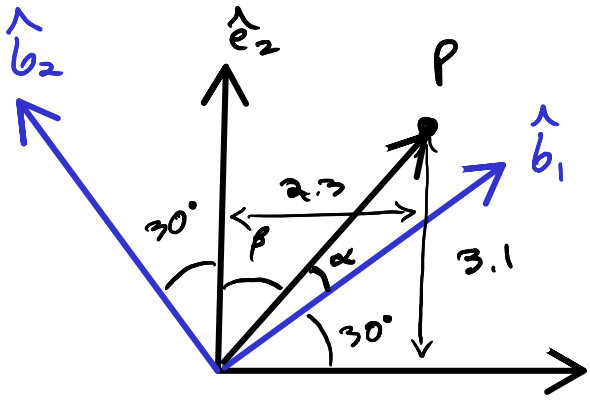
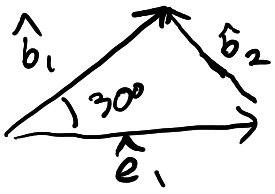
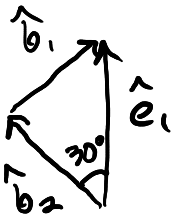


$$\bar{r}_P = 2.3\,\hat{e}_1 + 3.1\,\hat{e}_2\ [m] = x_b\,\hat{b}_1 + y_b\,\hat{b}_2$$



$$\hat{e}_1 = \cos\theta\,\hat{b}_1 - \sin\theta\,\hat{b}_2$$

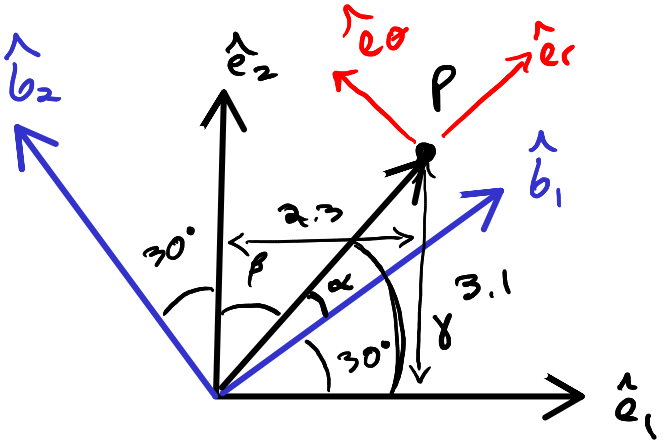


$$\hat{e}_2 = \sin\theta\,\hat{b}_1 + \cos\theta\,\hat{b}_2$$

$$\bar{r}_P = 2.3\left[\cos 30^\circ\,\hat{b}_1 - \sin 30^\circ\,\hat{b}_2\right]$$

$$+\ 3.1\left[\sin 30^\circ\,\hat{b}_1 + \cos 30^\circ\,\hat{b}_2\right]$$

$$\bar{r}_P = \left(2.3\cos 30^\circ + 3.1\sin 30^\circ\right)\hat{b}_1 + \left(3.1\cos 30^\circ - 2.3\sin 30^\circ\right)\hat{b}_2$$



