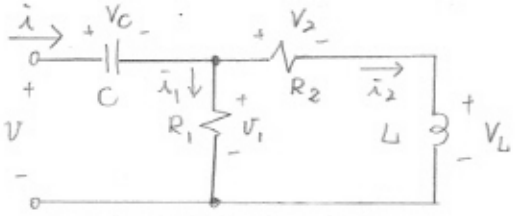
7.4



$Z = -j5 + 20 \| (4+j8) = 5\ k\Omega$, $|Z| = 5\ k\Omega$

$|\underline{I}| = 40/5 = 8\ mA$

$I_{rms} = 8/\sqrt{2} = 4\sqrt{2}\ mA$, $P = \frac{1}{2} \cdot 5 \cdot 8^2 = 160\ mW$

$|\underline{I_1}|^2 = \left|\frac{4+j8}{24+j8}\right|^2 \cdot 8^2 = 8$, $|\underline{I_2}|^2 = \left|\frac{20}{24+j8}\right|^2 \cdot 8^2 = 40$

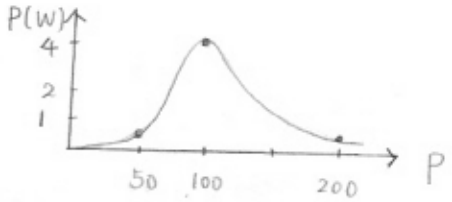
$\frac{1}{2} R_1 |\underline{I_1}|^2 + \frac{1}{2} R_2 |\underline{I_2}|^2 = 160\ mW = P$

7.7

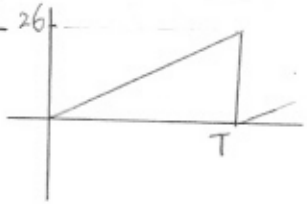
$Z(jw) = 50 + j(w - 10^4/w)$

$P = 50 \cdot \frac{20^2}{2|Z|^2} = 10^4 / [2500 + (w - \frac{10^4}{w})^2]$

w	P(w)
0^+	0
50	0.4
100	4
200	0.4
∞	0



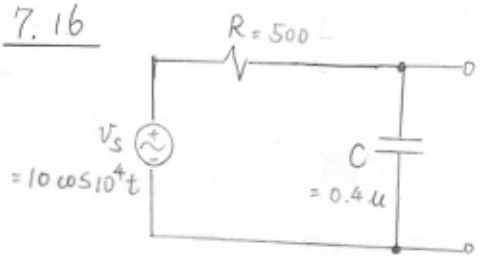
7.12



$i = \frac{26t}{T}$ for $0 \le t \le T$. $\int_0^T i^2 dt = \frac{26^2}{T^2} \int_0^T t^2 dt = \frac{26^2 T^3}{3T^2} = 225\ T$

$I_{rms} = \left(\frac{225\ T}{T}\right)^{1/2} = 15\ A$

7.16



$Z_s = 500 \| (-j250) = 100 - j200$, $Z = Z_s^* = 100 + j200$

$V_{rms}^2 = \left|\frac{-j250}{500-j250}\right|^2 \cdot 10^2/2 = 10$

$P_{max} = V_{rms}^2 / (4 \cdot 100) = 25\ mW$

7.19

(a) $Z = Z_s^* = 24 + j7\ k\Omega$, $P = P_{max} = 2.4^2/4.24 = 60\ mW$, Eff. = 50%

(b) $Z = (4+j3)C$, $|Z| = |Z_s| \Rightarrow 5C = 25$, $C = 5$, $Z = 20 + j15\ k\Omega$

$P = \frac{20 \cdot 2.4^2}{(24+20)^2 + (7+15)^2} = 47.6\ mW$, Eff. $= \frac{20}{24+20} = 45\%$

7.22

Z increases with w $\Rightarrow Z = wL$

$Q = (|\underline{V}|^2 |\underline{I}|^2 - P^2)^{1/2} = 960\ VAr$

(a) $R = |\underline{V}|^2/P = 20\ \Omega$, $L = |\underline{V}|^2/wQ = 39.8\ mH$

