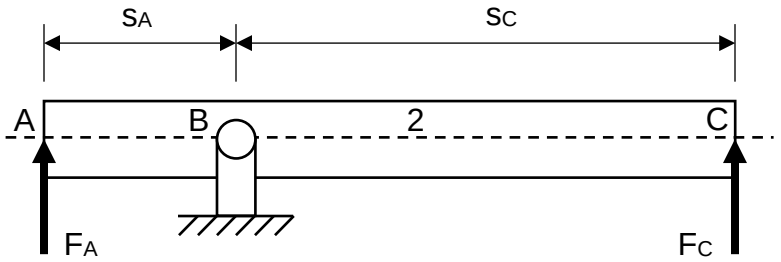
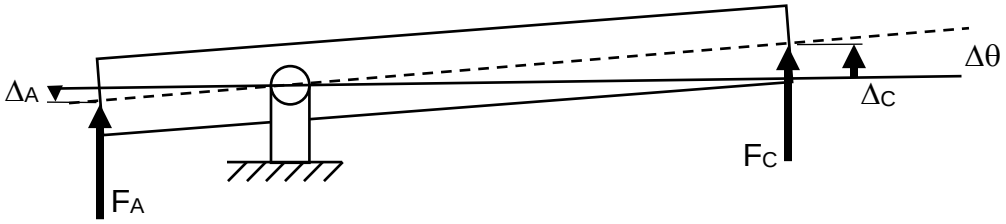
Virtual Work

Rigid bar in horizontal plane



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

Infinitesimal kinematically consistent displacements



Virtual work

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

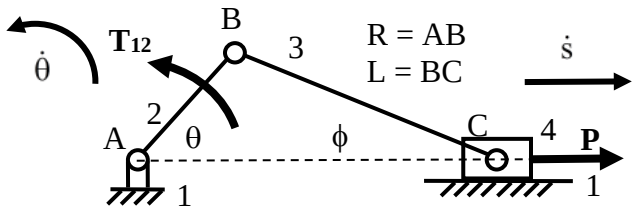
Virtual power

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

Virtual 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.

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

Virtual Work for Slider Crank



$$\dot{s} = -R\dot{\theta}\sin\theta - L\dot{\phi}\sin\phi = -R\dot{\theta}\left(\frac{\sin(\theta+\phi)}{\cos\phi}\right) \qquad \text{from Notes\_03\_01}$$

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

$$T_{12} = -\frac{P \circ \dot{s}}{\dot{\theta}} = \frac{PR\sin(\theta+\phi)}{\cos\phi} \qquad \text{matches Notes\_06\_01 for } \mu = 0$$