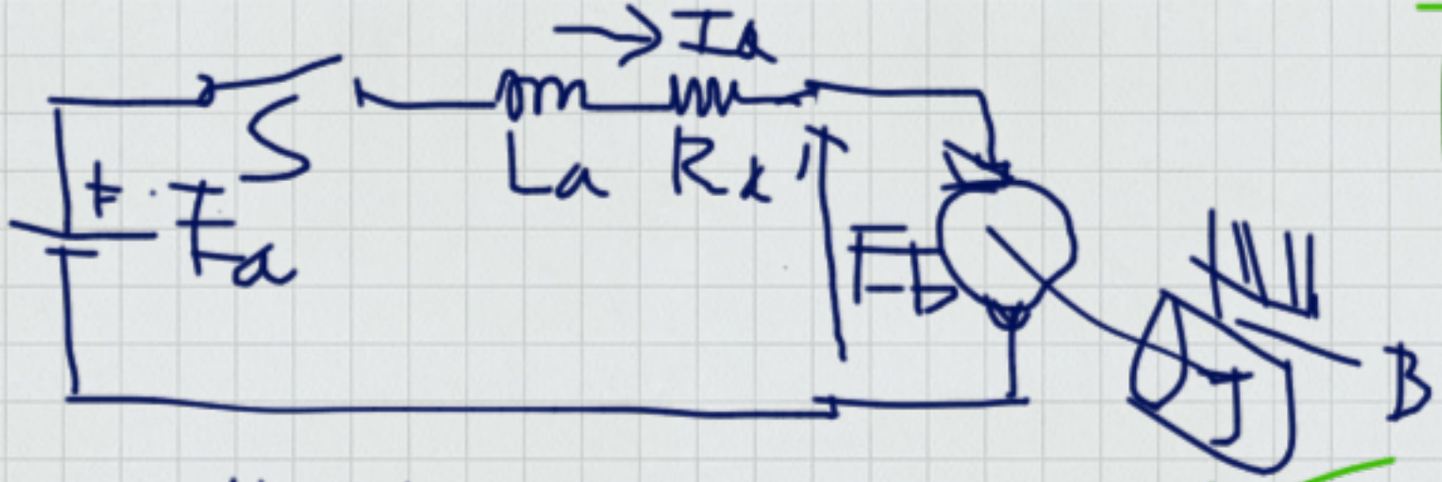

(3) $T(t) = K_m i_a(t)$

(4) $e_b(t) = K_b \omega(t)$

(1) $$\frac{di_a(t)}{dt} = \frac{1}{L_a}\left[e_a(t) - K_b\omega(t) - R_a i_a(t)\right]$$

(2) $$\frac{d\omega(t)}{dt} = \frac{1}{J}\left[K_m i_a(t) - B\omega(t)\right]$$

Transformasi Laplace :

(1) $$sI_a(s) = \frac{1}{L_a}\left[E_a(s) - K_b\omega(s) - R_a I_a(s)\right]$$

(2) $$s\omega(s) = \frac{1}{J}\left[K_m I_a(s) - B\omega(s)\right]$$

$$E_a(s) = \frac{E_{aNOM}}{s}$$

Jika $\boxed{G(s) = \frac{\omega(s)}{E_a(s)}}$

$\boxed{H(s) = \frac{I_a(s)}{E_a(s)}}$

maka:

$$\omega(s) = G(s) E_a(s)$$

$$I_a(s) = H(s) E_a(s)$$

Hasil Analisis:

$$\omega(t) = \mathcal{L}^{-1} \omega(s)$$

$$i_a(t) = \mathcal{L}^{-1} I_a(s)$$

(exact ⟶ Excel sbg REF)

$$(2) \rightarrow \quad Js\omega(s) = K_m I_a(s) - B\omega(s)$$

$$[Js+B]\omega(s) = K_m I_a(s)$$

$$I_a(s) = \frac{Js+B}{K_m}\omega(s)$$

$$(1) \quad s\left[\frac{Js+B}{K_m}\right]\omega(s) = \frac{1}{L_a}\left[E_a(s) - K_b\omega(s) - R_a\left(\frac{Js+B}{K_m}\right)\omega(s)\right]$$

$$s\left[JL_a s + BL_a\right]\omega(s) = K_m\left[E_a(s) - K_b\omega(s) - \frac{R_a(Js+B)}{K_m}\omega(s)\right]$$

$$= K_m E_a(s) - K_b K_L \omega(s) - R_a(Js+B)\omega(s)$$

$$\left[s(J L_a s + B L_a) + R_a (J s + B) + K_m K_b \right] \omega(s) = K_m E_a(s)$$

$$G(s) = \frac{\omega(s)}{E_a(s)} = \frac{K_m}{J L_a s^2 + (J R_a + B L_a) s + (R_a B + K_m K_b)}$$

$$\approx \frac{K_0}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

$$K_0 = \frac{K_m}{J L_a} \qquad \omega_n^2 = \frac{R_a B + K_m K_b}{J L_a}$$

$$2\xi\omega_n = \frac{J R_a + B L_a}{J L_a}$$

$$\omega(s) = G(s) E_a(s)$$

$$= \left[\frac{K_G}{s^2 + 2\xi\omega_n s + \omega_n^2}\right]\left[\frac{E_{aNOM}}{s}\right]$$

$$= \frac{K_G E_{aNOM}}{s\left(s^2 + 2\xi_\omega \omega_n s + \omega_n^2\right)}$$

$$\omega(t) = \mathcal{L}^{-1}\left\{\frac{K_G E_{aNOM}}{s\left(s^2 + 2\xi_\omega \omega_n s + \omega_n^2\right)}\right\}$$

[TABEL LAPLACE]

(1) $0 < \xi_\omega < 1 \longrightarrow$ underdamped

(2) $\xi_\omega = 1 \longrightarrow$ critically damped

(3) $\xi_\omega > 1 \longrightarrow$ overdamped

$$I_a(s) = \frac{Js+B}{K_m}\omega(s)$$

$$\frac{I_a(s)}{E_a(s)} = \frac{Js+B}{K_m}\frac{\omega(s)}{E_a(s)} = \frac{Js+B}{K_m}G(s)$$

$$H(s) = \frac{Js+B}{K_m}\frac{K_0}{s^2+2\xi\omega_n s+\omega_n^2}$$

$$I_a(s) = H(s)\cdot E_a(s) = \frac{(Js+B)K_0}{K_m(s^2+2\xi\omega_n s+\omega_n^2)}\cdot\frac{E_a NOL}{s}$$

$$= \frac{JK_0}{K_m}\left[\frac{E_a NOM}{s^2+2\xi\omega_n s+\omega_n^2}\right] + \left[\frac{BK_0 E_a NOM}{K_m s(s^2+\dots}\right]$$

$$i_a(t) = \mathcal{L}^{-1}I_a(s)$$