Problem 9 :

$$L\frac{di_a}{dt} = V_a - Ri_a - R_a \quad \text{—— (1)}$$

$$J\frac{d\omega}{dt} = T_e - T_l - B\omega \quad \text{—— (2)}$$

where, L = armature self inductance

R = armature Resistance

V_a = terminal ~~v~~ phase voltage. (also V_b, V_c)

i_a, i_b & i_c = motor input Current.

e_a = motor back emf

T_o = torque output.

T_l = load torque.

B = friction Co-efficient

J = Intertia.

$$T_e = \frac{e_a i_a + e_b i_b + e_c i_c}{\omega}$$

$$\theta_e = \frac{P}{2}\theta_m \quad (\theta_m - \text{mech rotor angle})$$

where, P = no of poles (θ_e - electrical rotor angle)

$e_a = K_w f(\theta_e) w$

where,

K_w : back emf constant.

$e_f = K_w f(\theta_e - 120°) w$

$e_c = K_w f(\theta_e + 120°) w$

we assume values,

$V_a = 30V$, $R = 4.98\Omega$ $L = 5.05$ mH

$P = 4$, $T = 15.17 \times 10^{-6} N$

$K_w = 56.23 \times 10^{-3}$, load time = 10s