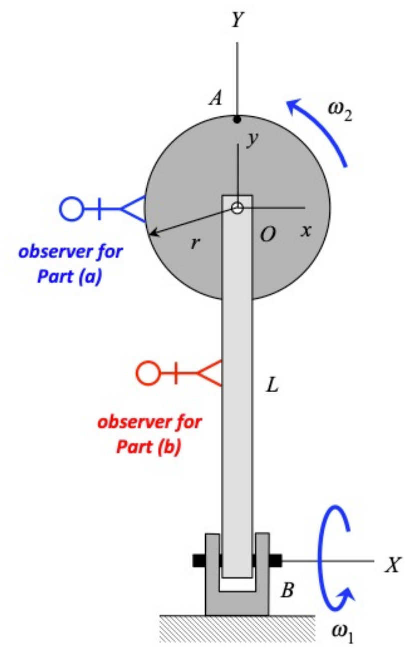
ME 274 – Spring 2023 Name ~~SOLUTION~~

10:30 section – Quiz 4



Arm OB (of length L) is rotating about the fixed X-axis at a constant rate of ω_1. A disk, of radius r, is pinned to OB at its center O, with the disk rotating at a constant rate of ω_2 relative to arm OB. Our goal here is to write down an expression for the acceleration of point A on the circumference of the disk using the following moving reference frame equation:

$$\vec{a}_A = \vec{a}_O + \left(\vec{a}_{A/O}\right)_{rel} + \vec{\alpha} \times \vec{r}_{A/O} + 2\vec{\omega} \times \left(\vec{v}_{A/O}\right)_{rel} + \vec{\omega} \times \left(\vec{\omega} \times \vec{r}_{A/O}\right)$$

Provide expressions for the following vectors in the above equation <u>*in terms of their xyz-components*</u> and in terms of, at most, ω_1, ω_2, r and L (you are NOT asked to actually find $\vec{a}_A$):

Part (a):

Here we will employ an observer and a set of *xyz*-axes that are both <u>*attached to the disk*</u>. Note that the *XYZ*-axes are fixed.

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

$$\vec{\alpha} = \cancel{\dot{\omega}_1}^{0} \hat{I} + \omega_1 \cancel{\dot{\hat{I}}}^{0} + \cancel{\dot{\omega}_2}^{0} \hat{k} + \omega_2 \dot{\hat{k}}$$
$$= \omega_2 \left[\omega_1 \hat{i} + \omega_2 \hat{k}\right] \times \hat{k}$$
$$= -\omega_1 \omega_2 \hat{j}$$

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

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

Part (b):

Here we will employ an observer and a set of *xyz*-axes that are both <u>*attached to arm OB*</u>. Note that the *XYZ*-axes are fixed.

$$\vec{\omega} = \omega_1 \hat{I} = \omega_1 \hat{i}$$

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

$$\left(\vec{v}_{A/O}\right)_{rel} = -r\omega_2 \hat{i}$$

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