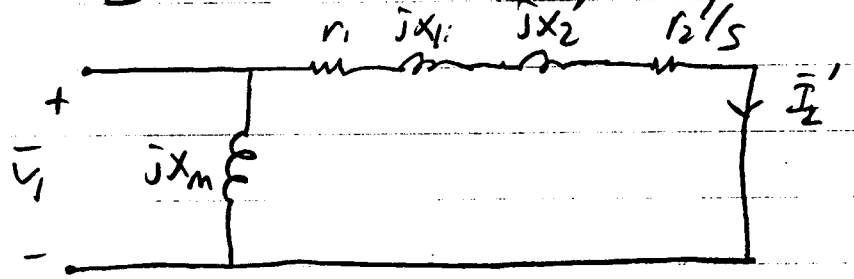
Final exam solution Spring 1997

**#1** (a) $\bar{I} = \frac{100}{10+j10} + \frac{500-j500}{100} = 5-j5+5-j5 = \underline{10-j10\ A}$

(b) want $\frac{100}{\frac{1}{j377C}} = j10$ $\quad j37{,}700C = j10$ $\quad \underline{C = 265\,\mu F}$

(c) $\bar{I} = 10\angle 0$

**#2**




(a)

$$T_{\substack{To\\shaft}} = \frac{P_{\substack{To\\ROTOR}}}{\omega_s} = \frac{3\times|\bar{I}_2'|^2 r_2'/s}{\omega_s} = \frac{3\times\left(|\bar{V}_1|^2/\left((r_1+r_2'/s)^2+(x_1+x_2')^2\right)\right) r_2'/s}{\omega_s}$$

$$= \frac{3|\bar{V}_1|^2 r_2' s}{\omega_s\left[(sr_1+r_2')^2+s^2(x_1+x_2')^2\right]}$$

(b) maximize $P_{\substack{To\\ROTOR}}$ ; $\frac{r_2'}{s} = \pm\sqrt{r_1^2+(x_1+x_2')^2}$

$$s_{\substack{max\\T}} = \frac{\pm r_2'}{\sqrt{r_1^2+(x_1+x_2')^2}}$$

**#3** (a) 2400V gives $\frac{100}{5} = 20$ times rated current, so apply $\frac{2400}{20} = \underline{120\ V}$

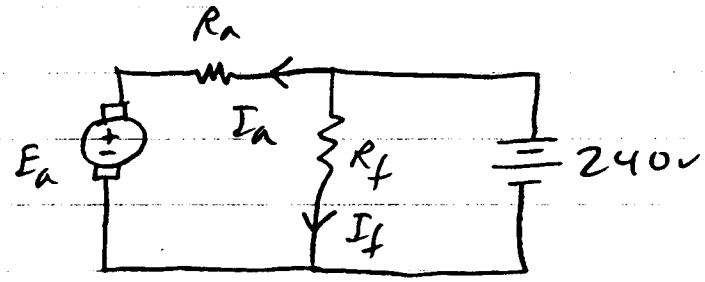
(b) $20.833\times 2400 = \underline{50\ kVA}$

(c) $\frac{120}{120}\times\frac{100}{5}\times 20.833\times\frac{20}{1} = \underline{8{,}333\ A}$

**#4** (a) $S = \frac{1200-1100}{1200} = \frac{1}{12}$ $\quad f_r = \frac{1}{12} \times 60 = \underline{\underline{5\ Hz}}$

(b) $T_{TO}_{start} = \frac{1700}{1200 \times \frac{2\pi}{60}} = \underline{\underline{13.5\ Nm}}$

**#5**




At no load $I_a = 0$ $\quad E_a = K_f^{SH} \times 1200 \times \frac{2\pi}{60} \times \frac{240}{R_f} = 240$

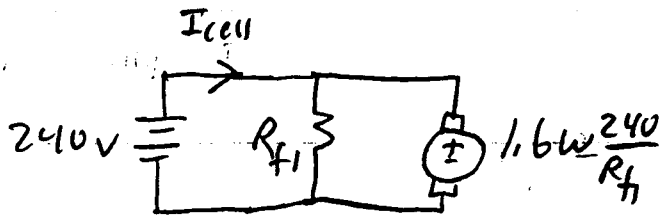
So $\frac{K_f^{SH}}{R_f} = \frac{.025}{\pi} = .0079577$

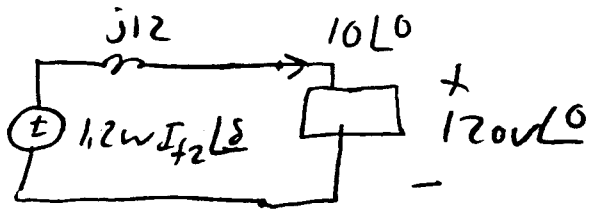
At full load $E_a I_a = 5 \times 746 = .0079577 \times 1000 \times \frac{2\pi}{60} \times 240\, I_a$,

so $I_a = 18.65A$

$240 = 18.65 R_a + .0079577 \times 1000 \times \frac{2\pi}{60} \times 240$ $\quad \underline{\underline{R_a = 2.14\Omega}}$

**#6**




(a) $1.2 \times \frac{377}{3} \times I_{f2} L\delta = j120 + 120L0 = 120\sqrt{2}\, L45$ $\quad I_{f2} = 1.125A$

$R_{f2}_{ADJ} = \frac{240}{1.125} - 100 = \underline{\underline{113\Omega}}$

$1.6 \times \frac{377}{3} \frac{240}{R_{f1}} = 240$

$R_{f1}_{ADJ} = \frac{1.6 \times 377}{3} - 150 = \underline{\underline{51\Omega}}$

(b) $P_{dc} = P_{ac} = 3 \times 120 \times 10 = 3600w$ $\quad I_{cell} = \frac{3600}{240} + \frac{240}{201} + 1.125$

$= \underline{\underline{17.32A}}$