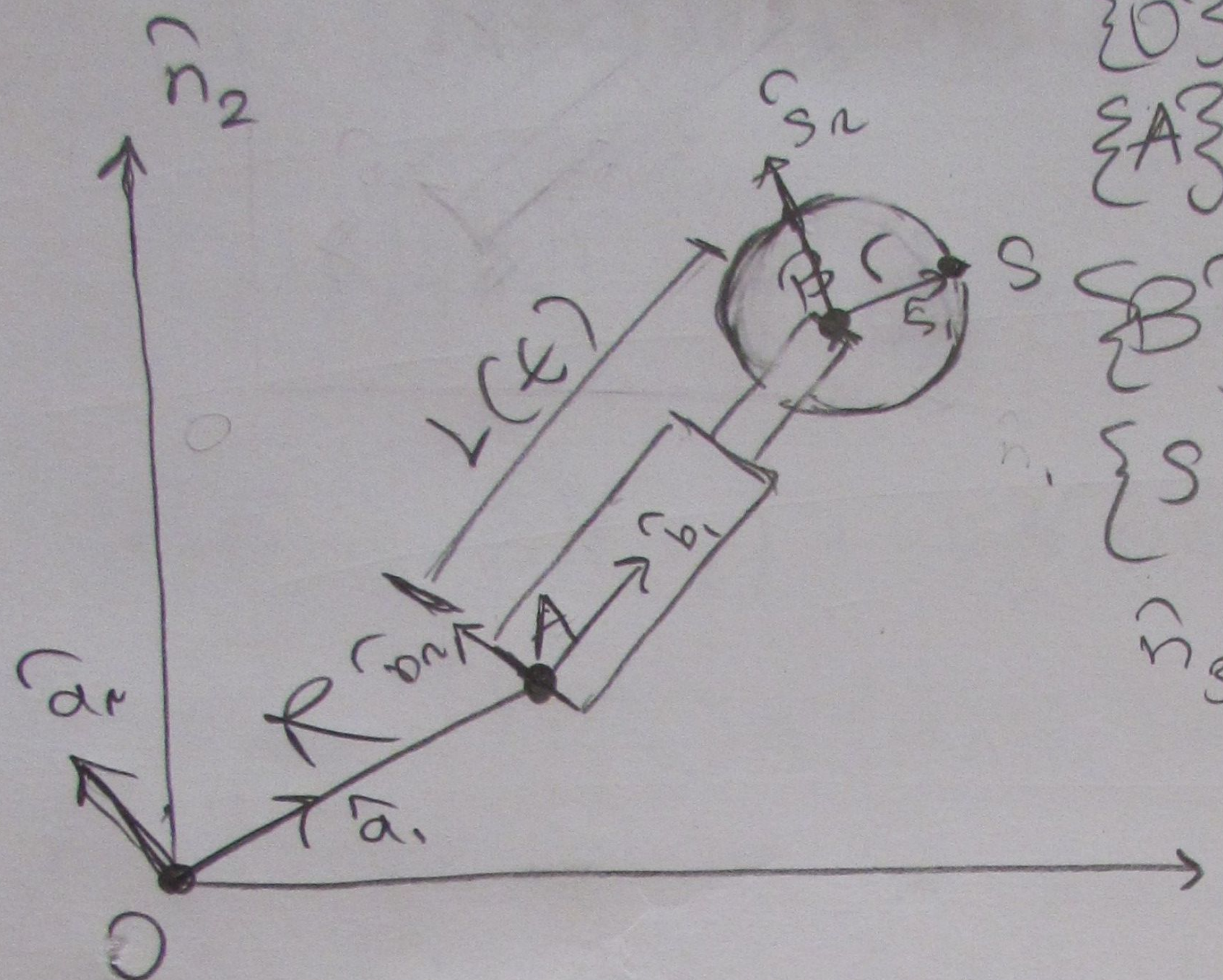
(1)



$$\left.\begin{array}{l} R:\text{const} \\ r:\text{const} \end{array}\right\} \ddot{\theta}=0$$

$$\{O\}=\{O,\hat{n}_1,\hat{n}_2,\hat{n}_3\}$$

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

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

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

$$\hat{n}_3=\hat{a}_3=\hat{b}_3=\hat{s}_3$$

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

$$\vec{\omega}_{B/A}=\dot{\beta}\hat{n}_3 \rightsquigarrow \vec{\omega}_{B/O}=(\dot{\alpha}+\dot{\beta})\hat{n}_3=\vec{\omega}_{B/A}+\vec{\omega}_{A/O}$$

