Date

* BLDC Motor

linear vltg eq^n expressed as

$$\begin{bmatrix} u_{AB} \\ u_{BC} \\ u_{CA} \end{bmatrix} = \begin{bmatrix} R & -R & 0 \\ 0 & R & -R \\ -R & 0 & R \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix} + \begin{bmatrix} L-M & M-L & 0 \\ 0 & L-M & M-L \\ M-L & 0 & L-M \end{bmatrix} \frac{d}{dt} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix} + \begin{bmatrix} e_A - e_B \\ e_B - e_C \\ e_C - e_A \end{bmatrix}$$

$$\therefore U_{AB} = U_d = r_a i + L_a \frac{di}{dt} + k_e \Omega \quad \text{--- (1)}$$

U_D = DC bus Vltg

r_a = winding wire resistance, $r_a = 2R$

L_a = winding equivalent line inductance = $2(L-M)$

k_e = Line back emf Coefficient - $4PNJB_m$

Modeling of BLDC motor.

∴ Taking inverse Laplace of eq^n (1)

$$\therefore U_d(s) = (r_a + L_a s) I(s) + k_e \Omega(s)$$

where,

Ω = mechanical angular speed of motor

∴ Electrical part TF

$$\therefore U_d(s) = (r_a + L_a s) I(s) + k_e \Omega(s)$$

$$\therefore \frac{I(s)}{U_d(s) - k_e \Omega(s)} = \frac{1}{r_a + L_a s}$$

* Mechanical Part.

$$T_e(s) - T_L(s) = (Js + B_v)\Omega(s)$$

$T_e(s) = K_T I(s)$

where,

T_e = Electromagnetic torque

K_T = motor torque Coefficient

T_L = load torque

J = moment of inertia of rotor

B_V = Coefficient of viscous friction

$$\therefore \frac{\Omega(s)}{T_e(s) - T_L(s)} = \frac{1}{Js + B_V}$$

∴ Assuming.

$T_L = 10\ Nm$

$K_e = 0.0275$

$B_V = 0.004586\ Wb$

$J = 0.0002\ kgm^2$

$T_T = 0.0275$

$l_a = 0.0001 H$

$r_a = 14\ m\Omega = 0.014\ \Omega$

∴ Electrical TF :-

$$\frac{I(s)}{V_d(s) - K_e\Omega(s)} = \frac{1}{r_a + l_a s} = \frac{1}{0.014 + 0.0001s}$$

Mechanical TF :-

$$\frac{\Omega(s)}{T_e(s) - T_L(s)} = \frac{1}{Js + B_V} = \frac{1}{0.0002s + 0.004586}$$