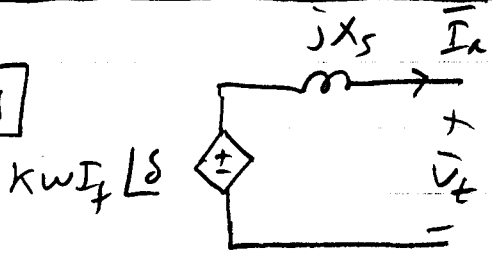
Exam II Solution Spring 1993

#1



$kw \times 2 = 120$ $\quad kw = 60$

$60 \times 1 = 5 X_s$ $\quad X_s = 12\,\Omega$

$60 \times 2.5 \angle\delta = j12 \times 5 \angle\alpha + 120\angle 0$ ($\bar{V}_t$ assumed equal to zero)

$150\cos\delta = 60\cos(\alpha+90^\circ) + 120$

$150\sin\delta = 60\sin(\alpha+90^\circ)$

$150^2 = 60^2 + 2\times 60\times 120\cos(\alpha+90^\circ) + 120^2$

$\alpha + 90^\circ = \pm 71.8^\circ$ $\quad \alpha = -18.2^\circ$ (Because generator)

$\bar{S}_{out} = 3\times 120\angle 0 \times 5\angle +18.2^\circ = 1800\angle -18.2^\circ = \boxed{1710 + j562}$

#2 $\quad P_{IN} = 0 \quad Q_{IN,3\phi} = 3000 \quad \bar{V}_t = 277\angle 0, \quad \bar{I}_{a_{IN}} = \frac{1000}{277}\angle -90^\circ$

$277\angle 0 = jX_s\left(\frac{1000}{277}\angle -90^\circ\right) + kw\times 1\angle 0$

or $\quad 277 = 3.61 X_s + kw \quad (A)$

$P_{IN} = 0 \quad Q_{IN,3\phi} = -3000 \quad \bar{V}_t = 277\angle 0, \quad \bar{I}_a = \frac{1000}{277}\angle +90^\circ$

$277\angle 0 = jX_s\left(\frac{1000}{277}\angle +90^\circ\right) + kw\times 3$

or $\quad 277 = -3.61 X_s + 3\,kw \quad (B)$

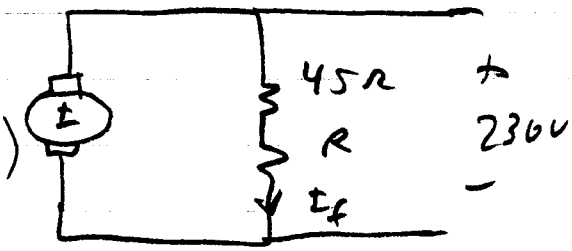
Adding (A) + (B) $\quad kw = 138.5$, so $X_s = 38.4\,\Omega$

(a) For $I_f = 0$, $\quad \bar{I}_a = \frac{277\angle 0}{j38.4} = 7.21\angle -90^\circ$ $\quad \boxed{Q_{IN,3\phi} = 6000 \text{ vars}}$

(b) $3000 = \frac{3\times 138.5\, I_f \times 277}{38.4}\sin\delta$ $\quad \sin\delta \to 1.0$ $\quad \boxed{I_{f_{MIN}} = 1.0\,A}$

#3

$\frac{Rpm}{150}(10+130I_f)$



$Rpm = 100$ $\quad \frac{100}{150}(10+130I_f) = 230$ $\quad I_f = 2.5769$

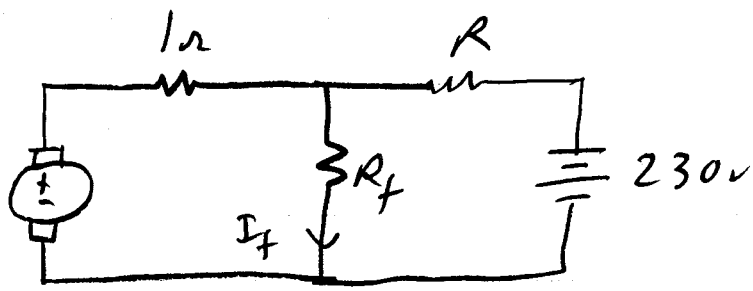
$R = 44.25\Omega$

$Rpm = 200$ $\quad \frac{200}{150}(10+130I_f) = 230$ $\quad I_f = 1.25$

$R = 139\Omega$

#4

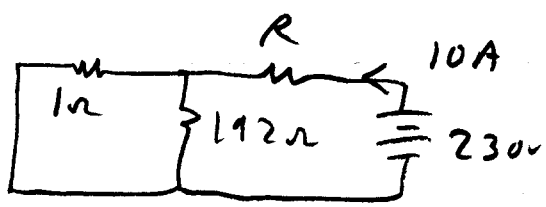
$\frac{Rpm}{1300}(14+180I_f)$



At 230V, 1300 Rpm no load, $14+180I_f = 230$

$I_f = 1.2A$ $\quad R_f = 192\Omega$

(a) At startup, $Rpm = 0$



$\left(\frac{192}{193}+R\right)10 = 230$ $\quad$ $R = 22\Omega$

(b) At no load with $R = 22$ in circuit,

$I_f = \frac{230}{192+22} = 1.0747A$ $\quad \frac{Rpm}{1300}(14+180\times 1.0747) = 192\times 1.0747$

$Rpm = 1293$