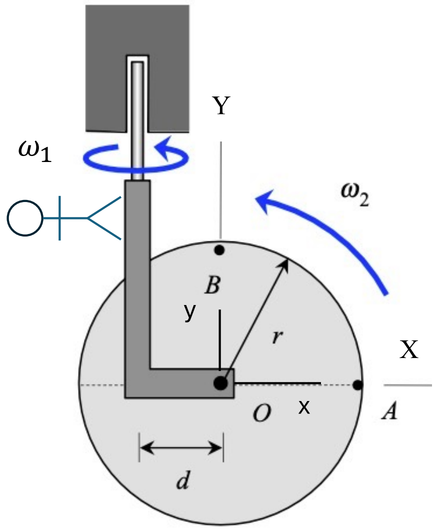
ME 274 – Spring 2025
Quiz04 – 3:30 section

Name SOLUTION

The L-shaped bracket is rotating about a fixed axis with a constant rate of ω_1. The wheel rotates with respect to the bracket with a constant rate of ω_2. It is desired to find the acceleration of point A on the wheel using the MRF kinematics equation: $\vec{a}_A = \vec{a}_O + (\vec{a}_{A/O})_{rel} + \vec{\alpha} \times \vec{r}_{A/O} + 2\vec{\omega} \times (\vec{v}_{A/O})_{rel} + \vec{\omega} \times (\vec{\omega} \times \vec{r}_{A/O})$. Write down expressions for the following terms using two different observers. In each case, the moving *xyz*-axes are aligned with the fixed *XYZ*-axes at the instant of interest.

Case 1:
Attach observer to the *bracket*
Attach *xyz*-axes to the *bracket*



$\vec{\omega} = \omega_1 \hat{J} = \omega_1 \hat{j}$

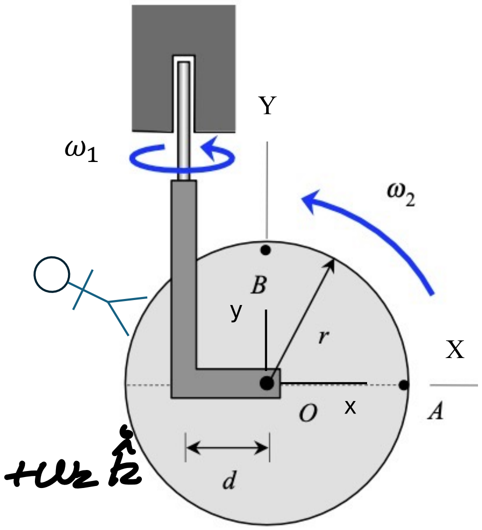
$\vec{\alpha} = \cancel{\dot{\omega}_1}^{0} \hat{J} + \omega_1 \cancel{\dot{\hat{J}}}^{0} = \vec{0}$

$(\vec{v}_{A/O})_{rel} = r\omega_2 \hat{j}$

$(\vec{a}_{A/O})_{rel} = -\dfrac{(r\omega_2)^2}{r}\hat{\imath} = -r\omega_2^2\hat{\imath}$

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

Case 2:
Attach observer to the *wheel*
Attach *xyz*-axes to the *wheel*



$\vec{\omega} = \omega_1 \hat{J} + \omega_2 \hat{k}$

$\vec{\alpha} = \cancel{\dot{\omega}_1}^{0} \hat{J} + \omega_1 \cancel{\dot{\hat{J}}}^{0} + \cancel{\dot{\omega}_2}^{0} \hat{k} + \omega_2 \dot{\hat{k}}$

$= \omega_2(\vec{\omega} \times \hat{k})$

$= \omega_2[\omega_1 \hat{j} + \omega_2 \hat{k}] \times \hat{k} = \omega_1\omega_2 \hat{\imath}$

$(\vec{v}_{A/O})_{rel} = \vec{0}$

$(\vec{a}_{A/O})_{rel} = \vec{0}$

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