Suppose equallibrium when $\theta = 0$ (def)

$$\tau = -(\theta r)\cdot(k_1 + k_2)$$

$$= -(k_1 + k_2) r \theta .$$

$$\Rightarrow \frac{d^2\theta}{dt^2} \cdot I = -(k_1 + k_2) r \theta .$$

$$\theta'' = -\frac{(k_1+k_2) r}{I}\theta . \longrightarrow K = (k_1 + k_2) r$$

Torsional Spring Constant.

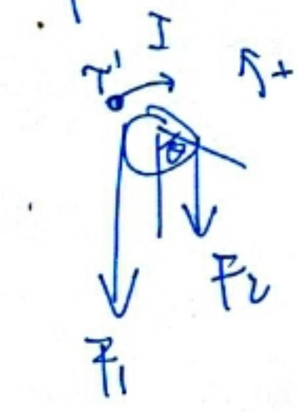
$\Rightarrow$ SHM: (No damp).

$$\omega = \sqrt{\frac{(k_1+k_2)r}{I}} . \quad T = 2\pi\sqrt{\frac{I}{(k_1+k_2)r}} = 2\pi\sqrt{\frac{I}{K}}$$

Electromagnetic damping

$\Rightarrow$ Damped SHM: (Damped)

By Electro-Magnetic Theorem. Electromagnetic damping:



$f \propto -V$, in this case, WLG $\tau' = -s\frac{d\theta}{dt}$ where s is the ~~ratiat~~ ratial.

$$\Rightarrow \tau = -(k_1+k_2) r\theta - s\frac{d\theta}{dt} .$$

$$\Rightarrow . \quad \theta'' + \frac{s}{I}\theta' + \frac{(k_1+k_2)r}{I}\theta = 0 .$$

$$\Rightarrow \theta = c_1 \cdot e^{\left(\frac{\sqrt{s^2 - 4I(k_1+k_2)r}}{2I} - \frac{s}{2I}\right)\cdot t} + c_2 \cdot e^{\left(\frac{\sqrt{s^2 - 4I(k_1+k_2)r}}{2I} - \frac{s}{2I}\right) t} .$$

Which could be an (underdamped) Sinusoidal function