

4-bar linkage  
general form

HW part 1

$$\begin{aligned}\vec{r}_A &= ? \\ \vec{r}_B &= ? \\ \vec{r}_C &= ?\end{aligned}$$

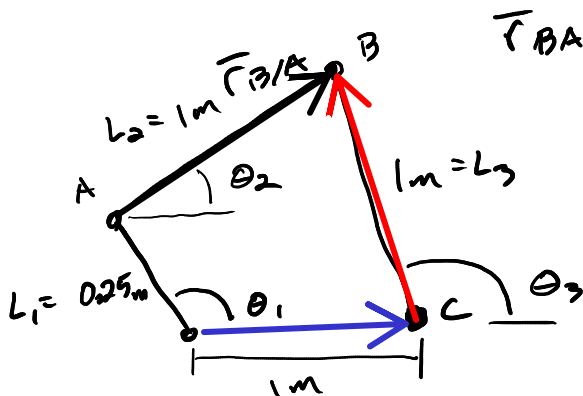
$$\dot{\theta}_1 = 10 \frac{\text{rad}}{\text{s}}$$

$$\vec{r}_O = 0\hat{i} + 0\hat{j}$$

$$\vec{r}_A = -0.2\hat{i} + 0.15\hat{j}$$

$$\vec{r}_B = 0.5\hat{i} + 0.86\hat{j}$$

$$\vec{r}_C = 1\hat{i}$$



$$\vec{r}_A + \vec{r}_{B/A} = \vec{r}_C + \vec{r}_{B/C}$$

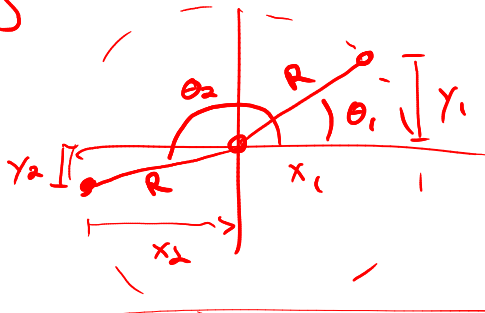
$$\vec{r}_A = L_1 (\cos\theta_1 \hat{i} + \sin\theta_1 \hat{j})$$

$$\vec{r}_{B/A} = L_2 (\cos\theta_2 \hat{i} + \sin\theta_2 \hat{j})$$

$$\vec{r}_{B/C} = L_3 (\cos\theta_3 \hat{i} + \sin\theta_3 \hat{j})$$

$$\vec{r}_C = 1\hat{i}$$

Trig Review



$$x_1 = R \cos\theta_1$$

$$y_1 = R \sin\theta_1$$

$$x_2 = R \cos\theta_2$$

$$y_2 = R \sin\theta_2$$

$$\star \boxed{\vec{r}_A + \vec{r}_{B/A} = \vec{r}_C + \vec{r}_{B/C}}$$

position constraint  
equation

$$\vec{r}_A = L_1 (\cos \theta_1 \hat{i} + \sin \theta_1 \hat{j})$$

$$\vec{r}_{B/A} = L_2 (\cos \theta_2 \hat{i} + \sin \theta_2 \hat{j})$$

$$\vec{r}_{B/C} = L_3 (\cos \theta_3 \hat{i} + \sin \theta_3 \hat{j})$$

$$\hat{i} \rightarrow L_1 \cos \theta_1 + L_2 \cos \theta_2 = 1 + L_3 \cos \theta_3 \quad \vec{r}_C = 1 \hat{i}$$

$$\hat{j} \rightarrow L_1 \sin \theta_1 + L_2 \sin \theta_2 = 0 + L_3 \sin \theta_3$$

2 eqns x 2 unknowns  
e.g. given  $\theta_1 \rightarrow$  get  $\theta_2, \theta_3$

velocity constraint

$$\vec{v}_A, \vec{v}_{B/A}, \vec{v}_C, \vec{v}_{B/C} ?$$

$$\frac{d}{dt} (\vec{r}_A + \vec{r}_{B/A} = \vec{r}_C + \vec{r}_{B/C})$$

$$v_x \rightarrow L_1 \dot{\theta}_1 \sin \theta_1 + L_2 \dot{\theta}_2 \sin \theta_2 = 0 + L_3 \dot{\theta}_3 \sin \theta_3$$

$$v_y \rightarrow L_1 \dot{\theta}_1 \cos \theta_1 + L_2 \dot{\theta}_2 \cos \theta_2 = 0 + L_3 \dot{\theta}_3 \cos \theta_3$$

$$\frac{d}{dt} (\cos 3t) = \frac{d}{d(3t)} \frac{d(3t)}{dt} (\cos 3t) = -3 \sin 3t$$

$$\frac{d}{dt} (\cos x) = \frac{dx}{dt} \cdot \frac{d}{dx} (\cos x) = \dot{x} (-\sin x)$$

$x = f(t)$