Final Exam solution Spring 1995

#1 (a) open circuit high side, meter the low voltage side.

$V_{low} = 120V$ $I_{low} = small$ $P_{low} = 0$ (for no losses)

(b) short circuit low side, meter the high voltage side.

$V_{high} = 240 \times \frac{8}{100}$ $I_{high} = \frac{1000}{240}$ $P_{high} = 0$ (for no losses)

#2 (a) **1.2 A** 3rd harmonic

(b) $\underset{Fund}{I} \approx 1\angle -90° + \frac{10000}{7200 \times 1.1}\angle 0$ (Assumes primary = 7200) $= 1.26 - j1$; $|I|_{fund} = 1.6\,A$

$I_{3rd} = 1.2\,A$ (as before)

#3 (a) $I = \left(\frac{230}{\sqrt{3}}\angle 0 / j34\right) + \left(\frac{230}{\sqrt{3}}\angle 0\right) // (2/5)$ $s = \frac{1200-1150}{1200} = .0417$

$= 2.77 - j3.9$ $|I| = 4.79\,A$

(b) $T = \frac{3 \times \left|\frac{230}{\sqrt{3}}\right|^2 / \left(\frac{2}{5}\right)}{2\pi 60/3} =$ **8.8 N·m.**

#4 $\frac{3 \times 277 E}{X_s} = 8000$ and $Q = 0$, so $E = 277$ $X_s = 28.77\,\Omega$

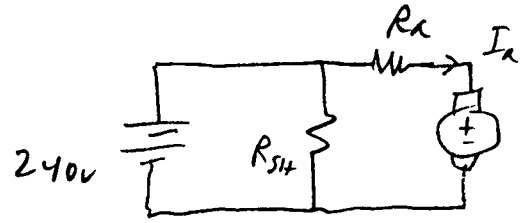
(a) $4000 = 8000 \sin(-\delta)$ $-\delta = 30°$ $Q = \frac{3 \times 277^2}{28.77} - \frac{3 \times 277^2}{28.77}\cos(-30°)$

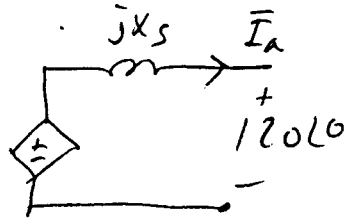
$Q = 1072$ VArs

(b) $|\bar{S}_{3\phi}| = \sqrt{4000^2 + 1072^2} = 4141\,VA = \sqrt{3} \times 480 I_\ell$ $I_\ell = 4.98\,A$

(continued)

#5





Assume $E_a = K_{sh} w I_{sh}$

$240 = K_{sh} w 3$

$K_{sh} w = 80$

$80 \times 2.8 \times I_a = 3730w$

$I_a = 16.65A$

$240 = 16.65 R_a + 80 \times 2.8$

$\boxed{R_a = 0.96\Omega}$

$K_f w 2 = 120 \qquad K_f w = 60$

Full load $= 5HP \times 746 = 3730w$ 3ϕ

Unity pf $\bar{I}_a = \frac{3730}{3 \times 120}\angle 0 = 10.36\angle 0$

$60 \times 3\angle -\delta = 10.36\angle 0\, jX_s + 120\angle 0$

$180 = \sqrt{120^2 + 10.36 X_s^2}$

$\boxed{X_s = 12.95\Omega}$

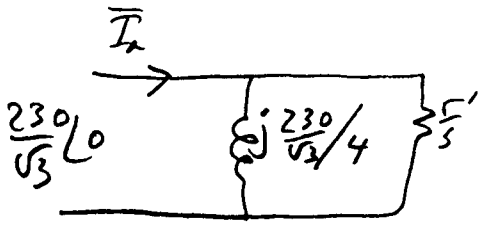
#6

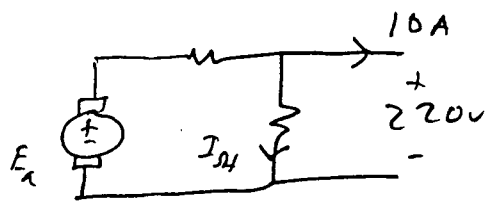
(a) Induction motor slows down

Voltage drop in armature

Demagnetization due to armature reaction

(b)





$P_{out} = 2200w$

$\bar{I}_a = -j4 + \frac{\left(\frac{2200}{3}\right)}{230/\sqrt{3}} = 5.5 + j4$

$\boxed{|\bar{I}_a| \approx 6.8A}$