

Electrical Circuit (2)

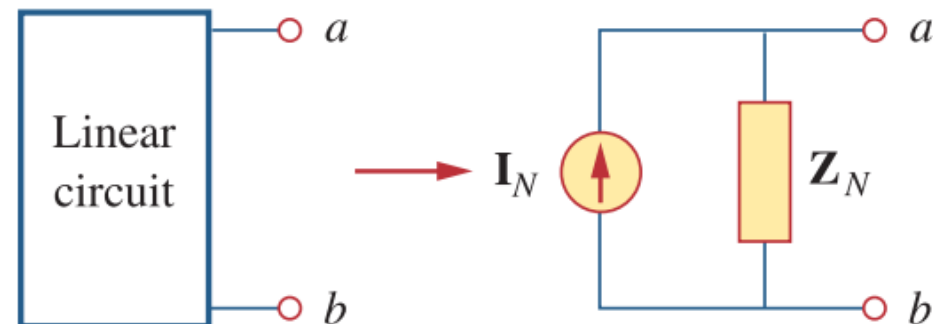
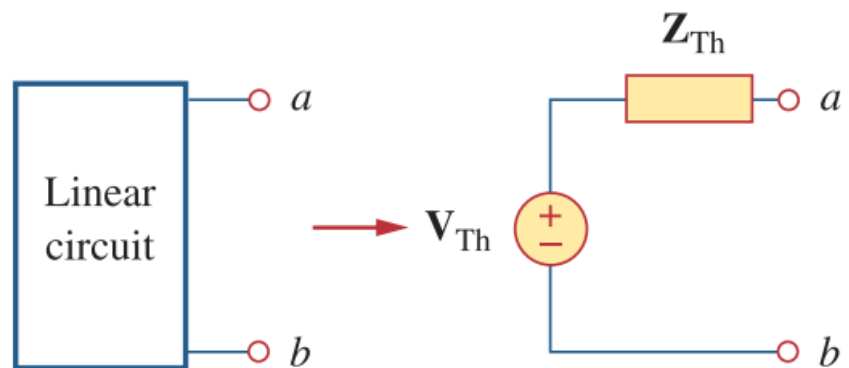
AC Thevenin and Norton (week4 class2)

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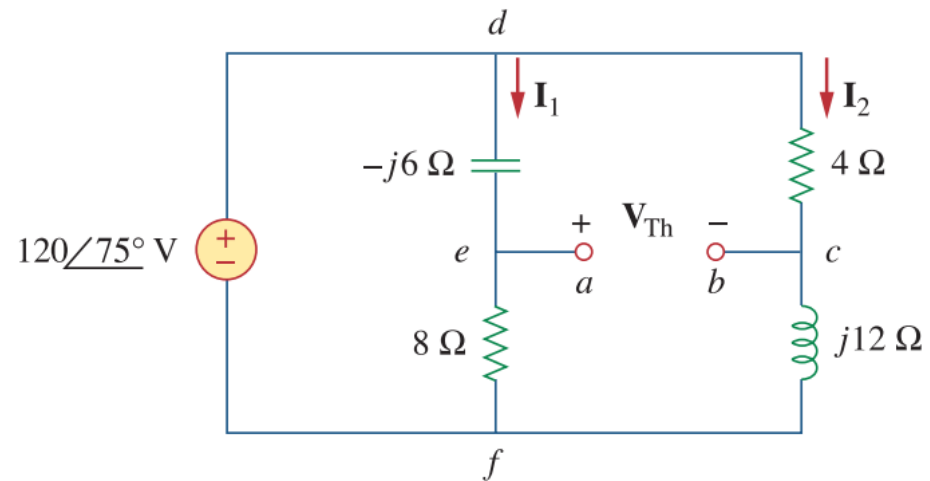
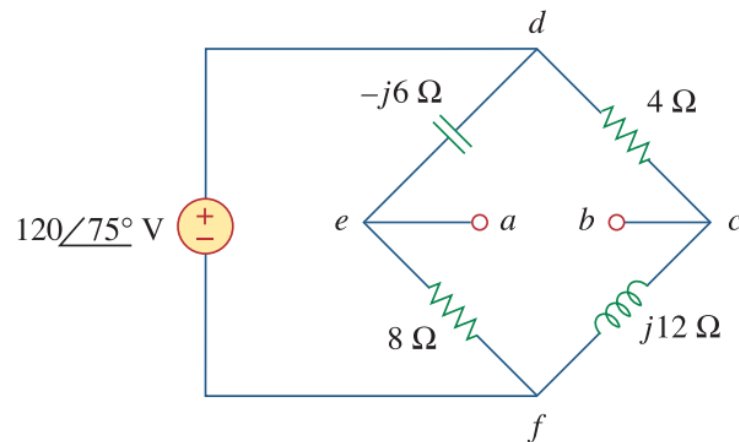
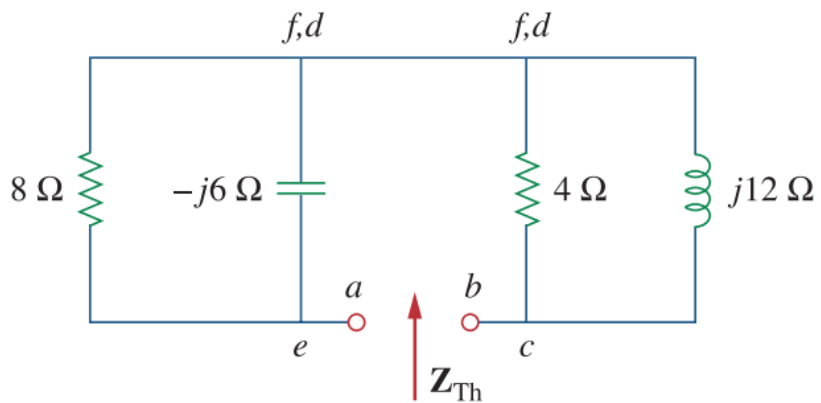
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Thevenin and Norton
Equivalent Circuits

