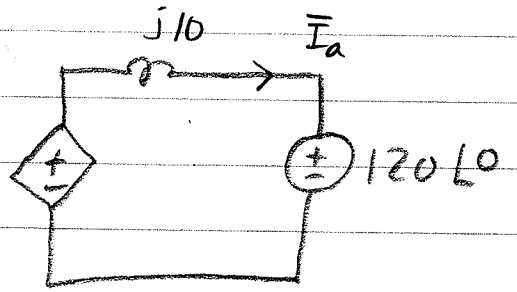
ECE 333

Exam II Solution Spring 2002

#1



$$4000 = \frac{3\times120\times87I_f}{10}\sin\delta$$

(a) $\delta = 90°$, $I_f = 1.28A$ $\quad I_a = \left|\dfrac{87\times1.28\angle90 - 120\angle0}{j10}\right|$

$$I_a = \frac{|j111.4 - 120|}{10} = 16.4\,A$$

(b) $Q = 0$, $\quad \dfrac{3\times120^2}{10} - \dfrac{3\times120\times87I_f}{10}\cos\delta = 0$ $\quad$ or $\quad I_f\cos\delta = 1.379$

and from $4000 = 3132I_f\sin\delta$ $\quad I_f\sin\delta = 1.277$

$$I_f^2 = 1.379^2 + 1.277^2 \qquad I_f = 1.88A$$

Unity power factor so $4000 = 3\times120\times I_a$ $\quad I_a = 11.1\,A$

(C) $4000 = 3\times120\times20\cos\phi$ $\quad \phi = \pm56°$

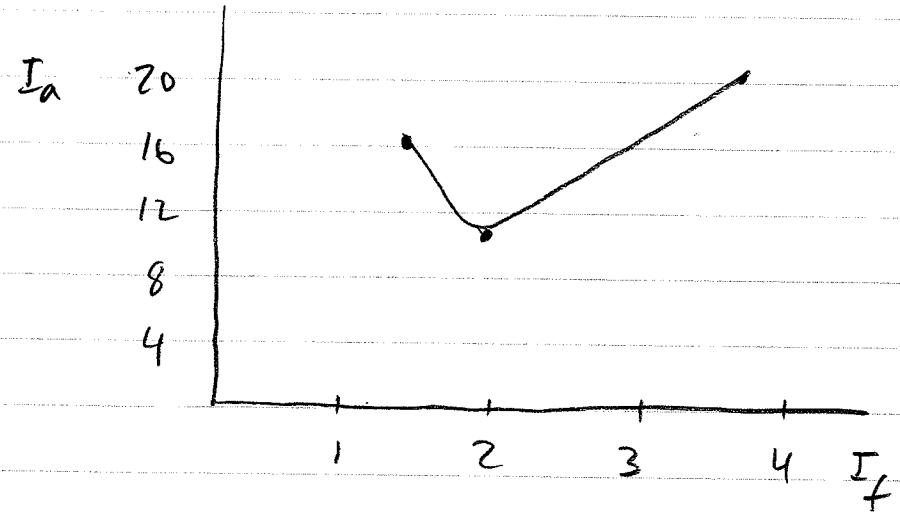
$$Q = 3\times120\times20\sin\phi = \pm5987 \text{ vars}$$

Since I_a for minimum I_f is 16.4A, this 20A condition must be on the overexcited side, so $Q_{OUT} = +5987$ VAR

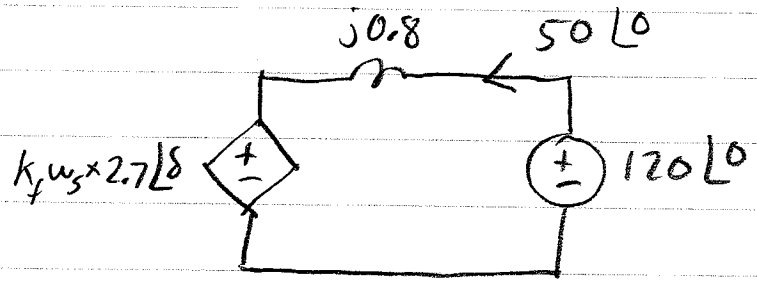
$$-5987 = \frac{3\times120^2}{10} - \frac{3\times120\times87I_f}{10}\cos\delta \qquad I_f\cos\delta = 3.29$$

$I_f\sin\delta = 1.277$

$$I_f^2 = 3.29^2 + 1.277^2 \qquad \underline{I_f = 3.53\,A}$$



#2



(a) $120\angle 0 = j0.8 \times 50 + k_f w_s \times 2.7 \angle \delta$ $\quad k_f w_s 2.7 \angle \delta = 120 - j40$

$\underline{\delta = -18^\circ}$

(b) From (a), $k_f w_s = \dfrac{\sqrt{120^2 + 40^2}}{2.7} = 46.8\ \Omega$

$P = 3 \times 50 \times 120 = 18{,}000\ W$ constant

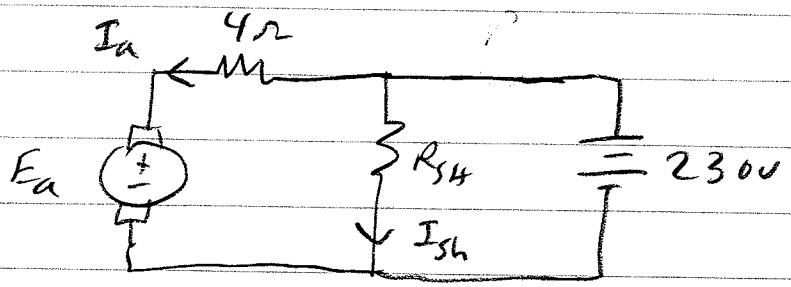
PF = 0.8 leading, $\bar{S} = \dfrac{18{,}000}{0.8}\underline{\angle -37^\circ} = 3 \times 120 \times \bar{I}_a^*$

$\bar{I}_a = 62.5\underline{\angle 37^\circ}$ $\quad 120\angle 0 = j0.8 \times 62.5\angle 37 + 46.8 I_f \angle \delta$

$46.8 I_f \angle \delta = 120 + 30 - j40 = 150 - j40 = 155\underline{\angle -15^\circ}$

$I_f = 3.3\ A$ $\quad$ (c) $\delta = -15^\circ$

#3

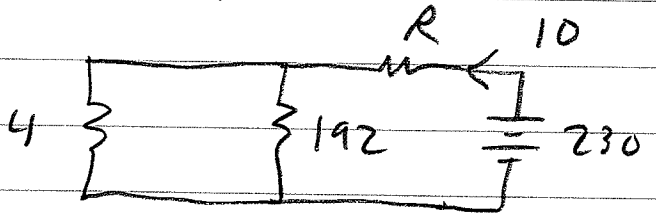


$$E_a = \frac{RPM}{1300}(14 + 180 I_{SH})$$

when $I_a = 0$ (no load) $\quad 14 + 180 I_{SH} = 230 \quad I_{SH} = 1.2A$

$$R_{SH} = 192\,\Omega$$

(a) Startup $E_a = 0$



$4 /\!/ 192 = 3.92$

$$230 = (R + 3.92)10 \qquad \underline{R = 19\,\Omega}$$

(b) $I_a = 0$ so $230 = I_t(19 + 192) \quad I_t = 1.1A$

$$\frac{RPM}{1300}(14 + 180 \times 1.1) = 192 \times 1.1$$

$$RPM = 1295$$