Exam I Solution Spring 1997

1. $456 = 4^2 \times 1 + P_L$ $\quad \boxed{P_L = 440\ W}$

$4 \times 110 = \sqrt{440^2 + Q_T^2}$ $\quad Q_T = 0$ $\quad \boxed{Q_L = 110^2 \times 0.1 = 1210\ VARs}$

Unity power factor load: $\boxed{\bar{V}_S = 1 \times 4\angle 0 + 110\angle 0 = 114\angle 0}$

2. (a) $V = .04 \times 2400 = 96$ volts

(b) $KVA = 10.417 \times 2400 = 25\ KVA$

(c) $\frac{96}{120} \times \frac{100}{4} = 20$ times rated (2000%)

3. $\bar{V}_{A2B2} = 480\angle 0^\circ$ $\quad \bar{V}_{C2O2} = 480\angle -120^\circ$

$\bar{V}_{B2C2} = 120\angle -120^\circ - 480\angle -120^\circ = -360\angle -120^\circ = 360\angle 60^\circ$

$\bar{V}_{O2A2} = -120\angle -120^\circ - 480\angle 0 = -420 + j104 = 433\angle 166^\circ$

4. From BR test, $r_1 + r_2' = 5\Omega$ so $r_1 = r_2' = 2.5\Omega$

$x_1 + x_2' = 7.48\Omega$

For max T, set $\frac{r_2'}{s} = \pm\sqrt{r_1^2 + (x_1 + x_2')^2} \Rightarrow s_{T_{max}} = \pm .317$

$s = +.317$ $\quad |\bar{I}_2'| = \frac{230/\sqrt{3}}{\sqrt{(2.5 + \frac{2.5}{.317})^2 + 7.48^2}} = 10.38A$ $\quad T = \frac{3 \times 10.38^2 \times \frac{2.5}{.317}}{2\pi 60/3}$

$\boxed{T_{+_{max}} = 20\ NM}$

$s = -.317$ $\quad |\bar{I}_2'| = \frac{230/\sqrt{3}}{\sqrt{(2.5 - \frac{2.5}{.317})^2 + 7.48^2}} = 14.4A$ $\quad T = \frac{3 \times 14.4^2 \times \frac{2.5}{-.317}}{2\pi 60/3}$

$\boxed{T_{-_{max}} = -39\ NM}$

4. continued

$S = 1$ (BR) $\quad |\bar{I}_2'| = \dfrac{230/\sqrt{3}}{\sqrt{(2.5+2.51)^2 + 7.48^2}} = 14.8\,A$

$$T = \frac{3 \times 14.8^2 \times \frac{2.5}{1}}{2\pi 60/3}$$

$$\boxed{T_{BR} = 13\ Nm}$$

Full load $\Rightarrow$ use $2HP = 1492\ W$

$$\boxed{T = \frac{1492}{2\pi 60/3} = 12\ Nm}$$

All are approximate - for various reasons.