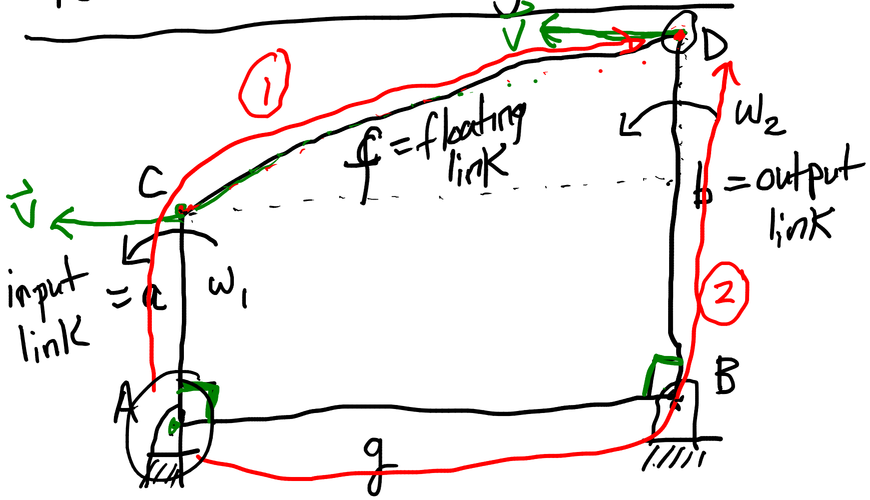
TAM 212

Four Bar Linkage Example



given $\vec{\omega}_1 = \omega_1 \hat{k}$

find $\vec{\omega}_2 = \omega_2 \hat{k}$

Question 1: At the instant shown, link f is undergoing

A) pure ~~rotation~~

B) pure translation

c) a mixture

translation:

$$|\vec{v}_C| = |\vec{v}_D|$$

$$\omega_1 a = \omega_2 b$$

$$\omega_2 = \left(\frac{a}{b}\right) \omega_1$$

$$\vec{v}_D = \vec{v}_C + \cancel{\vec{\omega}_f}^{\,0} \times \vec{r}_{CD}$$

Solving for ω_2

Route 1:

$$\vec{v}_C = \vec{v}_A + \vec{\omega}_1 \times \vec{r}_{AC}$$

$$\vec{v}_D = \vec{v}_C + \vec{\omega}_f \times \vec{r}_{CD}$$

$$\vec{v}_D = \cancel{\vec{v}_A} + \vec{\omega}_1 \times \vec{r}_{AC} + \vec{\omega}_f \times \vec{r}_{CD}$$

$$= (\omega_1 \hat{k} \times a\hat{j}) + [\omega_f \hat{k} \times (g\hat{i} + (b-a)\hat{j})]$$

$$= -\omega_1 a\hat{i} + \omega_f g\hat{j} - \omega_f (b-a)\hat{i}$$

$$= -[\omega_1 a + \omega_f (b-a)]\hat{i} + \underline{\underline{\omega_f g}}\,\hat{j}$$

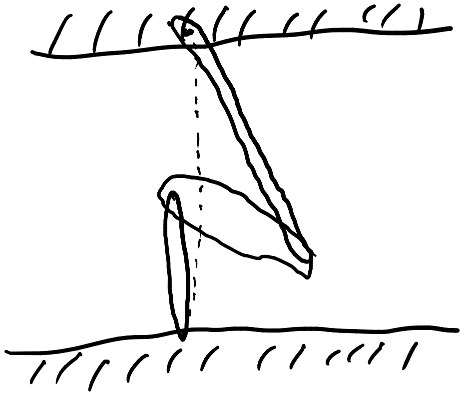
Route 2

$$\vec{v}_D = \cancel{\vec{v}_B} + \vec{\omega}_2 \times \vec{r}_{BD} = \omega_2 \hat{k} \times b\hat{j} = -\omega_2 b\hat{i} + 0\hat{j}$$

