KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

EE 306

Solved-HW # 4: DC Machines

6-3

(a) $I_a = a I_c = (6)(40) = 240\ A$

$K_a = \frac{PZ}{2\pi a} = \frac{(6)(48)(4)}{2\pi(6)} = 30.56$

$E_a = K_a \phi_p \omega_m = (30.56)(20\times10^{-3})(2\pi\,1200/60) = 76.8\ V$

$P_{dev} = E_a I_a = (76.8)(240) = 18{,}432\ W$

(b) $I_a = a I_c = (2)(40) = 80\ A$

$K_a = \frac{PZ}{2\pi a} = \frac{(6)(48)(4)}{2\pi(2)} = 91.67$

$E_a = K_a \phi_p \omega_m = (91.67)(20\times10^{-3})(2\pi\,1200/60) = 230.4\ V$

$P_{dev} = E_a I_a = (230.4)(80) = 18{,}432\ W$

6-7

(a) $I_t = \frac{P}{V_t} = \frac{50{,}000}{240} = 208.33\ A$

(b) $I_f = \frac{V_t}{R_f} = \frac{240}{120} = 2\ A$

(c) $I_a = I_t + I_f = 208.33 + 2 = 210.33\ A$

(d) $E_a = V_t + R_a I_a + V_{BD} = 240 + (0.1)(210.33) + 2 = 263\ V$

6-18

(a) $I_t = 38\ A$

$I_f = 2\ A$

$I_a = I_t - I_f = 38 - 2 = 36\ A$

$E_a = V_t - R_a I_a = 230 - (0.15)(36) = 224.6\ V$

$K_a = \frac{PZ}{2\pi a} = \frac{(4)(596)}{2\pi(2)} = 189.7$

$\omega_m = \frac{2\pi n}{60} = \frac{2\pi(1150)}{60} = 120.43\ rad/sec$

$\phi_p = \frac{E_a}{K_a \omega_m} = \frac{224.6}{(189.7)(120.43)} = 9.83\ mWb$

(b) $T_e = \frac{P_{dev}}{\omega_m} = \frac{E_a I_a}{\omega_m} = \frac{(224.6)(36)}{120.43} = 67.1\ N\text{-}m$

6-27

$E_{a1} = V_t - (R_a + R_s) I_{a1} - V_{BD} = 230 - (0.4+0.2)(37) - 2 = 205.8\ V$

(a) $E_{a2} = 230 - (0.4+0.2)(20) - 2 = 216\ V$

$$\frac{E_{a2}}{E_{a1}} = \frac{K_a \phi_2 (2\pi n_2/60)}{K_a \phi_1 (2\pi n_1/60)} = \frac{K_a' I_{a2} n_2}{K_a' I_{a1} n_1}$$

$$n_2 = \left(\frac{E_{a2}}{E_{a1}}\right)\left(\frac{I_{a1}}{I_{a2}}\right) n_1 = \left(\frac{216}{205.8}\right)\left(\frac{37}{20}\right)(1200) = 2330\ rpm$$

(b) $E_{a3} = 230 - (0.4+0.2)(1) - 2 = 227.4\ V$

$$n_3 = \left(\frac{E_{a3}}{E_{a1}}\right)\left(\frac{I_{a1}}{I_{a3}}\right) n_1 = \left(\frac{227.4}{205.8}\right)\left(\frac{37}{1}\right)(1200) = 49{,}060\ rpm$$

(c) $E_{a4} = 230 - (0.4+0.2)(60) - 2 = 192\ V$

$$n_4 = \left(\frac{E_{a4}}{E_{a1}}\right)\left(\frac{\phi_1}{\phi_2}\right) n_1 = \left(\frac{192}{205.8}\right)\left(\frac{1.25\phi_1}{\phi_1}\right)(1200) = 1399\ rpm$$