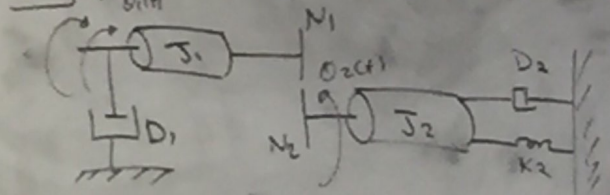
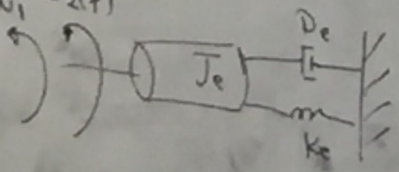
Ex] $T_i(t)$ $\theta_2(t)$



Find the TF. $\frac{\theta_2(s)}{T_i(s)}$

$T_i(t)\frac{N_2}{N_1}$ $\theta_2(t)$



$J_e = J_2 + J_1\left(\frac{N_2}{N_1}\right)^2$

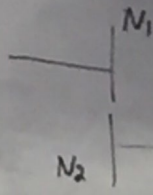
$D_e = D_2 + D_1\left(\frac{N_2}{N_1}\right)^2$

$K_e = K_2$

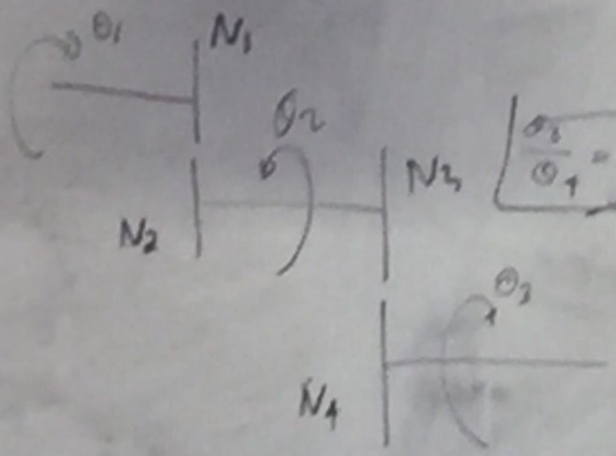
$\left[J_e s^2 + D_e s + K_e\right]\theta_2(s) = \frac{N_2}{N_1} T_i(s)$

$\frac{\theta_2(s)}{T_i(s)} = \frac{\frac{N_2}{N_1}}{\left(J_e s^2 + D_e s + K_e\right)}$

Gear Train



Gear Train



$$\frac{\theta_3}{\theta_2} = \frac{N_1}{N_4}$$

$$\frac{\theta_3}{\theta_1} = \frac{\theta_2}{\theta_3} = \frac{N_1}{N_3}$$

$$\frac{N_2}{N_1} T_1(s)$$

$$\theta_3 = \frac{N_3}{N_1} \theta_2$$

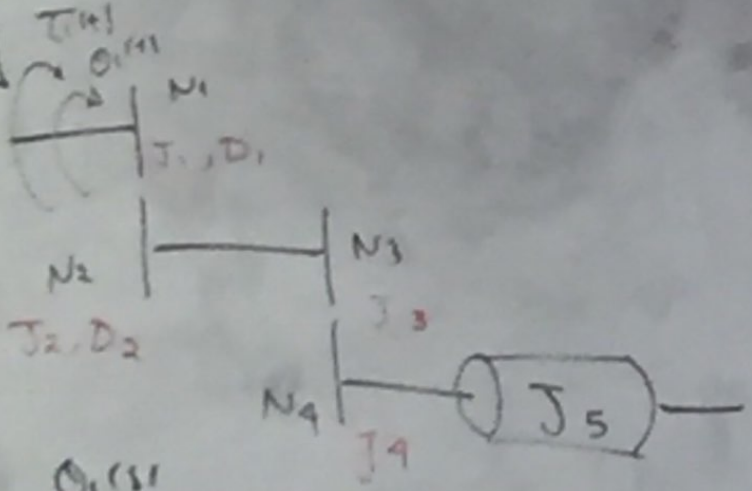
$$\frac{\theta_2}{\theta_1} = \frac{N_1}{N_2}$$

