

Electric Machinery Fundamentals Chapman 5th Edition Solution Manual.12

Q2. $N_{NL} = 900 \text{ rpm}$
 $I_{NL} = 2 \text{ A}$
 $V_T = 110 \text{ V}$
 $R_A = 0.6 \Omega$
 $R_F = 100 \Omega$
 $P_{\text{input}} = 3.2 \text{ kW}$
 $N_{FL} = ?$
 $T_{FL} = ?$
 $\eta_{FL} = ?$

SOLUTION

$$V_T = E_A + I_A R_A$$

$$I_F = \frac{V_T}{R_F} = \frac{110 \text{ V}}{100 \Omega} = 1.1 \text{ A} = 1.1 \text{ A}$$

$$I_A = I_{NL} - I_F = 2 \text{ A} - 1.1 \text{ A} = 0.9 \text{ A}$$

$$V_T = E_A + I_A R_A$$

$$E_A = V_T - I_A R_A$$

$$E_A = 110 \text{ V} - 0.9 \times 0.6$$

$$E_A = 109.46 \text{ V}$$

At Full Load

$$I_A = \frac{3.2 \text{ kW}}{110 \text{ V}} = 29.09 \text{ A}$$

$$I_{A_{FD}} = 29.09 - 1.1 \text{ A} = 27.99 \text{ A}$$

$$E_{A_{FD}} = V_T - I_{A_{FD}} R_A$$

$$= 110 \text{ V} - 27.99 \times 0.6 = 93.206 \text{ V}$$

$$N_{NL} = 900 \text{ rpm}$$

$$\frac{E_{A_{FD}}}{E_{A_{NL}}} = \frac{K \phi N_{FD}}{K \phi N_{FL}}$$

$$N_{FL} = \frac{E_{A_{FD}}}{E_{A_{NL}}} \times N_{NL}$$

$$N_{FL} = \frac{93.206}{109.46} \times 900 = 766.36 \text{ rpm}$$

$$\omega_{FL} = \frac{2\pi N_{FL}}{60} = 80.25 \text{ rad/s}$$

$$T_{FL} = \frac{P_{\text{shaft}}}{\omega_{FL}} = \frac{2608.94}{80.25} = 32.51 \text{ Nm}$$

$\eta = ?$

Losses:

$$I_{A_{FD}}^2 R_A = (27.99)^2 \times 0.6 = 470.064 \text{ W}$$

$$I_F^2 R_F = (1.1)^2 \times 100 = 121 \text{ W}$$

$$\eta = \frac{I/P - \text{Losses}}{I/P}$$

$$\eta = \frac{3200 - (470.064 + 121)}{3200}$$

$$\eta = \frac{3200 - 591.064}{3200}$$

$$\eta = \frac{2608.936}{3200} = 0.8153 = 81.53\%$$

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