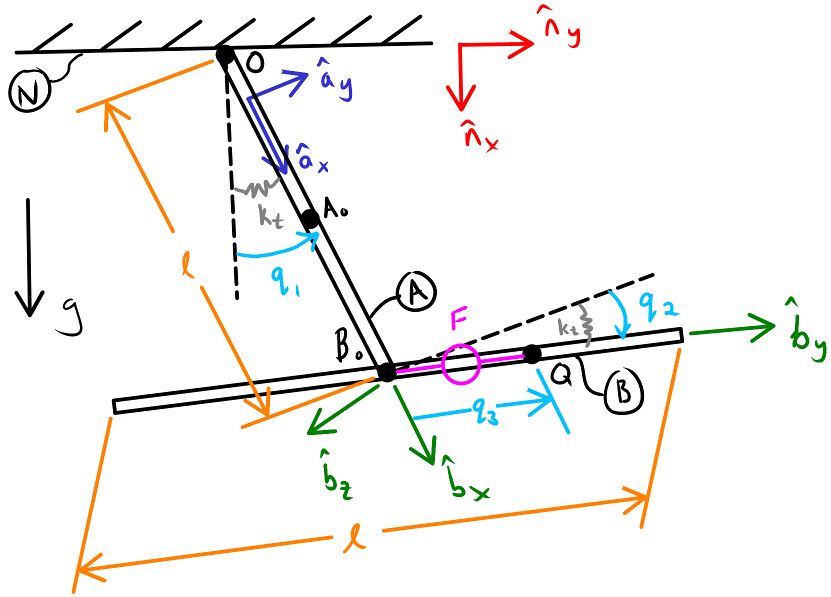

O
N
$\hat{a}_y$
$\hat{a}_x$
$\hat{n}_y$
$\hat{n}_x$
k_t
A_o
q_1
ℓ
g
A
F
q_2
k_t
$\hat{b}_y$
B_o
Q
B
q_3
$\hat{b}_z$
$\hat{b}_x$
ℓ

Equations of Motion

$\bar{F}_r$ generalized active forces

$\hookrightarrow \bar{F} = m\bar{a}$

$\bar{F}_r^*$ generalized inertia forces

DoF $p = n$ (no extra non + holonomic constraints)

$$\boxed{\bar{F}_r + \bar{F}_r^* = 0}$$

$\bar{F} - m\bar{a} = 0$

dynamical differential equations, also Kane's Equations

$$\bar{F} + \bar{F}_r^* = \bar{f}_d(\dot{\bar{u}}, \bar{u}, \bar{q}, t) = 0$$ dynamical

$$\bar{f}_k(\dot{\bar{q}}\bar{u}, \bar{q}, t) = 0$$ kinematical

$$\bar{f}_k = M_k \dot{\bar{q}} + \bar{g}_k(\bar{u}, \bar{q}, t) = 0 \Rightarrow \dot{\bar{q}} = -M_k^{-1}\bar{g}_k$$ ← explicit in the $\dot{\bar{q}}$

$$\bar{f}_d = M_d \dot{\bar{u}} + \bar{g}_d(\bar{u}, \bar{q}, t) = 0 \Rightarrow \dot{\bar{u}} = -M_d^{-1} g_d$$ ← explicit in the $\dot{\bar{u}}$

Trajectories of $\bar{q}(t)$ & $\bar{u}(t)$

$$\bar{q}(t) = \int_{t_0}^{t_f} -M_k^{-1}\bar{g}\, dt \qquad \bar{X} = \begin{bmatrix} \bar{q} \\ \bar{u} \end{bmatrix}$$

$$\underbrace{\overset{2n\times 2n}{\begin{bmatrix} M_k & 0 \\ 0 & M_d \end{bmatrix}}}_{M_m} \overset{\dot{\bar{x}}\ \ 2n\times 1}{\begin{bmatrix} \dot{\bar{q}} \\ \dot{\bar{u}} \end{bmatrix}} + \overset{2n\times 1}{\begin{bmatrix} \bar{g}_k \\ \bar{g}_d \end{bmatrix}} = \overset{2n\times 1}{\begin{bmatrix} \bar{0} \\ \bar{0} \end{bmatrix}}$$

$$M_m \dot{\bar{x}} + \bar{g}_m = 0 \Rightarrow \dot{\bar{x}} = -M_m^{-1}\bar{g}_m$$

trajectories

$$\bar{x}(t) = \int_{t_0}^{t_f} \dot{\bar{x}}\, dt = \int_{t_0}^{t_f} -M_m^{-1}\bar{g}_m\, dt$$