$$\theta_2 = \frac{N_1}{N_2} \theta_1$$

$$\theta_3 = \frac{N_2}{N_4} \frac{N_1}{N_2} \theta_1$$

$$\frac{\theta_3}{\theta_1} =$$

Ex1



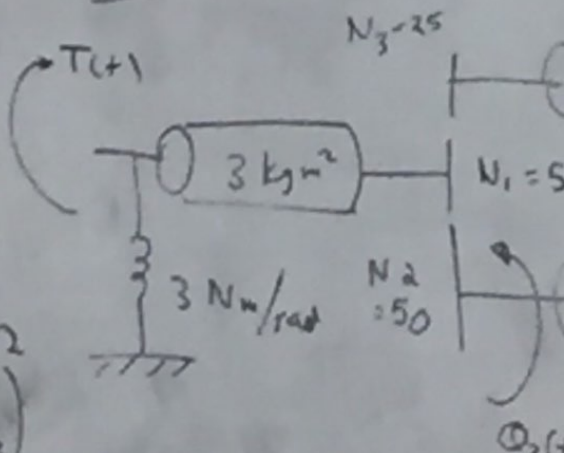
$$G(s) = \frac{\Theta_1(s)}{T_1(s)}$$

$$J_e = J_1 + (J_2 + J_3)\left(\frac{N_1}{N_2}\right)^2 + (J_4 + J_5)\left(\frac{N_3}{N_4}\cdot\frac{N_1}{N_2}\right)^2$$

$$D_e = D_1 + D_2\left(\frac{N_1}{N_2}\right)^2$$

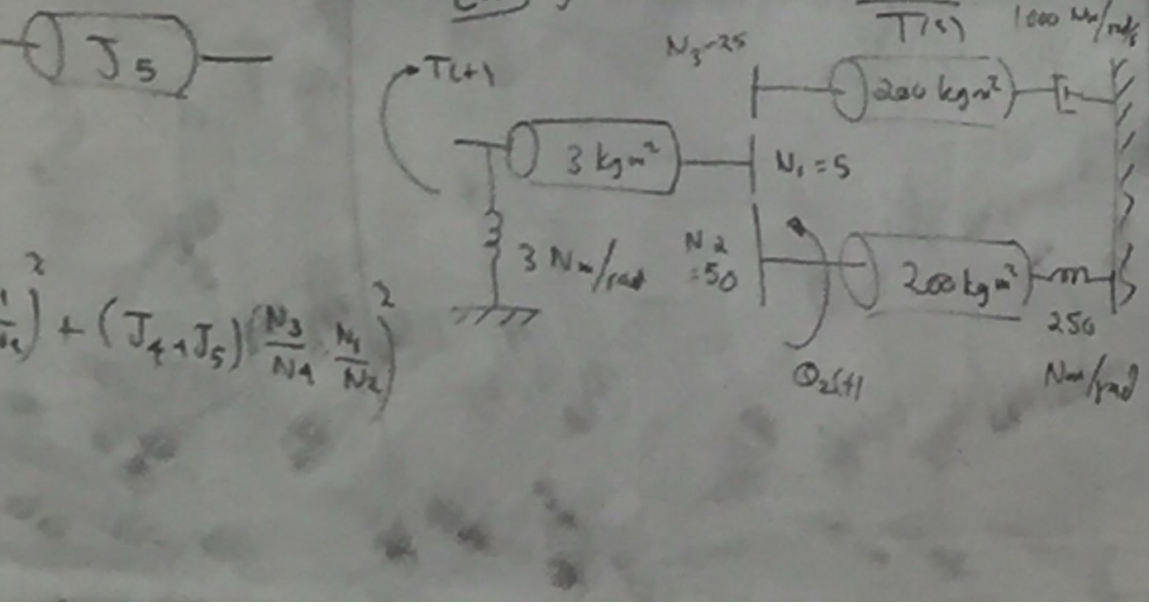
$$\frac{\Theta_1(s)}{T_1(s)} = \frac{1}{s(J_e s + D_e)}$$

Ex) find the T.F



$$\frac{\Theta_1(s)}{T_1(s)} = \frac{1}{s(J_e s + D_e)}$$

EX) find the TF $\frac{\Theta_2(s)}{T(s)}$



$$\left(\frac{N_1}{N_2}\right)^2 + (J_4 + J_5)\left(\frac{N_3}{N_4}\frac{N_1}{N_2}\right)^2$$

$$J_e = 200 + 3\times\left(\frac{50}{5}\right)^2 + 200\times\left(\frac{5}{25}\times\frac{50}{5}\right)^2 = 1300\ kg\,m^2$$

$$D_e = 1000\left(\frac{50}{25}\right)^2 = 4000\ N\,m\,s/rad.$$

$$K_e = 250 + 3\times\left(\frac{50}{5}\right)^2 = 550\ N\,m/rad.$$

$$\left[1300\,s^2 + 4000\,s + 550\right]\Theta_2(s) = \left(\frac{50}{5}\right)T(s)$$

$$\frac{\Theta_2(s)}{T(s)} = \frac{10}{1300\,s^2 + 4000\,s + 550}$$

2 8) Electromechanical System

Transfer function.

