Chapter 10, Solution 55.

Find the Thevenin and Norton equivalent circuits at terminals *a-b* for each of the circuits in Fig. 10.98.

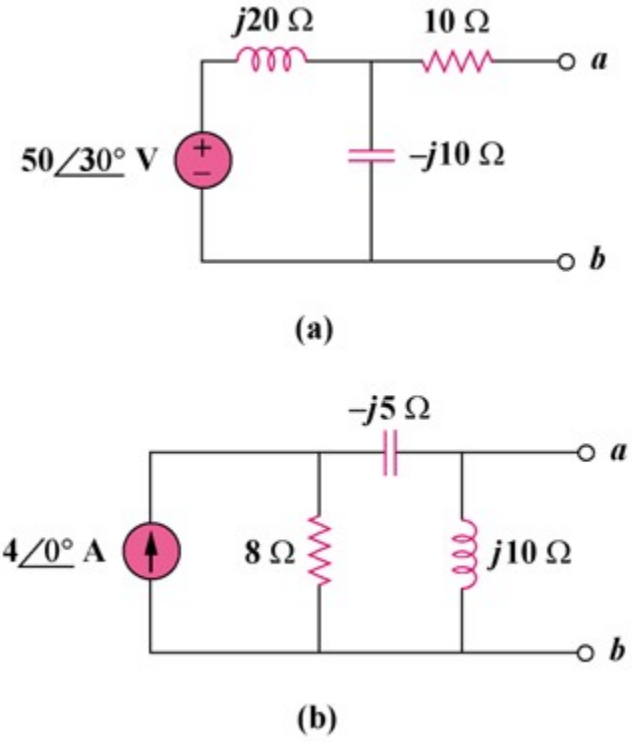
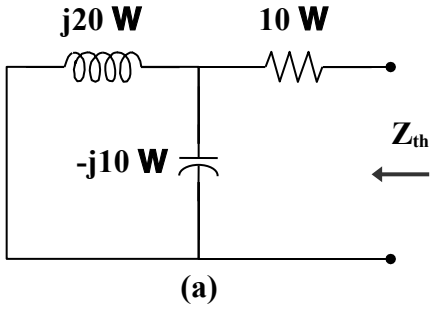


Figure 10.98
For Prob. 10.55.

Solution

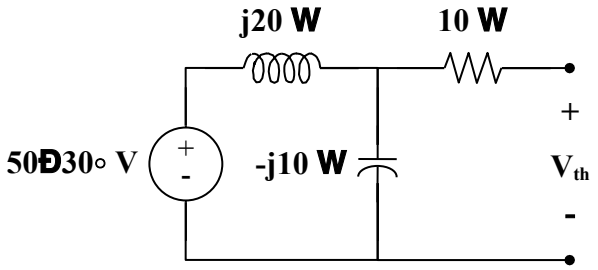
(a) To find $\mathbf{Z}_{th}$, consider the circuit in Fig. (a).



$$\mathbf{Z}_N = \mathbf{Z}_{th} = 10 + j20 \,||\, (-j10) = 10 + \frac{(j20)(-j10)}{j20 - j10}$$

$$= 10 - j20 = \mathbf{22.36Ð\text{-}63.43^{\circ}\ W}$$

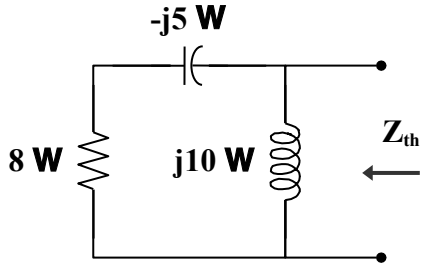
To find $\mathbf{V}_{th}$, consider the circuit in Fig. (b).



(b)

$$\mathbf{V}_{th} = \frac{-j10}{j20 - j10}(50\angle 30°) = \mathbf{50Ð–150◦\ V}$$

$$\mathbf{I}_N = \frac{\mathbf{V}_{th}}{\mathbf{Z}_{th}} = \frac{-50\angle 30°}{22.36\angle -63.43°} = \mathbf{2.236Ð–86.6◦\ A}$$

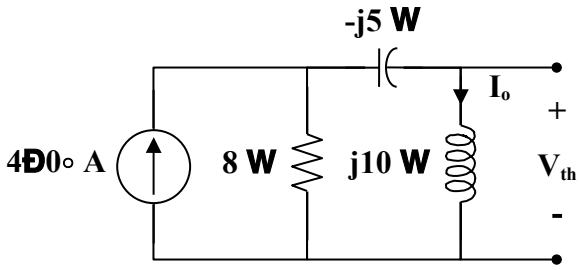


(c)

(b) To find $\mathbf{Z}_{th}$, consider the circuit in Fig. (c).

$$\mathbf{Z}_N = \mathbf{Z}_{th} = j10 \,||\, (8 - j5) = \frac{(j10)(8 - j5)}{j10 + 8 - j5} = \mathbf{10Ð26◦\ W}$$

To obtain $\mathbf{V}_{th}$, consider the circuit in Fig. (d).



(d)

By current division,

$$\mathbf{I}_o = \frac{8}{8 + j10 - j5}(4\angle 0°) = \frac{32}{8 + j5}$$

$$\mathbf{V}_{th} = j10\mathbf{I}_o = \frac{j320}{8 + j5} = \mathbf{33.92Ð58° V}$$

$$\mathbf{I}_N = \frac{\mathbf{V}_{th}}{\mathbf{Z}_{th}} = \frac{33.92\angle 58°}{10\angle 26°} = \mathbf{3.392Ð32° A}$$