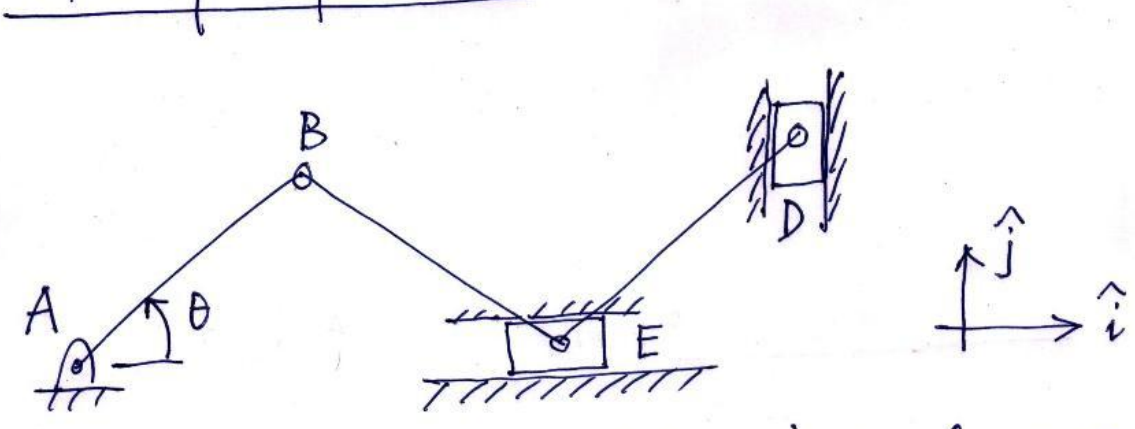
(1) Example problem



If all link lengths and the instantaneous configuration is known (given), and $\dot{\theta}$ and $\ddot{\theta}$ are also given, how to find the velocity and acceleration of slider D?

Take all angular velocities and accelerations to be counterclockwise. So $\underline{\omega}_{AB} = \omega_{AB}\hat{k}$ $= \dot{\theta}\hat{k}$.

$\underline{\dot{\omega}}_{AB} = \underline{\alpha}_{AB} = \alpha_{AB}\hat{k} = \ddot{\theta}\hat{k}$.

and $\underline{\omega}_{BE} = \omega_{BE}\hat{k}$.

ω_{BE} ← some scalar quantity.

Etc.

and $\underline{r}_{AB}$ is the position vector from A to B, while $\underline{r}_{BA} = -\underline{r}_{AB}$, etc.

(2)

$$\underline{V}_B = \cancel{\underline{V}_A}^{\,0} + \underline{\omega}_{AB} \times \underline{r}_{AB}$$

(known since $\dot{\theta}$ is given)

$$\underline{V}_E = \underline{V}_B + \underline{\omega}_{BE} \times \underline{r}_{BE}$$

$$= \underline{V}_B + \omega_{BE}\,\hat{k} \times \underline{r}_{BE} \quad \text{--- (1)}$$

scalar unknown

and also $\underbrace{\underline{V}_E = V_E\,\hat{i}}_{(2)}$ (no $\hat{j}$ component)

from (1) and (2)

$$\underline{V}_B + \omega_{BE}\,\hat{k} \times \underline{r}_{BE} = V_E\,\hat{i}$$

we get 2 scalar equations and solve for ω_{BE} and V_E. These become known.

<u>Now</u> $\underline{V}_D = \underline{V}_E + \omega_{ED}\,\hat{k} \times \underline{r}_{ED}$

scalar unknown

and $\underline{V}_D = V_D\,\hat{j}$

whence we find ω_{ED} and V_D. These become known.

③ Move on to accelerations.

$$\underline{a}_B = \cancel{\underline{a}_A}^{\,\underline{0}} + \underset{\substack{\uparrow \\ \text{one scalar,} \\ \text{known.}}}{\underline{\alpha}_{AB}} \times \underline{r}_{AB} + \underbrace{\underline{\omega}_{AB} \times \underline{\omega}_{AB} \times \underline{r}_{AB}}_{\text{known}}$$

$$\underline{a}_E = \underline{a}_B + \underset{\substack{\uparrow \\ \text{one scalar unknown.}}}{\underline{\alpha}_{BE}} \times \underline{r}_{BE} + \underline{\omega}_{BE} \times \underline{\omega}_{BE} \times \underline{r}_{BE}$$

and also $\underline{a}_E = \underset{\substack{\uparrow \\ \text{one scalar unknown.}}}{a_E} \hat{i}$

Whence we find α_{BE} and a_E.

Knowing $\underline{a}_E$, we have

$$\underline{a}_D = \underline{a}_E + \underset{\substack{\uparrow \\ \text{one scalar unknown}}}{\underline{\alpha}_{ED}} \times \underline{r}_{ED} + \underbrace{\underline{\omega}_{ED} \times \underline{\omega}_{ED} \times \underline{r}_{ED}}_{\text{known}}$$

also $\underline{a}_D = a_D \hat{j}$,

so we find α_{ED} and a_D.

Done.