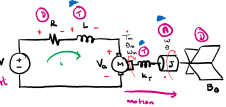
FAN



set of eqs (i)

- $V = V_R + V_L + V_a$ — (1)
  $i_R = i_L = i_m$ → motor's current
- $T_m = T_{K_T}$ — (2)
- $T_{K_T} = T_J + T_{B_\theta}$ — (3)

Coupling eqs. (iii):
$V_a = K_a \omega_m$
$T_m = K_f i_m$ → i_m

$\dot{\theta} = \omega$

Elemental eqs (ii):
$V_R = Ri$
$V_L = L i'$
$T_{K_T} = K_T(\theta_m - \theta)$
$T_J = J\dot{\omega}$
$T_{B_\theta} = B_\theta \omega$

STATE VAR.

$x_1 = i_L$
$x_2 = \theta$ — This is a bit diff. than in your table
$x_3 = \omega$

ELECTRICAL SUB.

From (1) $V = Ri_L + Li_L' + V_a$

$i_L' = -\frac{R}{L} i_L - \frac{1}{L} V_a + \frac{1}{L} V$ — (D1)
(V → input!)

MECH. SUB.

$\dot{\theta} = \omega$ — (D2)

From (2) and (3) $T_m = J\dot{\omega} + B_\theta \omega$ — (D3)

$\dot{\omega} = \frac{1}{J} T_m - \frac{B_\theta}{J} \omega$ — (D3)

$\dot{\omega} = \frac{K_f}{J} i_L - \frac{B_\theta}{J} \omega$ — ($\dot{\omega}$)

$V_a = K_a \omega_m$ — (Va)

$T_{K_T} = K_T(\theta_m - \theta)$ → $\frac{d}{dt}$

$\dot{T}_{K_T} = K_T(\omega_m - \omega)$
$\dot{T}_m = K_T(\omega_m - \omega)$
$K_f i_L' = K_T(\omega_m - \omega)$
$\omega_m = \frac{1}{K_T K_f} i_L' + \omega$

$V_a = \frac{K_a}{K_T} K_f i_L' + K_a \omega$ — (Va)

Substituting (Va) in (D1)

$i_L' = -\frac{R}{L} i_L + \frac{1}{L} V - \frac{K_a}{K_T L} K_f i_L' - \frac{K_a}{L} \omega$

$\left(1 + \frac{K_a K_f}{K_T L}\right) i_L' = -\frac{R}{L} i_L + \frac{1}{L} V - \frac{K_a}{L} \omega$

$\frac{K_T L + K_a K_f}{K_T L}$

$\Rightarrow i_L' = -\frac{K_T R}{K_T L + K_a K_f} i_L + \frac{K_T}{K_T L + K_a K_f} V - \frac{K_a K_T}{K_T L + K_a K_f} \omega$ — (i_L')

(i_L → x_1, ω → x_3)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \underbrace{\begin{bmatrix} -\frac{K_T R}{K_T L + K_a K_f} & 0 & -\frac{K_a K_T}{K_T L + K_a K_f} \\ 0 & 1 & 0 \\ \frac{K_f}{J} & 0 & -\frac{B_\theta}{J} \end{bmatrix}}_{A} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \underbrace{\begin{bmatrix} \frac{K_T}{K_T L + K_a K_f} \\ 0 \\ 0 \end{bmatrix}}_{B} V$$

V → u