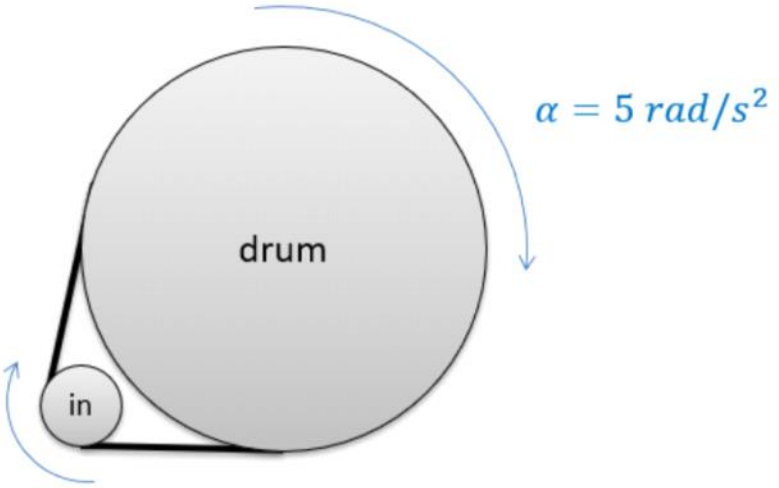
Problem 3

The drum in a washing machine can be approximated as a cylinder with a diameter of 80 cm, a depth of 60 cm, and a mass of 30 kg. The drum is driven by a belt that connects the outside of the drum to a 10 cm diameter pulley, which is driven by a motor. If we wish for the drum to accelerate at a rate of 5 rad/s^2, what torque should the motor apply to the input pulley? Assume the pulley itself has negligible mass?



Torque to spin drum

$$T = I\alpha$$

$$I_{cylinder} = \frac{1}{2}mr^2 = \frac{1}{2}(30\,kg)(.4\,m)^2 = 2.4\,kgm^2$$

$$T = (2.4\,kgm^2)(5\,rad/s^2) = \underline{12\,Nm}$$

Belt system

$$\frac{T_{in}}{r_{in}} = \frac{T_{out}}{r_{out}} \rightarrow \frac{T_{in}}{.05\,m} = \frac{12\,Nm}{.4\,m} \rightarrow \boxed{T_{in} = 1.5\,Nm}$$