ASSIGNMENT-7

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(1) 120V, 1500 rpm, 4P, m=1

coils of 4V, 5A

120 = Number of coils in series × 4

$N_{series} = 30$

Total number of coils = N_{series} × no. of parallel paths

= 30 × 4 = 120

240V, 1500 rpm, 4P, m=1

Same number of coils in both machines

$N_{series} = \frac{240}{4} = 60$

$\frac{120}{6}$ = no. of parallel paths = 2

a. DC machines 1: Lap wound.

2: wave wound.

b. 120

c. KW rating = $V_{branch} \times I_{branch}$ × no. of parallel paths.

DC machine 1 : 120×5×4 = 2.4 kW

2 : 240×5×2 = 2.4 kW

(2) 4P, 1000 rpm, $\phi_P = 0.025$ Wb, $N_c = 300$

Wave wound, m=1 ⇒ no. of parallel paths = 2

$N_{series} = \frac{N_c}{2} = 150$

a. $E = ZBVl$ $= ZBr\omega l = \frac{ZB}{2\pi} P A_p \omega = \frac{Z\omega P \phi_P}{2\pi}$

$Z = 2N_c = 600$

$E = \frac{600}{2\pi} \times 1000 \times \frac{2\pi}{60} \times 4 \times 0.025 = 1000V = 1 kV$

b. P = EI × no. of PP = 1000×25×2 = 50kW

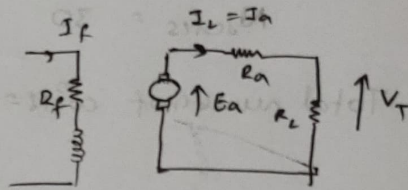
③ $R_a = 0.2\Omega$ $R_{fw} = 100\Omega$ $1200\,rpm$ $I_f = 0.8A \Rightarrow E_a = 114V$

a. $E_a = k\phi\omega$ $k\phi = \frac{114}{1200} \times \frac{60}{2\pi} = 0.907$

b. $E_a = 114V$ $I_a = \frac{E_a}{R_a + R_L} = \frac{114}{2.2} = 51.81\,A$

c. $\tau = \frac{E_a I_a}{\omega} = 47\,Nm$

$P_L = I_a^2 R_L = 5370.25\,W$



④ $n = 1200\,rpm$

a. $\tau = k\phi I_a = 0 \Rightarrow I_a = 0 \rightarrow V_T = E_a = k\phi\omega$

$\phi = cI_f$

$I_f = \frac{120}{100 + R_{fc}}$ $0 < R_{fc} < 150$

$I_{f,\,min} = \frac{120}{100 + 150} = 0.48A$ $E_{a\,min} \approx 90V$

$I_{f,\,max} = \frac{120}{100} = 1.2A$ $E_{a\,max} = 125V$

b. $I_f = 1A \Rightarrow R_{fc} = 20\Omega$

$V_T = E_a - I_a R_a$ $I_a = 50V$

$V_T = 120 - 50 \cdot 0.2 = 110V$

With AR :

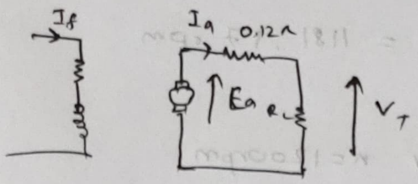
$I_f^* = I_f - 0.1 = 0.9A$

$E_a = 117V$

$V_T = 117 - 50 \cdot 0.2 = 107V$

(6) 24 kW, 240V, 1000 rpm

$R_a = 0.12\ \Omega$ $N_f = 600$ turns / pole



$n = 1000 rpm$

$E_a = 240V$ when $I_f = 1.8A$

$k\phi\omega$

a. $V_T = 225\ V$ $E_a = 240V$

$I_a = 125A$ $\tau_{ind} = \frac{E_a I_a}{\omega} = 286.48\ Nm$

c. $E = k\phi\omega$

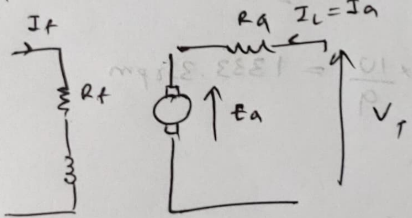
$\frac{E_1}{E_1} = \frac{I_{f'}}{I_{f_2}} \Rightarrow E_2 = 240 \times \frac{2.2}{1.8} = 293.3\ V$

$\phi = c N_f I_f$ $N_f = 600$

Increasing I_f to 2.2 is equivalent to increasing

N_f to $600 + \frac{2.2}{1.8} = 733.3$ turns

(7) $V_T = 240V$ $R_a = 0.06\Omega$



$I_L = 90A$

$n = 1200 rpm$

$E_a = k\phi\omega$ $T = k\phi I_a$

$240 = E_a + 90 \times 0.06$

$E_a = 234.6V$

a. $E_a I_a = T\omega$

$\frac{21114}{1200 \cdot 2\pi} \times 60 = T \Rightarrow 168.02\ Nm$

b. If $T = 280\ Nm$,

$k\phi I_a = 280 Nm$

$\frac{T_1}{T_2} = \frac{I_{a1}}{I_{a2}} \Rightarrow \frac{168.02}{280} = \frac{90}{I_{a2}} \Rightarrow I_{a2} = 149.98\ A$

$E_a = V_T - I_a R_a = 240 - 149.98 * 0.06$

$= 231V$

$\omega = \frac{E_a I_a}{\tau} = 123.73$ rad/s $= 1181.57$ rpm

(8) $V_T = 240$ $I_a = 40A$ $E_a = 230V$ $n = 1200$rpm.

a. Motor, as $V_T > E_a$

b. $\frac{V_T - E_a}{I_a} = R_a = 0.25\Omega$

c. $I_a^2 R_a = 400W$

d. $\tau_{ind} = \frac{E_a I_a}{\omega} = \frac{230 \times 40 \times 60}{1200 \times 2\pi} = 73.21$ Nm

e. i) $E_a = 240$

$\frac{E_{a_1}}{E_{a_2}} = \frac{n_1}{n_2} \Rightarrow n_2 = 1200 \times \frac{240}{230} = 1252.17$ rpm

ii) $I_a = 40A$

$E_a = 230V$

Assuming E_a remains same,

$\phi_1 \omega_1 = \phi_2 \omega_2 \Rightarrow \phi_1 n_1 = \phi_2 n_2$

$n_2 = \frac{n_1 \phi_1}{\phi_2} = 1200 \times \frac{10}{9} = 1333.33$rpm