_{eq} and C_{eq}) located at the third shaft (ie. shaft with n_3 and c_{t_3}).

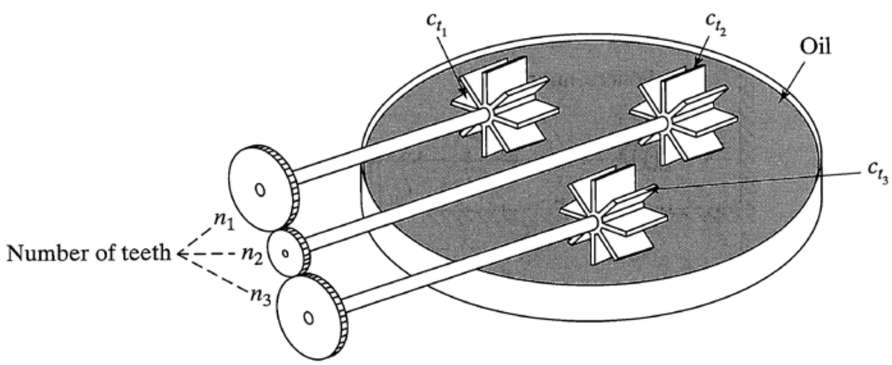


FIGURE 1.82 Dampers located on geared shafts.

(1) (2 pts) The angular velocity of shaft 3 is related to the angular velocity of shaft 1 by

a) $\omega_3 = (n_1 / n_3)\omega_1$

b) $\omega_3 = (n_3 / n_1)\omega_1$

c) $\omega_3 = (n_1 / n_3)^2 \omega_1$

d) $\omega_3 = (n_3 / n_1)^2 \omega_1$

(2) (5 pts) The inertia of the model is

a) $J_{eq} = (J_1 + J_2 + J_3)/3$

b) $J_{eq} = 3(J_1 + J_2 + J_3)$

c) $J_{eq} = \left(\frac{n_3}{n_1}J_1 + \frac{n_3}{n_2}J_2 + J_3\right)$

d) $J_{eq} = \left(\frac{n_3}{n_1}J_1^2 + \frac{n_3}{n_2}J_2^2 + J_3^2\right)^{1/2}$

e) $J_{eq} = \left(\frac{n_3^2}{n_1^2}J_1 + \frac{n_3^2}{n_2^2}J_2 + J_3\right)$

f) $J_{eq} = \left(\frac{n_3^2}{n_1^2}J_1^2 + \frac{n_3^2}{n_2^2}J_2^2 + J_3^2\right)^{1/2}$

(3) (7 pts) Use the energy method to determine the damping constant of the model, C_{eq}. Show essential work to receive credits.