20-R-VIB-DY-51 Advanced
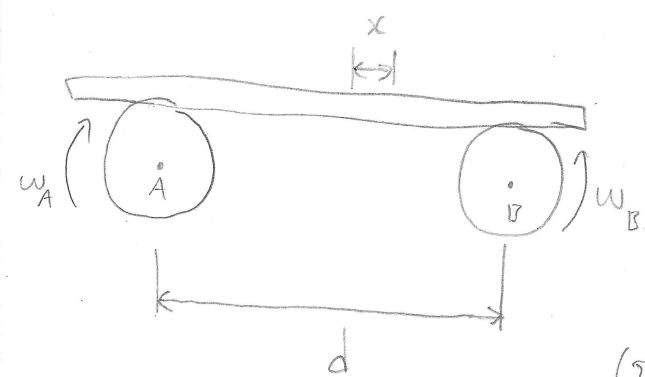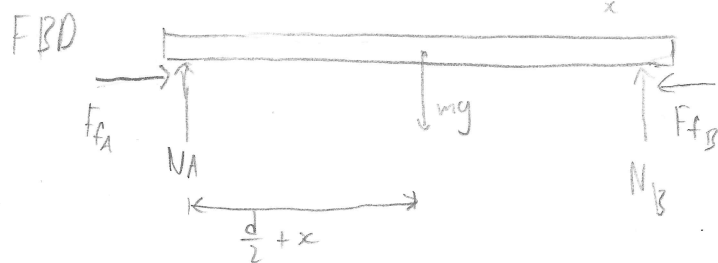
A plank is supported on two wheels which rotate in opposite directions at a constant angular velocity. The wheels are $d = 2m$ apart and have a coefficient of friction $\mu = 0.2$ with the plank. If the plank is displaced a small horizontal distance from the midpoint of the plank, determine the natural period of vibration of the board. Assume the wheels slip.

Solution

FBD

$$G\ \Sigma M_A = 0 \quad N_B\, d - mg\left(\frac{d}{2} + x\right) = 0$$

$$N_B = mg\left(\frac{1}{2} + \frac{x}{d}\right)$$

$$\Sigma F_y = 0 \quad N_A + N_B - mg = 0$$

$$N_A = mg\left(\frac{1}{2} - \frac{x}{d}\right)$$

$$\Sigma F_x = ma \quad F_{f_A} - F_{f_B} - ma = 0$$

$$\mu\, mg\left(\frac{1}{2} - \frac{x}{d}\right) - \mu\, mg\left(\frac{1}{2} + \frac{x}{d}\right) - ma = 0$$