Chapter 10, Solution 60.

Find the Thevenin equivalent of the circuit in Fig. 10.103 as seen from:

(a) terminals *a-b*
(b) terminals *c-d*

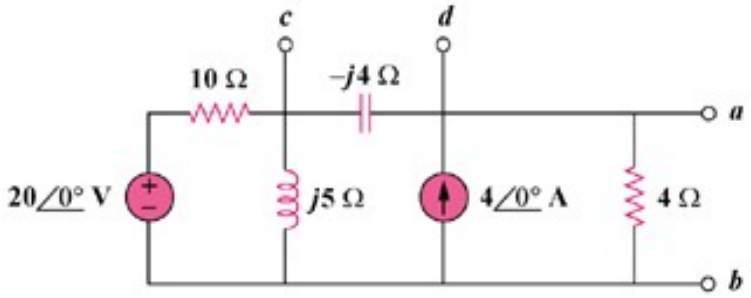
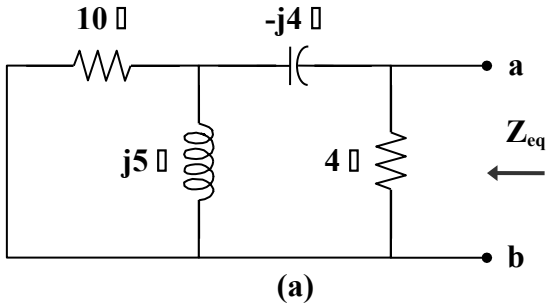


Figure 10.103
For Prob. 10.60.

Solution



(a)

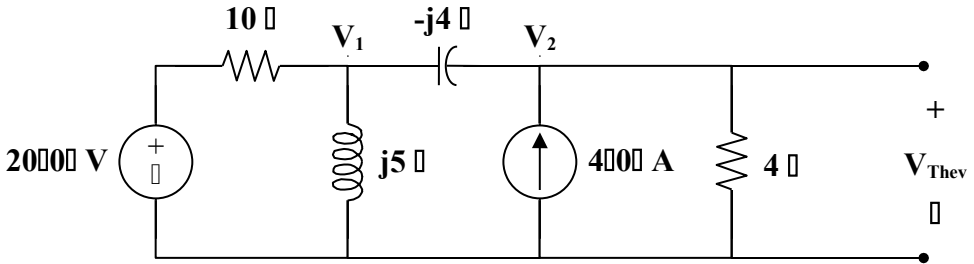
(a) To find $\mathbf{Z}_{eq}$, consider the circuit in Fig. (a).

$$\mathbf{Z}_{eq} = 4 \,\|\, (-j4 + 10 \,\|\, j5) = 4 \,\|\, (-j4 + 2 + j4)$$

$$\mathbf{Z}_{eq} = 4 \,\|\, 2$$

$$= \mathbf{1.333}\ \Omega$$

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



At node 1,

$$\frac{20 - \mathbf{V}_1}{10} = \frac{\mathbf{V}_1}{j5} + \frac{\mathbf{V}_1 - \mathbf{V}_2}{-j4}$$

$$(1 + j0.5)\mathbf{V}_1 - j2.5\mathbf{V}_2 = 20 \qquad (1)$$

At node 2,

$$4 + \frac{\mathbf{V}_1 - \mathbf{V}_2}{-j4} = \frac{\mathbf{V}_2}{4}$$

$$\mathbf{V}_1 = (1 - j)\mathbf{V}_2 + j16 \qquad (2)$$

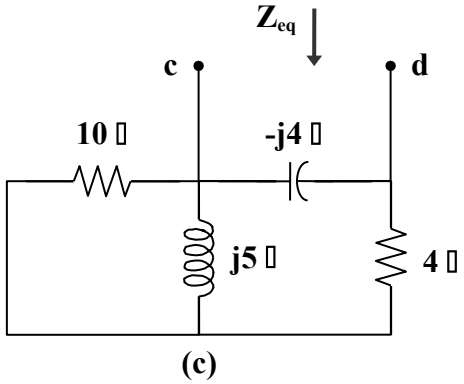
Substituting (2) into (1) leads to

$$28 - j16 = (1.5 - j3)\mathbf{V}_2$$

$$\mathbf{V}_2 = \frac{28 - j16}{1.5 - j3} = 8 + j5.333$$

Therefore,

$$\mathbf{V}_{Thev} = \mathbf{V}_2 = \underline{\mathbf{9.615}\angle\mathbf{33.69}^\circ\ \mathbf{V}}$$



(c)

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

$$\mathbf{Z}_{eq} = -j4 \,\|\, (4 + 10 \,\|\, j5) = -j4 \,\|\, \left(4 + \frac{j10}{2 + j}\right)$$

$$\mathbf{Z}_{eq} = -j4 \,\|\, (6 + j4) = \frac{-j4}{6}(6 + j4) = \mathbf{(2.667 - j4)\ \Omega}$$

To find $\mathbf{V}_{Thev}$, we will make use of the result in part (a).

$$\mathbf{V}_2 = 8 + j5.333 = (8/3)(3 + j2)$$

$$\mathbf{V}_1 = (1 - j)\mathbf{V}_2 + j16 = j16 + (8/3)(5 - j)$$

$$\mathbf{V}_{Thev} = \mathbf{V}_1 - \mathbf{V}_2 = 16/3 + j8 = \mathbf{9.614\angle 56.31^\circ\ V}$$