(b) $R = P/|\underline{I}|^2 = 7.2\ \Omega$, $L = Q/w|\underline{I}|^2 = 25.5\ mH$

7.26 (a) $|Z_M| = 6\,\Omega$, $|\underline{I}| = 240/6 = 40\,\Omega$, $pf = 3.6/6 = 0.6$ lagging

$P = 40^2 \cdot 3.6 = 5760$ W, $Q = 40^2 \cdot 4.8 = 7680$ w

(b) $C = 7680/\omega|\underline{V}|^2 = 354\,\mu F$, $P = 5760$ W

$|\underline{I}| = 5760/240 = 24$ A

(c) $j4.8 - j/\omega C = 0 \Rightarrow C = 553\,\mu F$, $|\underline{I}| = 240/3.6 = 66.7$ A

$P = 240 \cdot 66.7 = 16000$ W, $|\underline{V}_M| = |Z_M||\underline{I}| = 400$ V

Series resonant circuit.

7.31 (a) $|S_1| = 2000 \cdot 40 = 80000$ VA, $|S_2| = 2000 \cdot 15 = 30000$ VA

$P_1 = 80000 \cdot 0.5 = 40000$ W, $P_2 = 30000 \cdot 0.8 = 24000$ W

$Q_1 = (80000^2 - 40000^2)^{1/2} = 69.3$ kVAr, $Q_2 = -(30000^2 - 24000^2)^{1/2} = -18$ kVAr

$P = P_1 + P_2 = 64000$ W, $Q = Q_1 + Q_2 = 51.3$ kVAr

$S = (P^2 + Q^2)^{1/2} = 82000$ kVA, $|\underline{I}| = |S|/|\underline{V}| = 41$ A

$pf = P/|S| = 0.78$ lagging

(b) $|S| = 64000/0.95 = 67.4$ kVA $\Rightarrow |\underline{I}| = |S|/|\underline{V}| = 33.7$ A

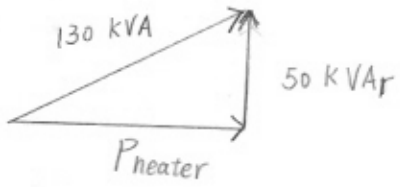
$Q_C + 51.3k = |S|(1 - 0.95^2)^{1/2} \Rightarrow Q_C = -30.3$ kVAr

7.34 $|S_{blower}| = 50/0.707 = 70.7$ kVA, $Q = 70.7 \cdot (1 - 0.707^2)^{1/2} = 50$ kVAr

$|S| = 1300 \cdot 100 = 130$ kVA

$P_{heater} = (130^2 - 50^2)^{1/2} - 50 = 70$ kW

$R_{heater} = 1300^2/70000 = 24.1\,\Omega$



7.40 $|\underline{V}\underline{I}_1|^2 = |\underline{S}_1|^2 = P^2 + Q^2$, $|\underline{V}\underline{I}_2|^2 = |\underline{S}_2|^2 = P^2 + (Q + Q_C)^2$, $Q_C = -\omega C|\underline{V}|^2$

$|\underline{V}\underline{I}_1|^2 - |\underline{V}\underline{I}_2|^2 = Q^2 - (Q + Q_C)^2 = -2QQ_C - Q_C^2$

$\Rightarrow |\underline{V}|^2(|\underline{I}_1|^2 - |\underline{I}_2|^2 = 2Q\omega C|\underline{V}|^2 - (\omega C|\underline{V}|^2)^2$

$\Rightarrow \quad Q = \frac{1}{2}\left[\omega C|\underline{V}|^2 + (|\underline{I}_1|^2 - |\underline{I}_2|^2)/\omega C\right]$,

$P = (|\underline{V}|^2|\underline{I}_1|^2 - Q^2)^{1/2}$