ED Chapter 10
Problem 1

$T = 100\,Nm$ $\qquad V_B = 300\,V_{dc}$ $\qquad \cos\phi = 0.9$

$\omega = 200\pi\,rad/s$ $\qquad \eta_m = 0.9$

i) $\quad V_{ph} = m\dfrac{V_B}{2\sqrt{2}} = 106.1\,V$

ii) $\quad V_{ph} = V_{ph}\cos\phi + jV_{ph}\sin\phi = E_{ph} + I_{ph}R_s + jX_{Ls}I_{ph}$

$\qquad = 95.46 + j\,46.23$

$\qquad P_o = 62.832\,kW$

$\qquad P_i = 69.813\,kW \quad = 3V_{ph}I_{ph}\cos\phi$

iii) $\quad I_{ph} = 243.7\,A$

ii) $\quad E_{ph} = 88.15\,V$

iv) $\quad I_{ph}X_{Ls} = 46.23\,V$

$\qquad 2\pi f_e L_s I_{ph} = 46.23 \qquad\qquad f_e = 2f_R$

$\qquad L_s = \dfrac{46.23}{I_{ph}\,400\pi}$

$\qquad = 15\,\mu H$

v) $\quad K = \dfrac{T}{3I_{ph}} = 136.8\times10^{-3}$

vi) $\quad P_L = P_i - P_o = 6.981\,kW$

$\qquad P_{cu} = 3I_{ph}^2 R = 5.345\,kW$

vii) $\quad P_{CFW} = 1.636\,kW$

ED Chapter 10
Problem 2

2a) $T = 20\,Nm$ $\qquad\qquad$ $V_B = 42\,V_{dc}$

$\omega_m = 6,000\,Rpm = 200\pi\,rad/s$ $\qquad$ $\eta_{motor} = 0.9$

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ $\cos\phi = 0.9$

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ $\sin\phi = 0.436$

i) $V_{ph} = m\,\dfrac{V_B}{2\sqrt{2}} \Rightarrow m = 1$

$\qquad V_{ph} = 14.85\,V$

ii) $V_{ph} = V_{ph}\cos\phi + j\,V_{ph}\sin\phi$

$\qquad\quad = E_{ph} + j\,X_{Ls}\,I_{ph} + R_s\,I_{ph}$

$\quad V_{ph}\cos\phi = 13.365\,V = E_{ph} + I_{ph}\,R_s$

$\quad V_{ph}\sin\phi = 6.473$

$\qquad P_o = 12.566\,kW$

$\qquad P_i = 13.962\,kW = 3\,V_{ph}\,I_{ph}\,\cos\phi$

iii) $\rightarrow \quad I_{ph} = 348.24\,A$

$\qquad E_{ph} = 13.365 - (348.24 \times 0.0015)$

ii)$\rightarrow E_{ph} = 12.84$

iv) $\qquad I_{ph}\,X_{Ls} = 6.473\,V$

$\qquad\qquad X_{Ls} = 0.018588\,\Omega = 2\pi f\,eL_s = \omega_e$

$\qquad\qquad$ 4-pole machine $\Rightarrow \omega_e = 2\,\omega_m$

$\qquad\qquad L_s = \dfrac{0.018588}{400\pi}$

$\qquad\qquad\quad = 14.79\,\mu H$

v) $\quad k = \dfrac{T}{3\,I_{ph}} = 0.01914$

$\qquad\quad = \dfrac{E_{ph}}{\omega} = 0.0204$

vi) $P_{LOSS} = P_i - P_o = 1,396\,W$ $\qquad$ vii) $P_{CFW} = P_{LOSS} - P_{LCu}$

$\qquad P_{LCu} = 3\,I^2 R_s = 545.72\,W$ $\qquad\qquad\qquad = 850.28\,W$

$P_0 = 13.92 \, kW$

$\omega_m = 173.99 \, rad/s \quad \Rightarrow \quad T = 80 \, Nm$

$K_T = 3.05 \, Nm/Arms$

$\rightarrow k = \frac{K_T}{3} = 1.016 \, Nm/Arms$

$\Rightarrow E_{ph} = k\omega$

$\rightarrow E_{ph} = 176.89 \, V$

$R_{ph} = \frac{R_W}{2} = \frac{1.06}{2} = 0.53 \, \Omega$

$L_s = \frac{L_W}{2} = \frac{6.58}{2} = 3.29 \, mH$

$\eta = 88\%$

$\rightarrow P_i = \frac{P_0}{\eta} = 15.818 \, kW$

$P_{Loss} = 1,898 \, W$

$\rightarrow I_{ph} = \frac{T}{3k} = 26.23 \, A$

~~$P_i = 3 V_{ph} I_{ph} \cos\phi$~~

~~$V_{ph} \cos\phi = \frac{P_i}{3 I_{ph}} = E_{ph} + I_{ph} R_{ph} = 226.9766$~~

~~$\cos\phi =$~~

$V_{ph} = E_{ph} + I_{ph} R_{ph} + j\omega_e L_s I_{ph}$

$\quad = 176.89 + (26.23 \times 0.53) + j\,(6 \times \omega_m \times L_s \times I_{ph})$

$\quad = (190.7919 + j90.09) \, V$

$\quad = 210.99 \quad \angle 25.276°$

$\cos\phi = 0.904$

$P_{cu} = 3 I_{ph}^2 R_{ph} = 1093.94 \, W$

$P_{cFW} = 804 \, W$