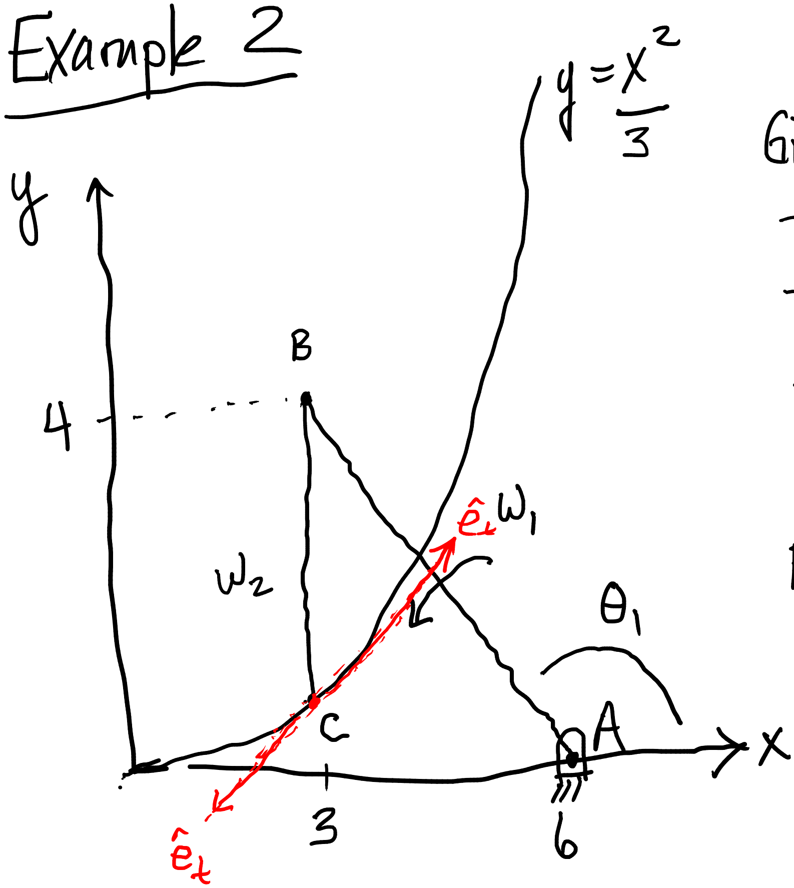
$$\omega_b = \left(\frac{a}{b}\right)\omega_1$$

equate $\hat{i}$-comp: $\omega_1 a + \omega_f (b-a) = \omega_2 b$

equate $\hat{j}$-comp: $\omega_f g = 0$ $\boxed{\omega_f = 0}$



Example 2



Given:
- position of A, B, C
- θ_1, $\vec{\omega}_1 = \omega_1 \hat{k}$, $\vec{\alpha}_1 = \alpha_1 \hat{k}$
- C is constrained to move on parabola

Find: $\vec{V}_c$, $\vec{a}_c$

Strategy: work from $A \to B \to C$
use constraints to solve for vars.

constraint: $\vec{V}_c = V_c \hat{e}_t$

$$\vec{V}_B = \underbrace{\vec{V}_A + \vec{\omega}_1 \times \vec{r}_{AB}}$$

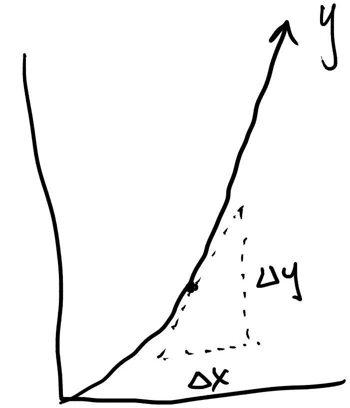
$$\vec{V}_c = \underline{\underline{\vec{V}_B}} + \vec{\omega}_2 \times \vec{r}_{BC}$$

$$\vec{V}_c = V_c \hat{e}_t = \cancelto{0}{\vec{V}_A} + \vec{\omega}_1 \times \vec{r}_{AB} + \underline{\underline{\vec{\omega}_2}} \times \vec{r}_{BC}$$

2 equations: $(\hat{i}, \hat{j})$ components

2 variables: ω_2, V_c

Find $\hat{e}_t$



$$y = \frac{x^2}{3}$$

$$\hat{e}_t = \frac{\Delta x\,\hat{i} + \Delta y\,\hat{j}}{\sqrt{(\Delta x)^2 + (\Delta y)^2}}$$

$$\Delta y = \Delta x \left(\frac{dy}{dx} \right)$$

$$\Delta x = 1$$

$$\Delta y = \frac{dy}{dx} = \frac{2}{3}x \Big|_{x=3} = 2$$

$$\hat{e}_t = \frac{\hat{i} + 2\hat{j}}{\sqrt{5}}$$

$$\vec{V}_c = \frac{V_c\,\hat{i} + 2V_c\,\hat{j}}{\sqrt{5}}$$