$$\bar{r}_P = 2.3\,\hat{e}_1 + 3.1\,\hat{e}_2 = r\,\hat{e}_r$$

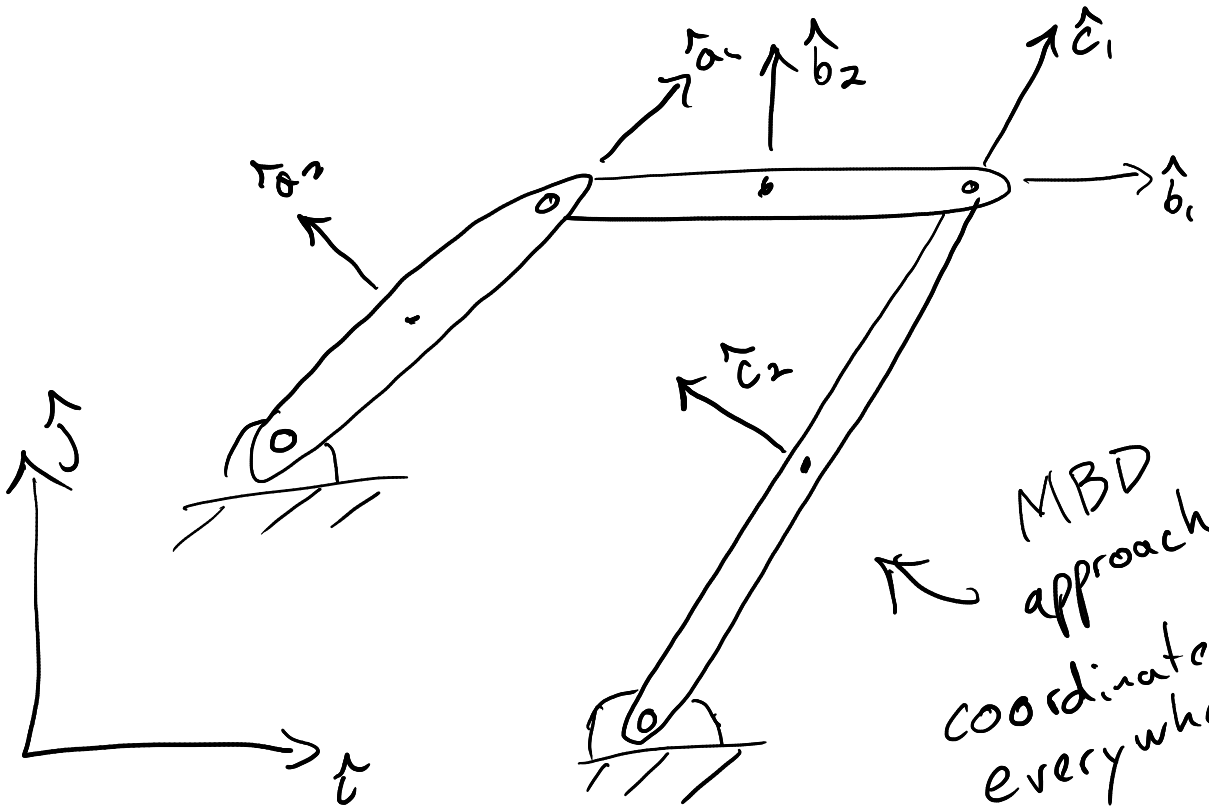
$$r = \sqrt{2.3^2 + 3.1^2}$$

in $\hat{e}_1$-$\hat{e}_2$ → (r, γ)

$\hat{b}_1$, $\hat{b}_2$ → (r, α)

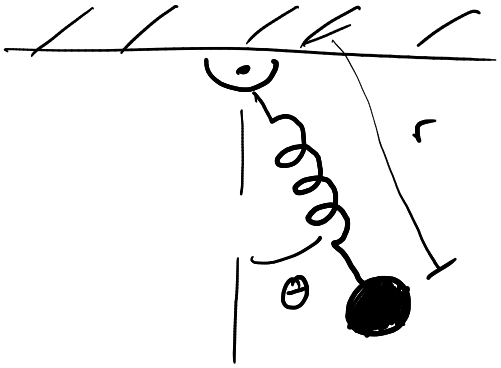
$$\tan\gamma = \frac{3.1}{2.3}$$

$$\bar{r} = 2.3\,\hat{e}_1 + 3.1\,\hat{e}_2 = r\,\hat{e}_r = \sqrt{2.3^2+3.1^2}\left(\underbrace{\frac{2.3}{r}}_{\cos\gamma}\hat{e}_1 + \underbrace{\frac{3.1}{r}}_{\sin\gamma}\hat{e}_2\right)$$



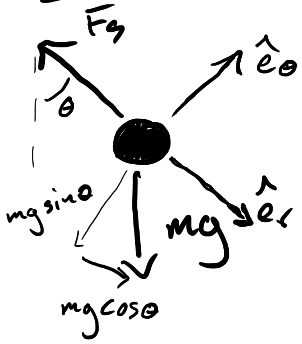
MBD approach

coordinates everywhere

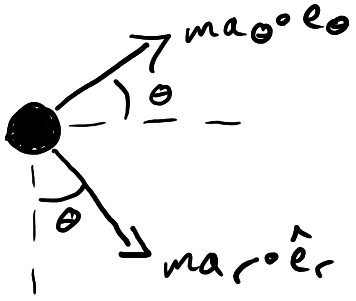


2 DOFs
=
× 2 eoms

FBD



KD



$\sum \bar{F} = m\bar{a}$

↳ $\bar{F} \cdot \hat{e}_r = ma_r$

$\bar{F} \cdot \hat{e}_\theta = ma_\theta$

$\hat{e}_r \Rightarrow -k(r-l_0) + mg\cos\theta = m(\overbrace{\ddot{r} - r\dot{\theta}^2}^{a_r})$

$\hat{e}_\theta \Rightarrow -mg\sin\theta = m(\underbrace{r\ddot{\theta} + 2\dot{r}\dot{\theta}}_{a_\theta})$