$$V_{Th} = Z_N I_N, \quad Z_{Th} = Z_N$$

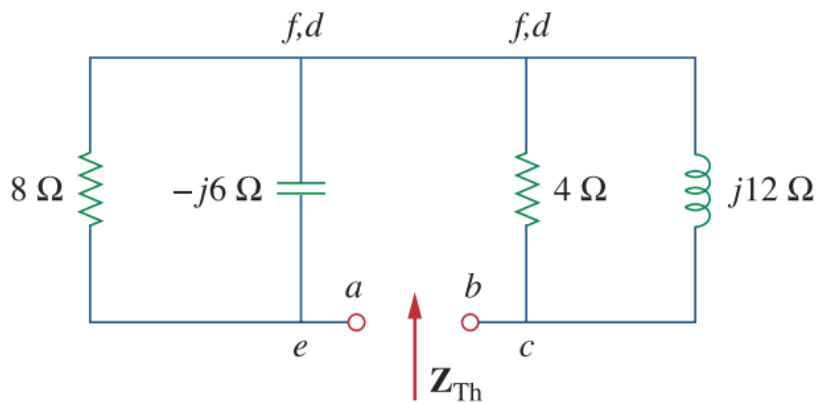
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Thevenin and Norton Equivalent Circuits



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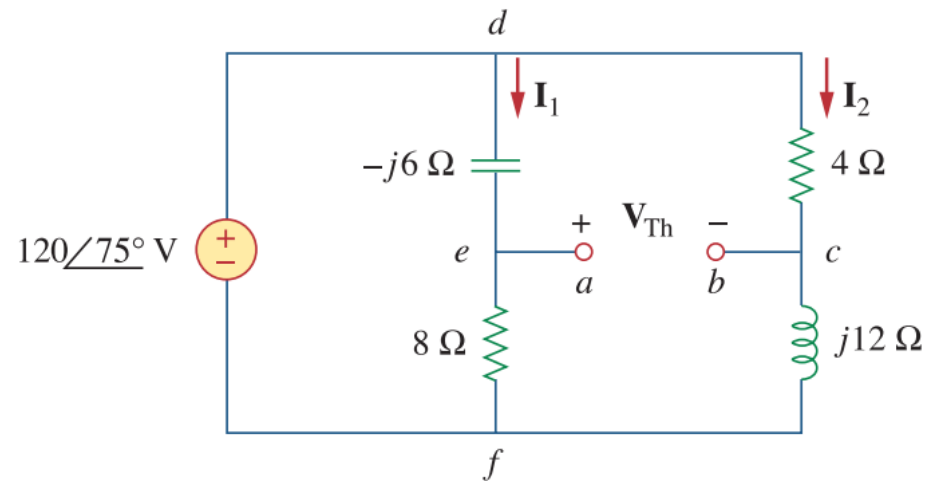
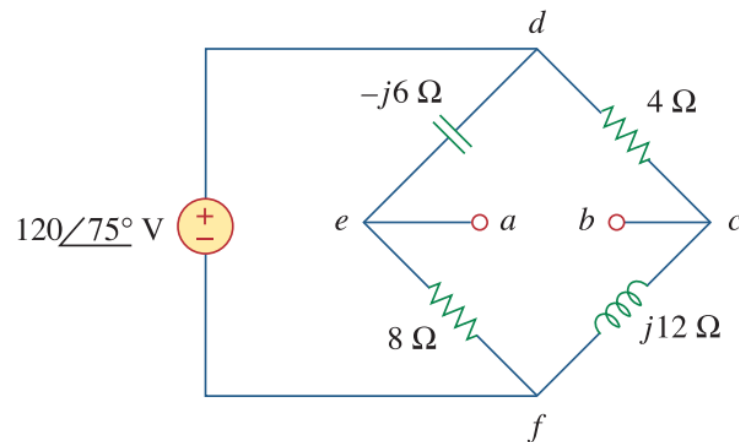
Thevenin and Norton Equivalent Circuits



$$\mathbf{Z}_1 = -j6 \parallel 8 = \frac{-j6 \times 8}{8 - j6} = 2.88 - j3.84 \, \Omega$$

$$\mathbf{Z}_2 = 4 \parallel j12 = \frac{j12 \times 4}{4 + j12} = 3.6 + j1.2 \, \Omega$$

$$\mathbf{Z}_{\text{Th}} = \mathbf{Z}_1 + \mathbf{Z}_2 = 6.48 - j2.64 \, \Omega$$