$e_a(t) =$

$i_a(t) =$

$v_b(t) =$

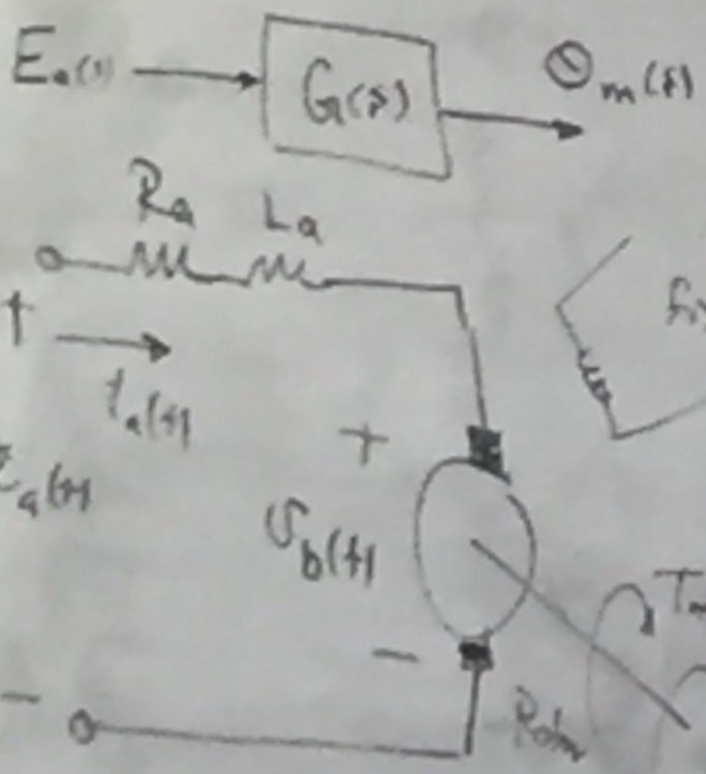
$R_a =$

$L_a =$

⇒ DC motor

$$\left\{ \begin{array}{l} F = B l\, i_a \\ v_b = B l\, v \end{array} \right\}$$

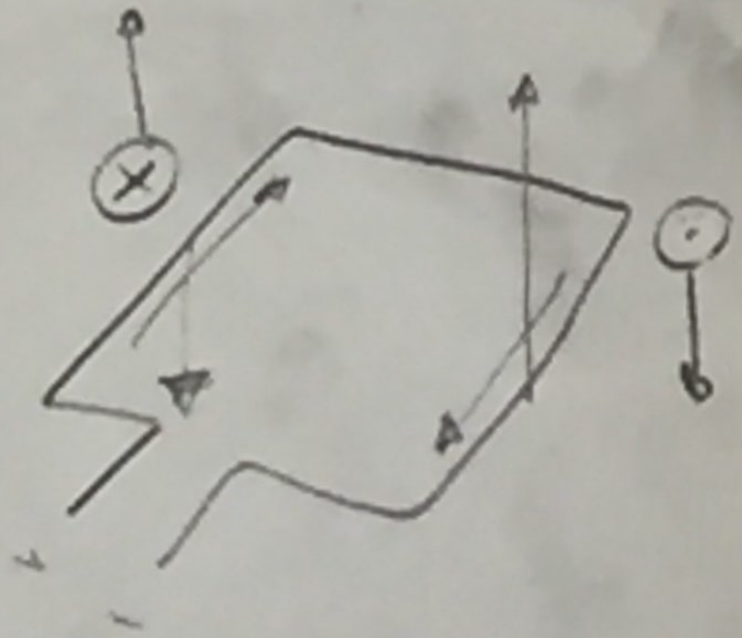
v → velocity



$)^2 + 200\times\left(\frac{5}{25}\times\frac{50}{5}\right)^2$

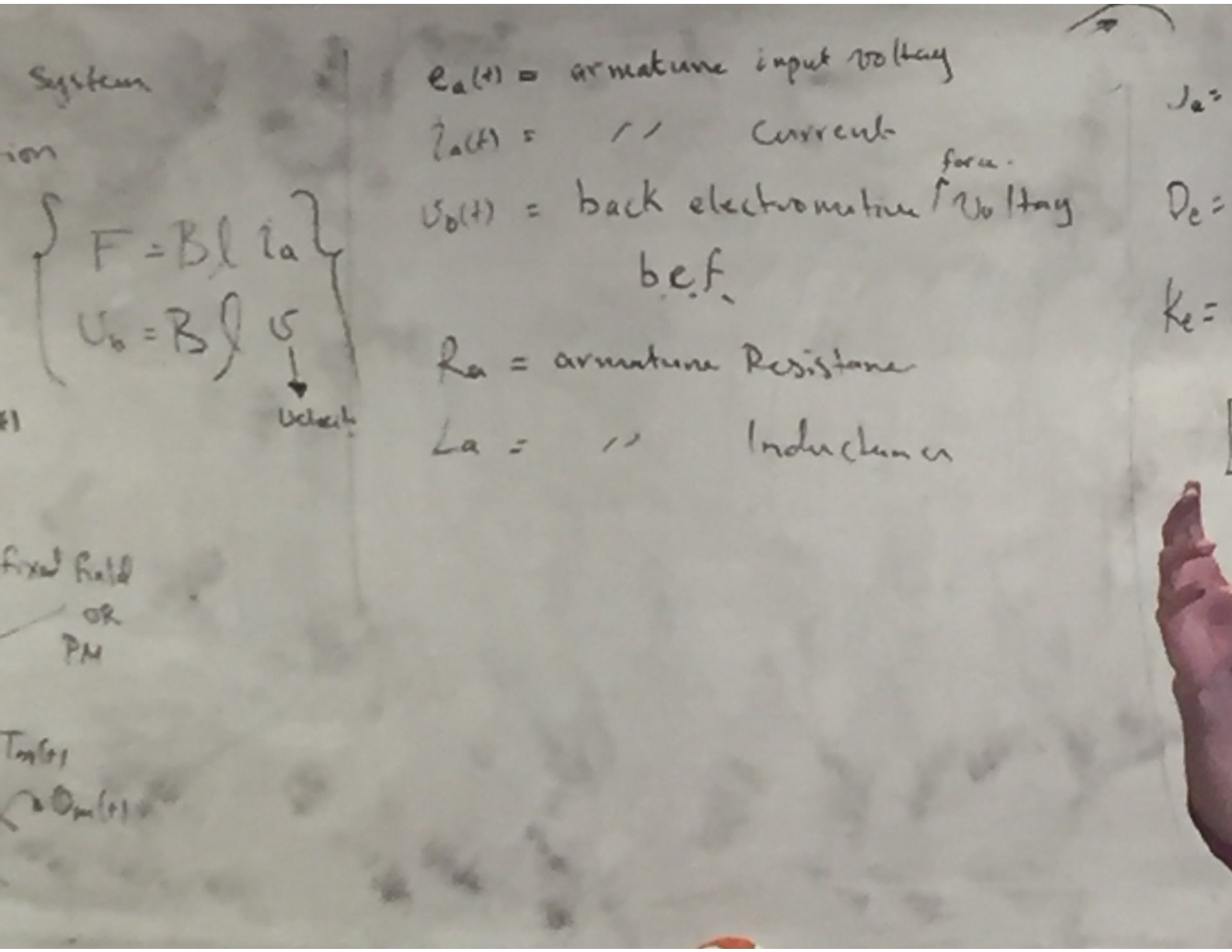
$)^2 = 400$

$\left(\frac{50}{5}\right)^2 = 55$



$4000s + 550]\,\theta_2$

$\frac{)}{5)} = \frac{10}{(300s^2+4000)+550}$



$e_a(t)$ = armature input voltage

$i_a(t)$ = " current

$v_b(t)$ = back electromotive force voltage.

b.e.f.

R_a = armature Resistance

L_a = " Inductance

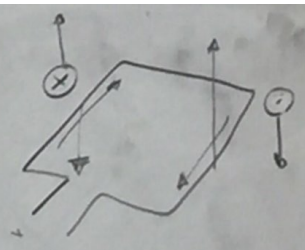
$T_m(t) = K_t \cdot i_a(t)$

