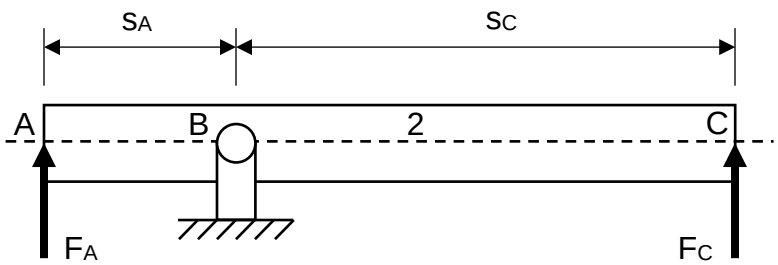
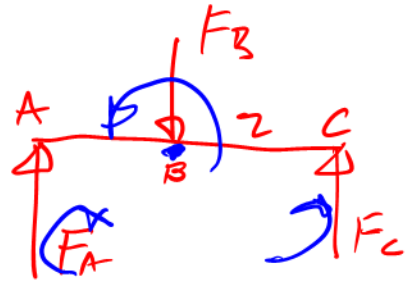
Virtual Work or Virtual Power

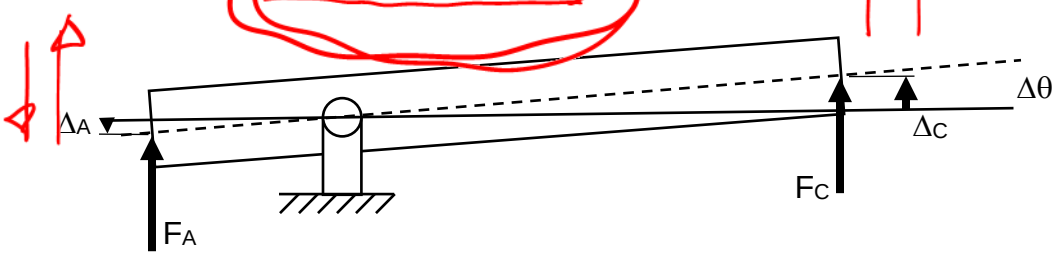
Rigid bar in horizontal plane





Newtonian $\sum M$ on 2 about B CCW + $\boxed{-F_A s_A + F_C s_C = 0}$

Infinitesimal kinematically consistent displacements



virtual displacement $\Delta\theta$

$W = \{F\} \circ \{\Delta\}$

Virtual work

$$\{F_A\} \circ \{\Delta_A\} + \{F_C\} \circ \{\Delta_C\} = 0 \qquad -F_A(s_A\,\cancel{\Delta\theta}) + F_C(s_C\,\cancel{\Delta\theta}) = 0 \qquad -F_A s_A + F_C s_C = 0$$

$\Delta_A = -s_A \Delta\theta$

Virtual power

$$\{F_A\} \circ \frac{\{\Delta_A\}}{\Delta t} + \{F_C\} \circ \frac{\{\Delta_C\}}{\Delta t} = 0 \qquad \{F_A\} \circ \{\dot{r}_A\} + \{F_C\} \circ \{\dot{r}_C\} = 0$$

virtual velocity

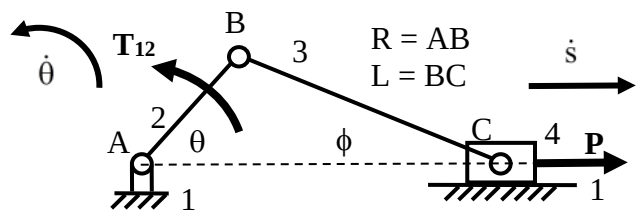
$\{\dot{r}_A\} \longrightarrow \{\dot{r}_C\}$

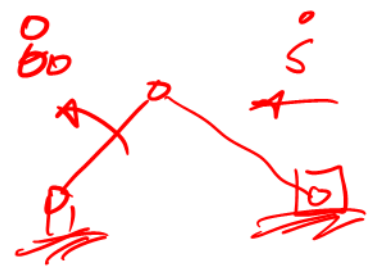
Virtual power for ground connections is zero because the velocity is zero. Virtual power across internal joints is zero because the force of link i on link j dotted with the velocity of the joint will be equal and opposite to the force of link j on link i dotted with the velocity of the joint. However virtual power across internal springs or dampers must be included.

$\{F_B\} \circ \{\dot{r}_2\}^B$

$$\sum\left(\{F_{EXT}\} \circ \{\dot{r}_{APPLIED}\}\right) + \sum\left(\{M_{EXT}\} \circ \{\omega_{APPLIED}\}\right) = 0$$

Virtual Work for Slider Crank





$$\dot{s} = -R\dot{\theta}\sin\theta - L\dot{\phi}\sin\phi = -R\dot{\theta}\left(\frac{\sin(\theta+\phi)}{\cos\phi}\right)$$ from Notes_03_01

$$T_{12} \circ \dot{\theta} + P \circ \dot{s} = 0$$

$$P \circ \dot{s} = -P\dot{s}$$

$$T_{12} = -\frac{P \circ \dot{s}}{\dot{\theta}} = \frac{PR\sin(\theta+\phi)}{\cos\phi}$$ matches Notes_06_01 for $\mu = 0$