Final Exam SP99 Solution

ECE 333

#1

$X_{01} = .04 \times \frac{2400^2}{10{,}000} = 23\,\Omega \qquad X_{02} = 23\left(\frac{1}{20}\right)^2 = .0575$

(a) $2400\angle\Theta = j23\frac{10{,}000}{2400}\angle 0 + V\angle 0 = V + j95.8$

$V^2 + 95.8^2 = 2400^2 \qquad V = 2398$ $\boxed{V_{load} = 119.9}$

(b) 25 times rated $= \frac{10000}{120} \times 25 = \boxed{2{,}083A}$

#2 (a) $80 = 4^2 \times (r_1 + r_2') \qquad r_1' = \frac{1}{2}\frac{80}{16} = 2.5\,\Omega \qquad X_1 + X_2' = \sqrt{\left(\frac{12/\sqrt{3}}{4}\right)^2 - 5^2} = 7.4\,\Omega$

For max P_1 set $\frac{2.5}{s} = |Z_{thr}| = \sqrt{2.5^2 + 7.4^2}$ $\boxed{s = 0.32}$ $\boxed{\begin{matrix}+ \text{ motor} \\ - \text{ gen}\end{matrix}}$

(b) $P_{\substack{To \\ Rotor \\ Mot}} = 3 \times \frac{|230/\sqrt{3}|^2 (2.5/.32)}{|2.5 + \frac{2.5}{.32} + j7.4|^2} = 2565\,W \qquad T = \frac{2565}{377/3} = \underline{20\,Nm}$

$P_{\substack{To \\ Rotor \\ Gen}} = \frac{3 \times |230/\sqrt{3}|^2 (2.5/-.32)}{|2.5 - \frac{2.5}{.32} + j7.4|^2} = -4980 \qquad T = -\frac{4980}{377/3} = \underline{-40\,Nm}$

(c) $s = 1 \qquad P_{\substack{To \\ Rotor}} = \frac{3 \times \left|\frac{230}{\sqrt{3}}\right|^2 (2.5)}{|2.5 + 2.5 + j7.4|^2} = 1658 \qquad T = \frac{1658}{377/3} = \underline{13}$

(d) $2 \times 746 = 1492\,W, \qquad T_{fl} \simeq \frac{1492}{377/3} = \underline{12\,Nm}$

#3

O.C. $\frac{208}{\sqrt{3}} = k_f w \phi_2 \qquad k_f w = 60$

S.C. $60 \times 1 = 6 X_s \qquad X_s = 10\,\Omega$

(a) $60 I_f \angle\delta = j10 \times 6\angle 0 + 120\angle 0 = 120 + j60 \qquad I_f\angle\delta = 2 + j1 = 2.24\angle 26°$

(b) The machine will slip poles as the turbine power keeps sending power while the output is zero.

#4 $I_f = \frac{28}{100} = .28$ $\quad 28 = 1\times 0 + 1.2\omega \times .28$

(a) $\omega = 83.3$ R/s

(b) $1.2 \times .28 \times I_a = 3$ $\quad I_a = 8.93A$ $\quad 28 = 1\times 8.93 + 1.2\omega \times .28$

$\omega = 56.8$ R/s

(c) $28 = 1\times 0 + 1.2 \times 100\, I_f$ $\quad I_f = .233$ $\quad R_f = 120$ add 20Ω

#5 $\delta(.01) = \pi/6 + (377-377).01 = \pi/6$

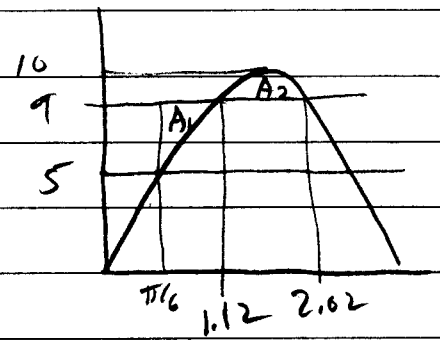
$\omega(.01) = 377 + (5-5).01 = 377$

$\delta(.02) = \pi/6 + (377-377).01 = \pi/6$

$\omega(.02) = 377 + (9-10\sin\pi/6).01 = 377.04$

$\delta(.03) = \pi/6 + (377.04-377)\times.01 = .524$

$\omega(.03) = 377.04 + (9-10\sin\pi/6).01 = 377.08$



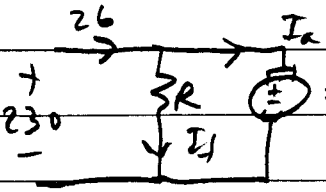
$$A_1 = \int_{\pi/6}^{1.12} (9-10\sin\delta)\,d\delta = \left[9\delta + 10\cos\delta\right]_{\pi/6}^{1.12} = 1.06$$

$$A_2 = \int_{1.12}^{2.02} (10\sin\delta - 9)\,d\delta = \left[-10\cos\delta - 9\delta\right]_{1.12}^{2.02} = 0.6$$

NO

#6 (a) $5{,}000 = \sqrt{3}\times 230\, I_\ell$ $\quad I_\ell = 12.6A$

(b) $E = j1.5\times 12.6\angle 0 + \frac{230}{\sqrt{3}}\angle 0 = 133 + j18.9 = 133\angle 8^\circ$

(c) 

$230 = 230$ $\quad 230\, I_a = 5000$ $\quad I_a = 21.7$ $\quad I_f = 4.3A$

$R_f = 53\Omega$

(d) $P = 0$ $\quad 133\angle 0 - \frac{230}{\sqrt{3}}\angle 0 = j1.5\, I\angle\theta$ $\quad I = .14A$