Circuits II

Home Work # 3 (Ch10) Solution

AP 10.6

$$S_1 = 15{,}000(0.6) + j15{,}000(0.8) = 9000 + j12{,}000\,\text{VA}$$

$$S_2 = 6000(0.8) - j6000(0.6) = 4800 - j3600\,\text{VA}$$

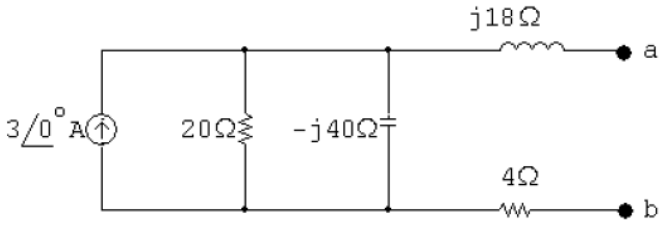
$$S_T = S_1 + S_2 = 13{,}800 + j8400\,\text{VA}$$

$$S_T = 200\mathbf{I}^*; \qquad \text{therefore} \quad \mathbf{I}^* = 69 + j42 \qquad \mathbf{I} = 69 - j42\,\text{A}$$

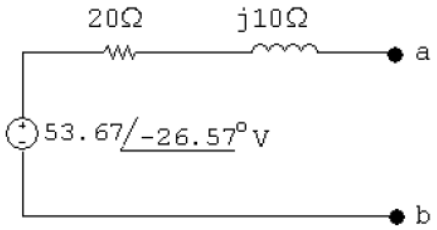
$$\mathbf{V}_s = 200 + j\mathbf{I} = 200 + j69 + 42 = 242 + j69 = 251.64\underline{/15.91^\circ}\,\text{V (rms)}$$

AP 10.7 **[a]** The phasor domain equivalent circuit and the Thévenin equivalent are shown below:

Phasor domain equivalent circuit:



Thévenin equivalent:



$$\mathbf{V}_{\text{Th}} = 3\frac{-j800}{20 - j40} = 48 - j24 = 53.67\underline{/-26.57^\circ}\,\text{V}$$

$$Z_{\text{Th}} = 4 + j18 + \frac{-j800}{20 - j40} = 20 + j10 = 22.36\underline{/26.57^\circ}\,\Omega$$

For maximum power transfer, $\quad Z_{\text{L}} = (20 - j10)\,\Omega$

[b] $\mathbf{I} = \dfrac{53.67\underline{/-26.57^\circ}}{40} = 1.34\underline{/-26.57^\circ}\,\text{A}$

Therefore $\quad P = \left(\dfrac{1.34}{\sqrt{2}}\right)^2 20 = 17.96\,\text{W}$

[c] $R_{\text{L}} = |Z_{\text{Th}}| = 22.36\,\Omega$

[d] $\mathbf{I} = \dfrac{53.67\underline{/-26.57^\circ}}{42.36 + j10} = 1.23\underline{/-39.85^\circ}\,\text{A}$

Therefore $\quad P = \left(\dfrac{1.23}{\sqrt{2}}\right)^2 (22.36) = 17\,\text{W}$

P 10.2 [a] coffee maker = 1200 W frying pan = 1196 W

microwave oven = 1450 W toaster = 1146 W

$\sum P = 4992\,\text{W}$

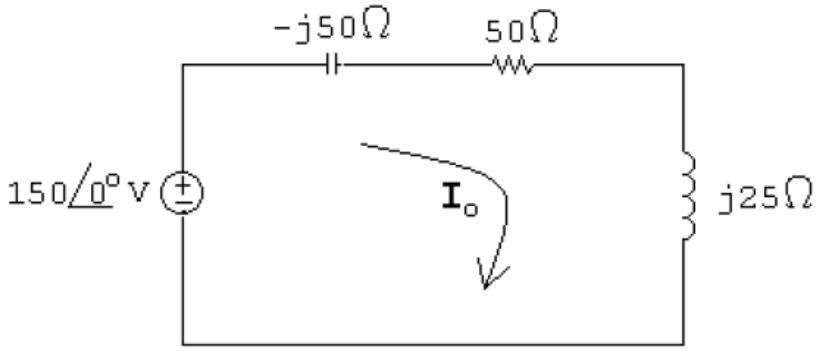
Therefore $I_{\text{eff}} = \dfrac{4992}{120} = 41.6\,\text{A}$

The breaker will not trip.

[b] $\sum P = 4992 + 860 + 630 = 6482\,\text{W};$ $I_{\text{eff}} = \dfrac{6482}{120} = 54.02\,\text{A}$

The breaker will trip because the current is greater than 50 A

P 10.18 $j\omega L = j25\,\Omega;$ $\dfrac{1}{j\omega C} = -j75\,\Omega$



$$\mathbf{I}_o = \frac{j150}{50 - j25} = 2.4 + j1.2\,\text{A}$$

$$P = \frac{1}{2}|\mathbf{I}_o|^2(50) = \frac{1}{2}(7.2)(50) = 180\,\text{W}$$

$$Q = \frac{1}{2}|\mathbf{I}_o|^2(25) = 90\,\text{VAR}$$

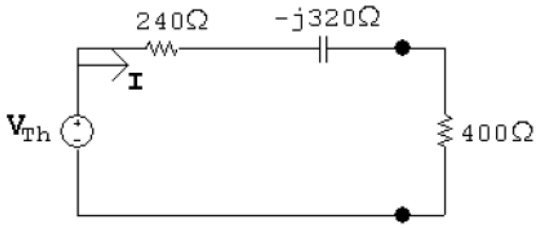
$$S = P + jQ = 180 + j90\,\text{VA}$$

$$|S| = 201.25\,\text{VA}$$

P 10.46 **[a]** $Z_{\text{Th}} = 200 - j480 + \dfrac{(j200)(500 + j300)}{500 + j500} = 240 - j320 = 400\underline{/-53.13^\circ}\,\Omega$

$\therefore \quad R = |Z_{\text{Th}}| = 400\,\Omega$

[b] $\mathbf{V}_{\text{Th}} = \dfrac{j200}{500 + j300 + j200}(300\underline{/0^\circ}) = 60 + j60\,\text{V(rms)}$



$$\mathbf{I} = \frac{60 + j60}{640 - j320} = 37.5 + j112.5\ \text{mA(rms)} = 118.59\underline{/71.57^\circ}\ \text{mA(rms)}$$

$$P = (0.11859)^2(400) = 5.625\,\text{W}$$

[c] Pick the $390\,\Omega$ resistor from Appendix H for the closest match:

$$\mathbf{I} = \frac{60 + j60}{630 - j320} = 120.084\underline{/71.93^\circ}\ \text{mA(rms)}$$

$$P = (0.120084)^2(390) = 5.624\,\text{W}$$