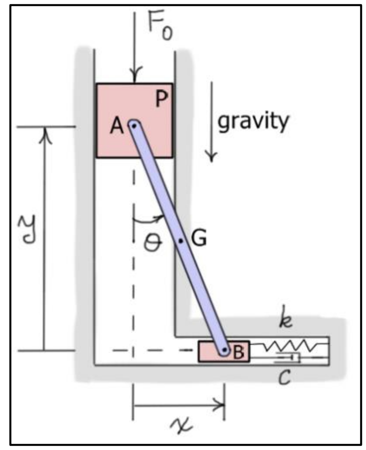
# ME 5550 Intermediate Dynamics
# Exercises #10

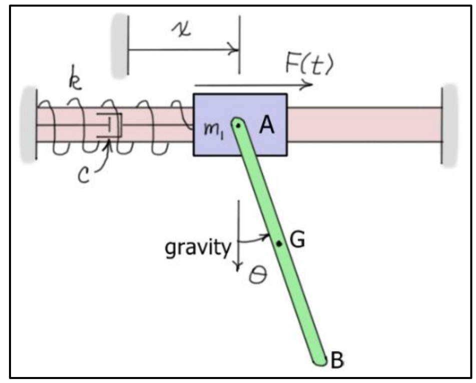
1) Find the equilibrium positions of the system of Exercises #8, problem #1. Use the following data.

$$mg = 4 \text{ lb} \qquad \ell = 2 \text{ ft}$$
$$m_p g = 3 \text{ lb} \qquad k = 17.68 \text{ lb/ft}$$
$$F_0 = 20 \text{ lb}$$

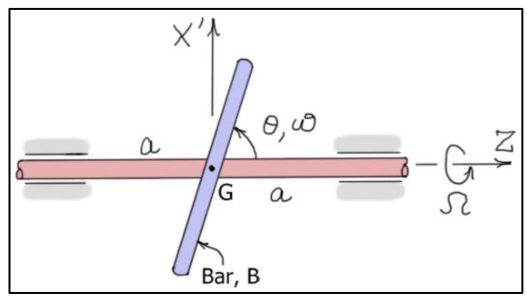



2) Show that $x = \theta = 0$ is an equilibrium position for the system of Exercises #8, problem #2. Linearize the equations of motion about this position and calculate the natural frequencies and mode shapes of the system using the following physical data. Describe the motion of each mode.

$$m_1 g = 10 \text{ lb} \qquad \ell = 2 \text{ ft}$$
$$m_2 g = 5 \text{ lb} \qquad k = 300 \text{ lb/ft}$$




3) Given that $M_\theta = 0$ and $\dot{\phi} = \Omega = \text{constant}$, find the equilibrium positions for the angle $\theta$ for the bar of Exercises #8, problem #3. Then linearize the equation of motion about these positions. Determine the stability of small motions about each of these positions. Find the torque $M_\phi$ required so that $\dot{\phi} = \Omega = \text{constant}$.




4) Given that $M_\theta = 0$, $\dot{\phi} = \Omega = \text{constant}$, and $b = 0$, show that the equilibrium position for the angle $\theta$ for the bar of Exercises #8, problem #4 is approximately $\theta_{eq} \cong 58.7 \text{ (deg)}$. Then linearize the equation of motion about this position and determine the stability of small motions about that position. Find the torque $M_\phi$ required so that $\dot{\phi} = \Omega = \text{constant}$. Use the following physical data:

$$mg = 5 \text{ lb} \qquad k = 10 \text{ ft-lb/rad}$$
$$\ell = 2 \text{ ft} \qquad \Omega = 4\pi \text{ rad/s}$$
$$c = 0$$