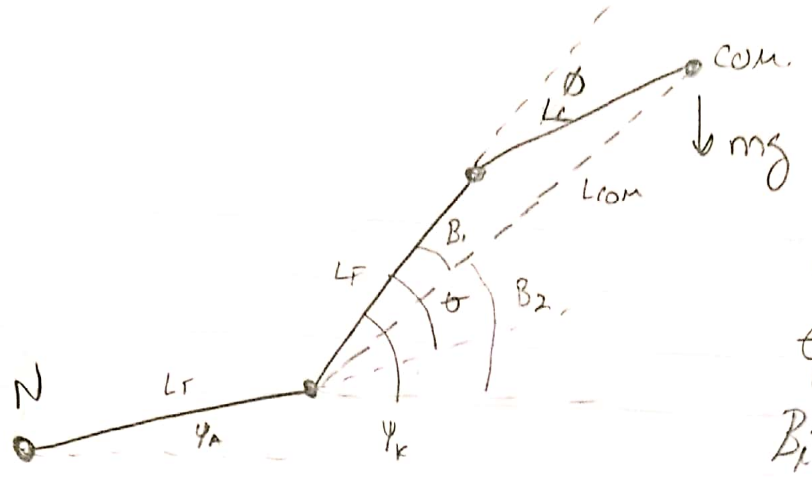


ψ_A - ankle elevation angle
ψ_K - absolute knee elevation angle
θ - knee flexion angle
ϕ = hip flexion angle
B_i - internal COM angle
B_2 - external COM angle

Geometric approximations.

if given ϕ, using law of cosines

$$\boxed{L_{com} = \sqrt{L_F^2 + L_c^2 - 2 L_F \cdot L_c \cos(180-\phi)}}$$

to find B_i, use law of sines

$$\frac{\sin(B_1)}{L_c} = \frac{\sin(180-\phi)}{L_{com}}.$$

$$\boxed{B_i = \sin^{-1}\left(\sin(180-\phi)\frac{L_c}{L_{com}}\right)}$$

$$B_2 = \psi_K - B_i = (\theta + \psi_A) - B_i$$

How do we get B_2 since ψ_K is techically unknown

$$\Sigma M = 0$$

$$(N) \cdot L_T \cos(\psi_A) = (mg) \cdot L_{com} \cos(B_2)$$

$$\boxed{B_2 = \cos^{-1}\left(\frac{\tau_N}{mg\, L_{com}}\right)}$$

we will be given

N, L_T & $\psi_A \Rightarrow \tau_N$

Mg, L_F, L_C, $\phi \Rightarrow L_{com}$ & B_1 (& τ_{mg})

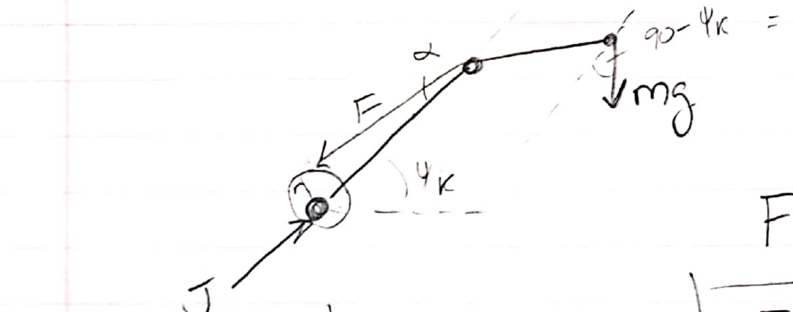
using this, we can retrieve B_2.

since

$$\boxed{\theta = B_1 + B_2 - \psi_A}$$

we can get each point of the movement using N & know geometry.

Now w/ θ, analyze forces



$\psi_k = \theta + \psi_A$

$\Sigma F_y = 0$

$F \sin\alpha = mg \cos(\psi_k)$

$$\boxed{F = mg \frac{\cos(\theta + \psi_A)}{\sin\alpha}}$$

$\Sigma F_x = 0$

$$\boxed{J = mg \sin(\theta + \psi_A) + F\cos\alpha}$$

$\alpha = \tan^{-1}\left(\frac{r}{L_F}\right)$

$r \approx 0.025\ m$