1. (10 pts) For the geometric model given below, $K_i$ and $C_i$ are torsional spring and torsional damper connected to the center of the disk and $k_1$ is a translation spring connected to the disk peripheral.

The governing equation of the system is

a) $J\ddot{\theta} = C_i \dot{\theta} + 2(K_i + R^2 k_1)\theta$

b) $J\ddot{\theta} = C_i \dot{\theta} + (K_i + R^2 k_1)\theta$

c) $(J + mR^2)\ddot{\theta} + C_i \dot{\theta} + (K_i + R^2 k_1)\theta = 0$

d) $J\ddot{\theta} + C_i \dot{\theta} + 2(K_i / R^2 + k_1)\theta = 0$

e) $J\ddot{\theta} + C_i \dot{\theta} + (K_i + R^2 k_1)\theta = 0$

f) $J\ddot{\theta} + C_i \dot{\theta} + 2(K_i + R^2 k_1)\theta = 0$
2. (10 pts) Refer to the geometric model below. The pivoted L-shaped bar is rigid and massless and the two point masses $m_1$ and $m_2$ are welded to the bar. The motion is small and the gravity is not considered.

(1)(2 pts) The moment of inertia of the mass-bar structure with respect to the pivot is

a) $J = m_1 b^2 + m_2 a^2$

b) $J = m_1 d^2 + m_2 a^2$

c) $J = m_1 (b + d) + m_2 a$

d) $J = m_1 (b + d)^2 + m_2 a^2$

e) $J = m_1 (b^2 + d^2)^{1/2} + m_2 a$

f) $J = m_1 (b^2 + d^2) + m_2 a^2$

(2)(8 pts) The governing equation of the system with variable $x$ is

a) $\left(\frac{b^2 + d^2}{a^2} m_1 + m_2\right) \ddot{x} + c\dot{x} + kx = 0$

b) $\left(\frac{b^2 + d^2}{a^2} m_1 + m_2\right) \ddot{x} + \frac{a^2}{b^2 + d^2} \ddot{c}x + \frac{a^2}{b^2 + d^2} kx = 0$

c) $\left(\frac{(b + d)^2}{a^2} m_1 + m_2\right) \ddot{x} + \frac{a^2}{(b + d)^2} \ddot{c}x + \frac{a^2}{(b + d)^2} kx = 0$

d) $\left(\frac{b + d}{a} m_1 + m_2\right) \ddot{x} + \frac{a}{b + d} \ddot{c}x + \frac{a}{b + d} kx = 0$

e) $\left(m_1 + \frac{a^2}{b^2 + d^2} m_2\right) \ddot{x} + c\dot{x} + kx = 0$

f) $\left(m_1 + \frac{b^2 + d^2}{a^2} m_2\right) \ddot{x} + c \left(\frac{a^2}{b^2 + d^2}\right) \ddot{x} + k - \frac{a^2}{b^2 + d^2} x = 0$
3. (20 pts) Examine the geometric model shown below.

(1) (2 pts) The moment of inertia of the disk about the contact point is

a) $J_{dc} = \frac{2}{5}mr^2$

b) $J_{dc} = \frac{1}{2}mr^2$

c) $J_{dc} = \frac{3}{2}mr^2$

d) $J_{dc} = \frac{2}{5}mr$

e) $J_{dc} = \frac{1}{2}mr$

f) $J_{dc} = \frac{3}{2}mr$
(2) (3 pts) The moment of inertia of the bar about its pivot is

a) \[ J_{bp} = \frac{1}{12} mL^2 \]

b) \[ J_{bp} = \frac{1}{9} mL^2 \]

c) \[ J_{bp} = \frac{1}{3} mL^2 \]

d) \[ J_{bp} = \frac{1}{12} mL \]

e) \[ J_{bp} = \frac{1}{9} mL \]

f) \[ J_{bp} = \frac{1}{3} mL \]

(3) (5 pts) A factor that relates the angular motion of the disk to the angular motion of the bar is

a) \[ \frac{L}{3r} \]

b) \[ \frac{L}{2r} \]

c) \[ \frac{2L}{3r} \]

d) \[ \frac{1}{3} \left( \frac{L}{r} \right)^2 \]

e) \[ \frac{1}{2} \left( \frac{L}{r} \right)^2 \]

f) \[ \frac{2}{3} \left( \frac{L}{r} \right)^2 \]
(4) (10 pts) The governing equation of the system in variable $x$ is

a) $m\ddot{x} + \left( \frac{5L^2 + 27r^2}{2L^2} \right) \dddot{x} + \left( \frac{7L^2 + 81r^2}{2L^2} \right) kx = 0$

b) $m\ddot{x} + 3 \frac{r}{L} \dddot{x} + 9 \frac{r}{L} kx = 0$

c) $m\ddot{x} + 3 \left( \frac{r}{L} \right)^2 \dddot{x} + 9 \left( \frac{r}{L} \right)^2 kx = 0$

d) $m\ddot{x} + \frac{2}{7} \dddot{x} + \frac{6}{7} kx = 0$

e) $m\ddot{x} + \frac{2}{5} \dddot{x} + \frac{6}{5} kx = 0$