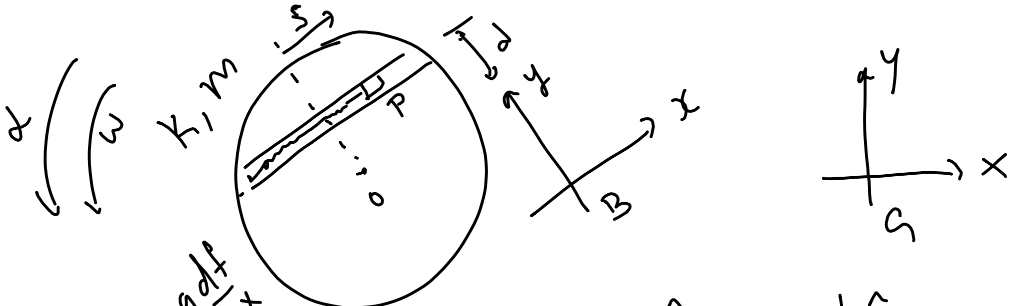


$$\frac{d(fg)}{dx} = f\frac{dg}{dx} + g\frac{df}{dx}$$

$$\vec{r}_{P/O} = s\,\hat{i}_{rel} + d\,\hat{j}_{rel}$$

$$\vec{V}_{P/O} = \dot{\vec{r}}_{P/O} = \dot{s}\,\hat{i}_{rel} + \dot{d}\,\hat{j}_{rel} + s\,\dot{\hat{i}}_{rel} + d\,\dot{\hat{j}}_{rel}$$

$$\dot{\hat{i}}_{rel} = \vec{\omega} \times \hat{i}_{rel}\,, \quad \dot{\hat{j}}_{rel} = \vec{\omega} \times \hat{j}_{rel}$$

$$\vec{V}_{P/O} = \dot{s}\,\hat{i}_{rel} + \dot{d}\,\hat{j}_{rel} + \vec{\omega} \times (s\,\hat{i}_{rel} + d\,\hat{j}_{rel})$$

$$= \dot{s}\,\hat{i}_{rel} + \dot{d}\,\hat{j}_{rel} + \vec{\omega} \times \vec{r}_{P/O}$$

$$\vec{V}_{P/O} = \dot{s}\,\hat{i}_{rel} + \vec{\omega} \times \vec{r}_{P/O} \quad //$$

$$\vec{r}_{P/O} = s\,\hat{i}_{rel} + d\,\hat{j}_{rel}$$

$$\dot{\vec{r}}_{P/O}\Big|_{rel} = \dot{s}\,\hat{i}_{rel} + \dot{d}\,\hat{j}_{rel}$$

$$\vec{V}_{P/O} = \dot{\vec{r}}_{P/O,rel} + \vec{\omega} \times \vec{r}_{P/O}$$

$$= \dot{s}\,\hat{i}_{rel} + \dot{d}\,\hat{j}_{rel} + \vec{\omega} \times \vec{r}_{P/O}$$

$$= \dot{s}\,\hat{i}_{rel} + \vec{\omega} \times \vec{r}_{P/O}$$

$$= \dot{s}\,\hat{i}_{rel} + \vec{\omega} \times (s\,\hat{i}_{rel} + d\,\hat{j}_{rel})$$

$\vec{\rho}_{rel} = s\hat{i}_{rel} + d\hat{j}_{rel}$

$$\vec{a}_{P/O} = \ddot{\vec{\rho}}_{rel} + 2(\vec{\omega} \times \dot{\vec{\rho}}_{rel}) + \vec{\alpha} \times \vec{\rho}_{rel} + \vec{\omega} \times (\vec{\omega} \times \vec{\rho}_{rel})$$

$$= \ddot{s}\hat{i}_{rel} + 2(\omega \hat{k}_{rel} \times \dot{s}\hat{i}_{rel}) + \alpha \hat{k}_{rel} \times (s\hat{i}_{rel} + d\hat{j}_{rel}) - \omega^2 (s\hat{i}_{rel} + d\hat{j}_{rel})$$

$$= \ddot{s}\hat{i}_{rel} + 2\omega\dot{s}\hat{j}_{rel} + (\alpha s \hat{j}_{rel} - \alpha d \hat{i}_{rel}) - \omega^2 s \hat{i}_{rel} - \omega^2 d \hat{j}_{rel}$$

