ME 274 – Spring 2025 Name: SOLUTION
Quiz05 – 1:30 section

Arm AB rotates about a fixed vertical axis with a constant rate of ω_1. A ring, with its center at O and of radius r, rotates about arm AB with a constant rate of ω_2. A particle P moves along the ring with $\dot{\theta} = constant$. Let the XYZ axes be fixed, and the xyz axes be attached to the ring. At the position shown, $\theta = 90°$ and the xyz axes are aligned with the XYZ axes. It is desired to use the following equation to determine the acceleration of P for the position shown:

$$\vec{a}_P = \vec{a}_O + \left(\vec{a}_{P/O}\right)_{rel} + \vec{\alpha} \times \vec{r}_{P/O} + 2\vec{\omega} \times \left(\vec{v}_{P/O}\right)_{rel} + \vec{\omega} \times \left[\vec{\omega} \times \vec{r}_{P/O}\right]$$

Provide expressions for the following terms appearing in this equation.

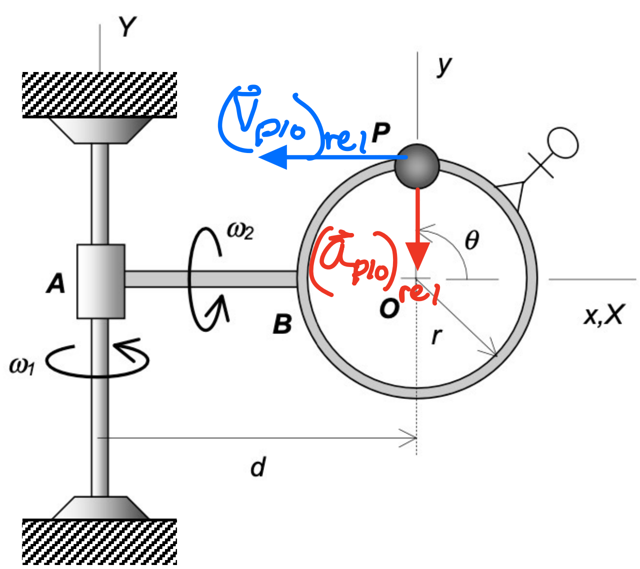
$\vec{a}_O = -d\omega_1^2 \hat{\imath}$ (see below)

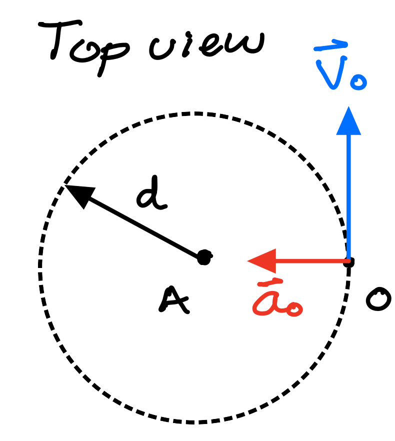
$\vec{\omega} =$ ang. vel. of observer $= \omega_1 \hat{J} + \omega_2 \hat{\imath} = \omega_1 \hat{\jmath} + \omega_2 \hat{\imath}$

$\vec{\alpha} = \frac{d\vec{\omega}}{dt} = \dot{\omega}_1^{\,0} \hat{J} + \omega_1 \dot{\hat{J}}^{\,0} + \dot{\omega}_2^{\,0} \hat{\imath} + \omega_2 \dot{\hat{\imath}} = \omega_2 \underbrace{(\omega_1 \hat{\jmath} + \omega_2 \hat{\imath})}_{\vec{\omega}} \times \hat{\imath} = -\omega_1 \omega_2 \hat{k}$

$\left(\vec{v}_{P/O}\right)_{rel} =$ vel. of P as seen by observer $= -r\dot{\theta}\hat{\imath}$

$\left(\vec{a}_{P/O}\right)_{rel} =$ acc. " " " " " " $= -r\dot{\theta}^2 \hat{\jmath}$





$|\vec{V}_o| = d\omega_1$

$\vec{a}_o = -\frac{|\vec{V}_o|^2}{d}\hat{I} = -d\omega_1^2 \hat{I}$