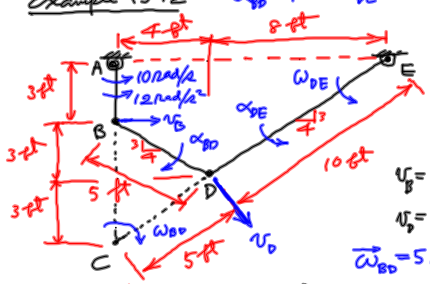
Tuesday, 10/13/09 } a quiz & a mid term exam will
Thursday, 10/15/09 } be given to the class on these two days.

There will be a homework collection next Tuesday.

Example 15.12 $\vec{\alpha}_{BD} = ?$ $\vec{\alpha}_{DE} = ?$



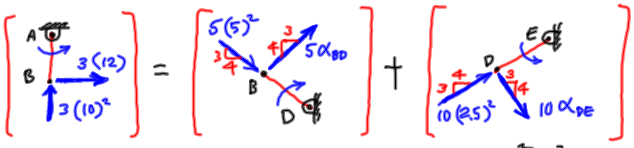
The i.c. of AB is at A.
" " " DE " " E
" " " BD " " C
$\vec{\omega}_{AB} = 10$ rad/s ↻
$\vec{\alpha}_{AB} = 12$ rad/s² ↻

$v_B = 3(10) = 6\,\omega_{BD}$, $\omega_{BD} = 5$
$v_D = 5(5) = 10\,\omega_{DE}$, $\omega_{DE} = 2.5$
$\vec{\omega}_{BD} = 5$ rad/s ↺ $\vec{\omega}_{DE} = 2.5$ rad/s ↻

$$\vec{a}_B = \vec{a}_{B/A} + \cancel{\vec{a}_A} = \vec{a}_{B/A} = \vec{a}_{B/D} + \vec{a}_D = \vec{a}_{B/D} + (\vec{a}_{D/E} + \cancel{\vec{a}_E}) = \vec{a}_{B/D} + \vec{a}_{D/E}$$

$$\boxed{\vec{a}_{B/A} = \vec{a}_{B/D} + \vec{a}_{D/E}}$$

Linkage eq. for accelerations
(Relative accelerations must be due to rotation.)

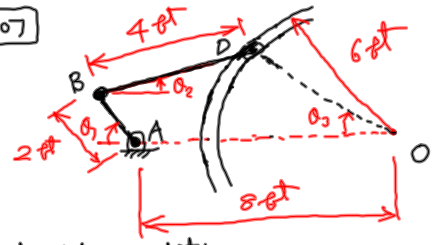


$$\Sigma V_x: \quad 3(12) = \tfrac{4}{5}(5)(5)^2 + \tfrac{3}{5}(5\alpha_{BD}) + \tfrac{4}{5}(10)(2.5)^2 + \tfrac{3}{5}(10\alpha_{DE})$$

$$\Sigma V_y: \quad 3(10)^2 = -\tfrac{3}{5}(5)(5)^2 + \tfrac{4}{5}(5\alpha_{BD}) + \tfrac{3}{5}(10)(2.5)^2 - \tfrac{4}{5}(10\alpha_{DE})$$

$\therefore \alpha_{BD} = \boxed{}$ $\alpha_{DE} = \boxed{}$ $\boxed{\vec{\alpha}_{BD} = 23.2 \text{ rad/s}^2 ↺}$ $\boxed{\vec{\alpha}_{DE} = 30.6 \text{ rad/s}^2 ↻}$

15.107



4-bar linkage system
$\vec{\omega}_{BD} = ?$ $\vec{v}_D = ?$
when $\theta_1 = 0$, $\theta_2 \approx 0$, $\theta_3 \approx 0$
$\vec{\omega}_{AB} = 2$ rad/s ↻
$\dot{\theta}_1 = -2$ rad/s

Constraint condition:

$$\boxed{\vec{AB} + \vec{BD} + \vec{DO} = \vec{AO}}$$

$$2(-\cos\theta_1\,\vec{i} + \sin\theta_1\,\vec{j}) + 4(\cos\theta_2\,\vec{i} + \sin\theta_2\,\vec{j}) + 6(\cos\theta_3\,\vec{i} - \sin\theta_3\,\vec{j}) = 8\,\vec{i}$$

$\vec{i}$: $-2\cos\theta_1 + 4\cos\theta_2 + 6\cos\theta_3 = 8$ ..... (1)

$\vec{j}$: $2\sin\theta_1 + 4\sin\theta_2 - 6\sin\theta_3 = 0$ ..... (2)

$$\sin\theta = \theta - \frac{\theta^3}{3!} + \cdots \approx \theta$$

$$\cos\theta = 1 - \frac{\theta^2}{2!} + \frac{\theta^4}{4!} - \cdots \approx 1 - \frac{\theta^2}{2}$$

$$-2\left(1 - \frac{\theta_1^2}{2}\right) + 4\left(1 - \frac{\theta_2^2}{2}\right) + 6\left(1 - \frac{\theta_3^2}{2}\right) = 8$$

$$\cancel{(-2+4+6)} + (\theta_1^2 - 2\theta_2^2 - 3\theta_3^2) = \cancel{8}$$

$$\theta_1^2 - 2\theta_2^2 - 3\theta_3^2 = 0 \quad \text{..... (1')}$$

$2\theta_1 + 4\theta_2 - 6\theta_3 = 0$ $\quad \theta_1 + 2\theta_2 - 3\theta_3 = 0$ ..(2')

$\boxed{\dot{\theta}_2 = \frac{1}{5}(-1 \pm \sqrt{6})\,\dot{\theta}_1}$ $\boxed{\dot{\theta}_3 = \boxed{}\,\dot{\theta}_1}$

$2\theta_2 = 3\theta_3 - \theta_1$ $\quad \theta_2 = 1.5\theta_3 - 0.5\theta_1$

$\theta_1^2 - 2(1.5\theta_3 - 0.5\theta_1)^2 - 3\theta_3^2 = 0$

$a\theta_3^2 + b\theta_3 + c = 0$, $a = \boxed{}$, $b = \boxed{}$, $c = \boxed{}$
V.V. ... Q.P. (see P. 691)