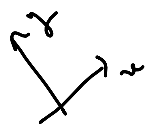
$$\vec{a}_{P/O} = (\ddot{s} - \alpha d - \omega^2 s)\hat{i}_{rel} + (2\omega\dot{s} + \alpha s - \omega^2 d)\hat{j}_{rel}$$

$$\vec{a}_P = \cancel{\vec{a}_O}^{\,0} + \vec{a}_{P/O}$$

$$= (\ddot{s} - \alpha d - \omega^2 s)\hat{i}_{rel} + (2\omega\dot{s} + \alpha s - \omega^2 d)\hat{j}_{rel}$$

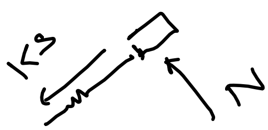
April 11, 2017

$$\vec{a}_p = (\ddot{s} - \alpha d - \omega^2 s)\,\hat{i}_{rel}$$
$$+ (2\omega\dot{s} + \alpha s - \omega^2 d)\,\hat{j}_{rel}$$



$$\vec{F} = m\vec{a} \;//$$

along 'x'



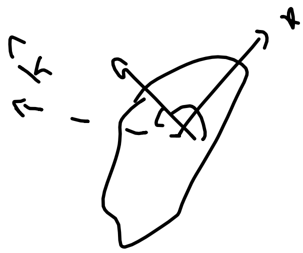
$$-ks = m(\ddot{s} - \alpha d - \omega^2 s)$$

$$\ddot{s} + \left(\frac{k}{m} - \omega^2\right)s - \alpha d = 0 \;/\, \text{EOM} \;//$$

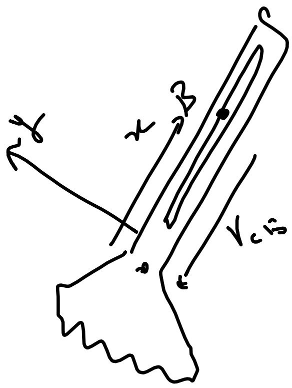
along 'y':

$$N = m(2\omega\dot{s} + \alpha s - \omega^2 d) \;/\, N \;//$$

why is $\vec{w} \times (\vec{w} \times \vec{r}) = -|\vec{w}|^2 \vec{r}$
in planar case?



$$\vec{w} = w\hat{k}$$
$$\vec{r} = r_x \hat{i} + r_y \hat{j}$$
$$\vec{w} \times (\vec{w} \times \vec{r}) = w\hat{k} \times (w\hat{k} \times (r_x \hat{i} + r_y \hat{j}))$$
$$= w\hat{k} \times (w r_x \hat{j} - w r_y \hat{i})$$
$$= -w^2 r_x \hat{i} - w^2 r_y \hat{j}$$
$$= -w^2 (r_x \hat{i} + r_y \hat{j}) = -|\vec{w}|^2 \vec{r}$$
$$\vec{w} \times (\vec{w} \times \vec{r}) = (\vec{r} \cdot \vec{w})\vec{w} - (\vec{w} \cdot \vec{w})\vec{r}$$
$$\vec{a} \times (\vec{b} \times \vec{c}) = (\vec{a} \cdot \vec{c})\vec{b} - (\vec{a} \cdot \vec{b})\vec{c} \quad //$$

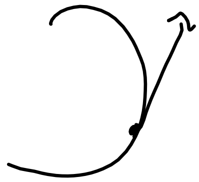


$$\vec{V}_B = \vec{V}_{B/C}\big|_{rel} + \vec{\omega}_{BC} \times \vec{r}_{B/C}$$

$$= \dot{r}_{BC}\,\hat{i} + \omega_{CD}\, r_{BC}\,\hat{j}$$

$$= r_{AB}\,\dot{\omega}_{AB}\,\hat{i}$$

$r_{AB}\omega_{AB}\hat{i}$



$\omega_{CD} = 0$