$$\boxed{T_m(t) = k_t \cdot I_a(s)} \quad (A)$$

$v_b(t) = K_b$ with

$= K_b \frac{d}{dt} \theta_m(t)$

$$\boxed{V_b(s) = K_b\, s\, \theta_m(s)} \quad (B)$$



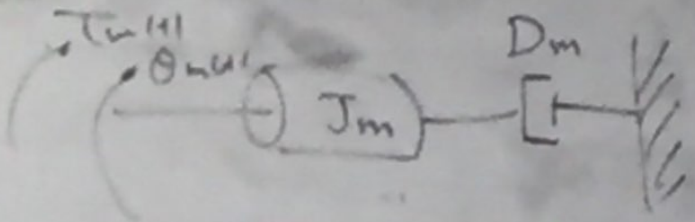
$$(R_a + sL_a) I_a(s) + V_b(s) = E_a(s) \quad (1)$$

$A \& B \rightarrow (1)$

$$\boxed{(R_a + sL_a)\frac{T_m(s)}{k_t} + k_b\, s\, \theta_m(s) = E_a(s)} \quad (2)$$

In general

Mechanical load



$J_m = J_a + J_L$ reflected to the armature

$D_m = D_a + D_L$ " " " "

$\Theta_m(s)\left[J_m s^2 + D_m s\right] = T_m(s)$ —— (C)

$e_a(t)$ = armature input vo

$i_a(t)$ = " " curren

$v_b(t)$ = back electromot

b.e.f.

R_a = armature Resista

L_a = " Induct

$T_m(t) = K_t \cdot i_a(t)$

$T_m(s) = k_t \cdot I_a(s)$