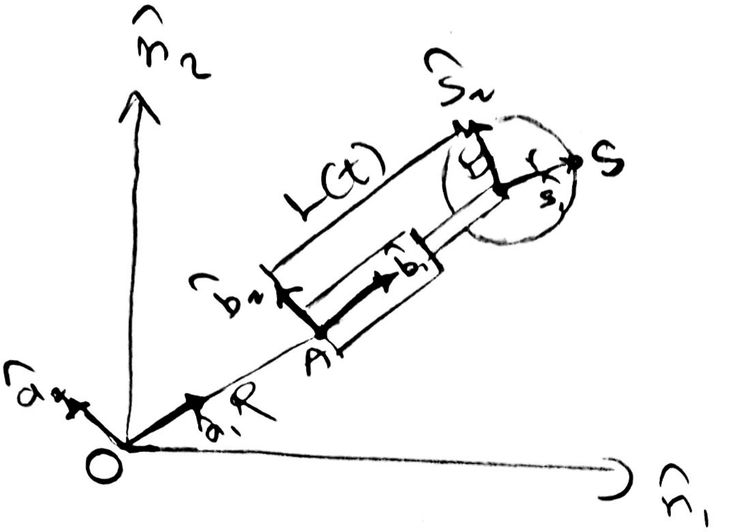

R: constant
r: constant
$\ddot{\theta} = 0$

$\{0\} \equiv \{O, \hat{n}_1, \hat{n}_2, \hat{n}_3\}$

$\{A\} \equiv \{O, \hat{a}_1, \hat{a}_2, \hat{n}_3\}$

$\{B\} = \{A, \hat{b}_1, \hat{b}_2, \hat{n}_3\}$

$\{S\} = \{B, \hat{s}_1, \hat{s}_2, \hat{n}_3\}$

$\vec{\omega}_{A/0} = \dot{\alpha}\hat{n}_3$

$\vec{\omega}_{B/0} = \dot{\beta}\hat{n}_3,$

$\vec{\omega}_{S/B} = \dot{\theta}\hat{n}_3 \Rightarrow \vec{\omega}_{S/0} = \vec{\omega}_{S/B} + \vec{\omega}_{B/0} = (\dot{\theta}+\dot{\beta})\hat{n}_3$

(1) Determine the inertial velocity of point S.

$\vec{r}_{S/0} = R\hat{a}_1 + L\hat{b}_1 + r\hat{s}_1 \quad (L \equiv L(t))$

$$(\vec{r}_{S/0})' = \cancel{{}^{A}\frac{d}{dt}(R\hat{a}_1)}^{\,0} + \omega_{A/0} \times (R\hat{a}_1) + {}^{B}\frac{d}{dt}(L\hat{b}_1) + \omega_{B/0} \times (L\hat{b}_1)$$
$$+ \cancel{{}^{S}\frac{d}{dt}(r\hat{s}_1)}^{\,0} + \omega_{S/0} \times (r\hat{s}_1)$$

$$= (\dot{\alpha}\hat{n}_3) \times (R\hat{a}_1) + \dot{L}\hat{b}_1 + (\dot{\beta}\hat{n}_3) \times (L\hat{b}_1)$$
$$+ (\dot{\theta}+\dot{\beta})\hat{n}_3 \times r\hat{s}_1$$

$$\boxed{v_{S/0} = \dot{\alpha}R\hat{a}_2 + \dot{L}\hat{b}_1 + \dot{\beta}L\hat{b}_2 + (\dot{\theta}+\dot{\beta})r\hat{s}_2}$$

(2) Determine the inertial acceleration of point S.

$$\vec{a}_{S/O} = \left(\vec{v}_{S/O}\right)^{\cdot} =$$

$$= \frac{{}^{A}d}{dt}(\dot{\alpha} R \hat{a}_2) + \omega_{A/O} \times (\dot{\alpha} R \hat{a}_2) + \frac{{}^{B}d}{dt}(\dot{L}\hat{b}_1) + \omega_{B/O} \times \dot{L}\hat{b}_1$$

$$+ \frac{{}^{B}d}{dt}(\dot{\beta} L \hat{b}_2) + \omega_{B/O} \times (\dot{\beta} L \hat{b}_2) + \frac{{}^{S}d}{dt}((\dot{\theta}+\dot{\beta}) r \hat{s}_2)$$

$$+ \omega_{S/O} \times ((\dot{\theta}+\dot{\beta}) r \hat{s}_2)$$

$$= \ddot{\alpha} R \hat{a}_2 + (\dot{\alpha}\hat{n}_3) \times (\dot{\alpha} R \hat{a}_2) + \ddot{L}\hat{b}_1 + (\dot{\beta}\hat{n}_3) \times (\dot{L}\hat{b}_1)$$

$$+ \ddot{\beta} L \hat{b}_2 + \dot{\beta}\dot{L}\hat{b}_2 + (\dot{\beta}\hat{n}_3) \times (\dot{\beta} L \hat{b}_2) + \ddot{\beta} r \hat{s}_2$$

$$+ (\dot{\theta}+\dot{\beta})\hat{n}_3 \times ((\dot{\theta}+\dot{\beta}) r \hat{s}_2)$$

$$\vec{a}_{S/O} = \ddot{\alpha} R \hat{a}_2 - \dot{\alpha}^2 R \hat{a}_1 + \ddot{L}\hat{b}_1 + \dot{\beta}\dot{L}\hat{b}_2 + \ddot{\beta} L \hat{b}_2$$

$$+ \dot{\beta}\dot{L}\hat{b}_2 - \dot{\beta}^2 L \hat{b}_1 + \ddot{\beta} r \hat{s}_2 - (\dot{\theta}+\dot{\beta})^2 r \hat{s}_1$$

$$\boxed{\vec{a}_{S/O} = -\dot{\alpha}^2 R \hat{a}_1 + \ddot{\alpha} R \hat{a}_2 + (\ddot{L} - \dot{\beta}^2 L)\hat{b}_1 + (\ddot{\beta} L + 2\dot{\beta}\dot{L})\hat{b}_2 - (\dot{\theta}+\dot{\beta})^2 r \hat{s}_1 + \ddot{\beta} r \hat{s}_2}$$

(3) Determine the velocity of point A as seen by an observer attached on the rotating disk sitting at location S. $\vec{\omega}_{B/S} = -\vec{\omega}_{S/B} = -\dot{\theta}\hat{n}_3$ (3)

$\vec{r}_{A/S} = -r\hat{s}_1 - L\hat{b}_1$

$$\frac{{}^S d}{dt}\left(\vec{r}_{A/S}\right) = \cancel{\frac{{}^S d}{dt}\left(-r\hat{s}_1\right)}^{\,0} + \frac{{}^B d}{dt}\left(-L\hat{b}_1\right) + \omega_{B/S} \times \left(-L\hat{b}_1\right)$$

$$= -\dot{L}\hat{b}_1 + \left(-\dot{\theta}\hat{n}_3\right) \times \left(-L\hat{b}_1\right)$$

$$\boxed{\frac{{}^S d}{dt}\left(\vec{r}_{A/S}\right) = -\dot{L}\hat{b}_1 + \dot{\theta}L\hat{b}_2}$$