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

(1-1)- $\vec{r}_{S/O}=R\hat{a}_1+L\hat{b}_1+r\hat{s}_1$

$$v_{S/O}=(\dot{\vec{r}}_{S/O})=\cancel{{}^{A}\frac{d}{dt}(R\hat{a}_1)}^{\,0}+\omega_{A/O}\times(R\hat{a}_1)$$

$$+{}^{B}\frac{d}{dt}(L\hat{b}_1)+\omega_{B/O}\times(L\hat{b}_1)+\cancel{{}^{S}\frac{d}{dt}(r\hat{s}_1)}^{\,0}+\omega_{S/O}\times(r\hat{s}_1)$$

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

$$+(\dot{\theta}+\dot{\alpha}+\dot{\beta})\hat{n}_3\times(r\hat{s}_1)$$

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

(1.2)

$$\vec{a}_{s/o} = (\dot{\vec{r}}_{s/o}) =$$

$$ {}^{A}\frac{d}{dt}(\dot\alpha R \hat a_2) + \omega_{A/o} \times (\dot\alpha R \hat a_2) + {}^{B}\frac{d}{dt}(\dot L \hat b_1) + \omega_{B/o} \times (\dot L \hat b_1)$$

$$+ {}^{B}\frac{d}{dt}((\dot\alpha+\dot\beta) L \hat b_2) + \omega_{B/o} \times ((\dot\alpha+\dot\beta) L b_2)$$

$$+ {}^{S}\frac{d}{dt}((\dot\theta+\dot\alpha+\dot\beta) r \hat s_2) + \omega_{s/o} \times (\dot\theta+\dot\alpha+\dot\beta) r \hat s_2$$

$$= \ddot\alpha R \hat a_2 + (\dot\alpha \hat n_3) \times (\dot\alpha R \hat a_2) + \ddot L \hat b_1 +$$

$$(\dot\alpha+\dot\beta)\hat n_3 \times \dot L \hat b_1 + (\ddot\alpha+\ddot\beta) L \hat b_2 + (\dot\alpha+\dot\beta)\dot L \hat b_2$$

$$+ (\dot\alpha+\dot\beta)\hat n_3 \times (\dot\alpha+\dot\beta) L \hat b_2 + (\ddot\alpha+\ddot\beta) r \hat s_2$$

$$+ (\dot\theta+\dot\alpha+\dot\beta)\hat n_3 \times (\dot\theta+\dot\alpha+\dot\beta) r \hat s_2$$

remember $\dot\theta \hat n_3$ is constant

$$= \ddot\alpha R \hat a_2 - \dot\alpha^2 R \hat a_1 + \ddot L \hat b_1 + (\dot\alpha+\dot\beta)\dot L \hat b_2 + (\ddot\alpha+\ddot\beta) L \hat b_2$$

$$+ (\dot\alpha+\dot\beta)\dot L \hat b_2 - (\dot\alpha+\dot\beta)^2 L \hat b_1 + (\ddot\alpha+\ddot\beta) r \hat s_2$$

$$- (\dot\theta+\dot\alpha+\dot\beta)^2 r \hat s_1$$

$$\boxed{\begin{aligned} &= -\dot\alpha^2 R \hat a_1 + \ddot\alpha R \hat a_2 + (\ddot L - (\dot\alpha+\dot\beta)^2 L)\hat b_1 \\ &+ ((\ddot\alpha+\ddot\beta) L + 2(\dot\alpha+\dot\beta)\dot L)\hat b_2 - (\dot\theta+\dot\alpha+\dot\beta)^2 r \hat s_1 \\ &+ (\ddot\alpha+\ddot\beta) r \hat s_2 = \vec a_{s/o} \end{aligned}}$$

(1-3) $\vec{r}_{A/S} = -r\hat{s}_1 - L\hat{b}_1$ $\qquad \omega_{A/S} = -\omega_{S/A} = -(\dot{\theta}+\dot{\beta})\hat{n}_3$

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

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

$$\boxed{{}^{S}\frac{d}{dt}(r_{A/S}) = -\dot{L}\hat{b}_1 + (\dot{\theta}+\dot{\beta})L\hat{b}_2}$$

2- $[B(\sigma)] = (1-\sigma^2)[I_{3\times3}] + 2[\tilde{\sigma}] + 2\sigma\sigma^T$