Angular velocity TF,

$$\omega = \frac{\left(\frac{1}{J}\right) K_p \omega_r (s + K_i) + sT}{s^2 + s\left(\frac{1}{J}\right)\left(K_p + K_i J_m\right) + \left(\frac{1}{J}\right)\left(K_p K_i\right)}$$

In order for system to have no oscillations,

$$K_p^2 + 2K_i K_p J_m + K_i^2 J_m^2 \geq 4J K_p K_i$$

If $K_i = K_p = K$,

$$K^2 + 2K^2 J_m + K^2 J_m^2 \geq 4K^2 J$$

Assuming $J_m = J$,

$$K^2 + K^2 J^2 - 2K^2 J \geq 0$$

$$1 + J^2 - 2J \geq 0$$

$$J^2 - 2J + 1 \geq 0$$

$$(J - 1)^2 \geq 0$$

CANNOT APPLY SQRT TO BOTH SIDES

$$K^2 + K^2 J^2 - 2K^2 J \geq 0$$

Is always fulfilled.

Time constant,

$$\tau_\omega = \frac{2J}{K_p + K_i J_m}$$

Since $K_i = K_P = K$,

$$\tau_\omega \approx \frac{2J}{K(1 + J)} \approx \frac{2J}{K}$$

Hence, for most motors, $K = 50 * J$ and $K_{pp} = 10 * J$?