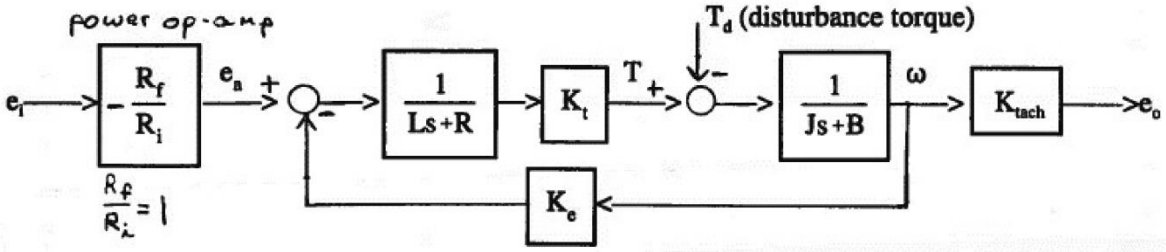
Given:



The transfer function between e_o and e_i is:

$$\left(e_i\left(-\frac{R_f}{R_i}\right) - K_e\omega\right)\left(\frac{1}{Ls+R}\right)(K_t)\left(\frac{1}{Js+B}\right) = \omega$$

Since the input is simulated to be DC, $Ls \approx Js \approx 0$, and solve for relationship between e_i and ω:

$$\frac{RB\omega}{K_t} + K_e\omega = e_i\left(-\frac{R_f}{R_i}\right)$$

$$\omega\left(\frac{RB}{K_t} + K_e\right) = e_i(-\frac{R_f}{R_i})$$

$$K_{tach}\omega = e_o = \frac{K_{tach}e_i(-\frac{R_f}{R_i})}{\left(\frac{RB}{K_t} + K_e\right)}$$

From which, I solved for K_t:

$$e_o\left(\frac{RB}{K_t} + K_e\right) = K_{tach}e_i(-\frac{R_f}{R_i})$$

$$\frac{RB}{K_t} + K_e = \frac{K_{tach}e_i\left(-\frac{R_f}{R_i}\right)}{e_o}$$

$$\frac{RB}{K_t} = \frac{K_{tach}e_i\left(-\frac{R_f}{R_i}\right)}{e_o} - K_e$$

$$\frac{K_t}{RB} = \frac{1}{\frac{K_{tach}e_i\left(-\frac{R_f}{R_i}\right)}{e_o} - K_e}$$

$$K_t = \frac{RB}{\frac{K_{tach}e_i\left(-\frac{R_f}{R_i}\right)}{e_o} - K_e} = \frac{RB}{K_{tach}\left(\frac{e_i}{e_o}\right)\left(-\frac{R_f}{R_i}\right) - K_e}$$

I expect to get a constant K_t for all values of $e_o = e_{tach}$ and e_i = Input voltage (1 – 10 V).