Problem 9:

Derivation:

Given Equations:

a) $V_a = R_a I_a + L_a\left(\frac{dI_a}{dt}\right) + e_a$

$\therefore L_a\left(\frac{dI_a}{dt}\right) = V_a - R_a I_a - e_a$ ——— ①

b) $V_b = R_b I_b + L_b\left(\frac{dI_b}{dt}\right) + e_b$

$L_b\left(\frac{dI_b}{dt}\right) = V_b - R_b I_b - e_b$ ——— ②

c) $V_c = R_c I_c + L_c\left(\frac{dI_c}{dt}\right) + e_c$

$L_c\left(\frac{dI_c}{dt}\right) = V_c - R_c I_c - e_c$ ——— ③

d) $J\frac{d\omega}{dt} = T_e - B\omega - T_M$. ——— ④

Substituting, $L_a = L_b = L_c = L$

$R_a = R_b = R_c = R$, we have eq^n ①, ② & ③ as,

$L\left(\frac{dI_a}{dt}\right) = V_a - RI_a - e_a$

$L\left(\frac{dI_b}{dt}\right) = V_b - RI_b - e_b$

$L\left(\frac{dI_c}{dt}\right) = V_c - RI_c - e_c$.

where, $e_a = K_e \omega f(\theta)$

$e_b = K_e \omega f(\theta - 2\pi/3)$

$e_c = K_e \omega f(\theta - 4\pi/3)$

In ④, $T_e = \frac{(e_a I_a + e_b I_b + e_c I_c)}{\omega}$