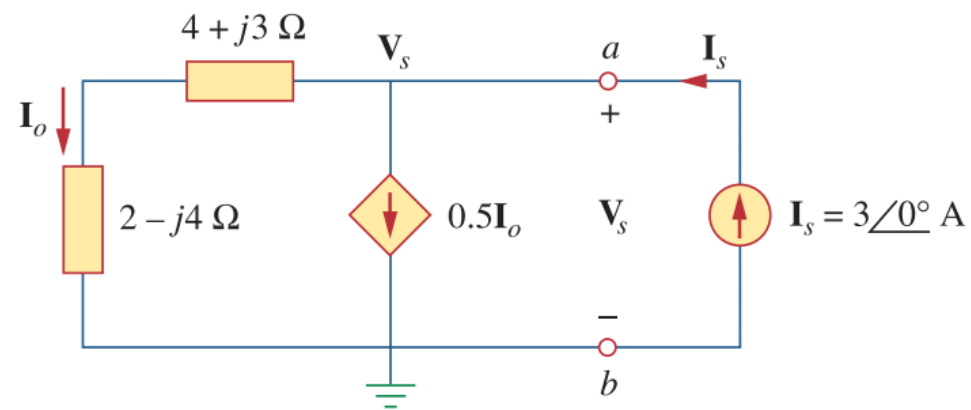
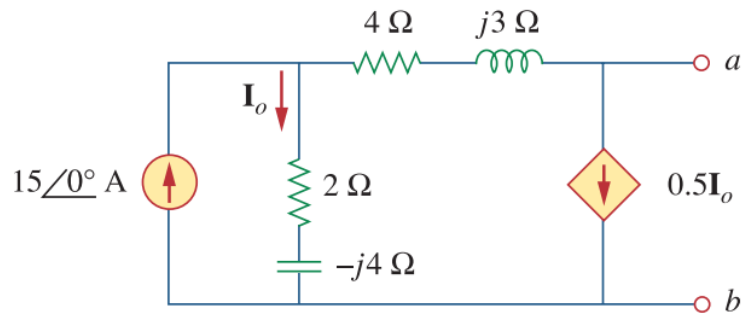
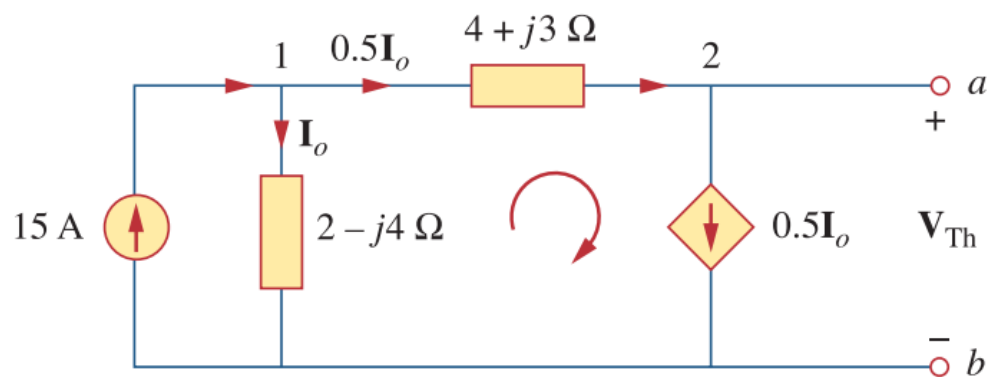
$$\mathbf{I}_1 = \frac{120 \angle 75^\circ}{8 - j6} \text{ A}, \quad \mathbf{I}_2 = \frac{120 \angle 75^\circ}{4 + j12} \text{ A}$$

$$\mathbf{V}_{\text{Th}} - 4\mathbf{I}_2 + (-j6)\mathbf{I}_1 = 0$$

$$\begin{aligned} \mathbf{V}_{\text{Th}} = 4\mathbf{I}_2 + j6\mathbf{I}_1 &= \frac{480 \angle 75^\circ}{4 + j12} + \frac{720 \angle 75^\circ + 90^\circ}{8 - j6} \\ &= 37.95 \angle 3.43^\circ + 72 \angle 201.87^\circ \\ &= -28.936 - j24.55 = 37.95 \angle 220.31^\circ \text{ V} \end{aligned}$$

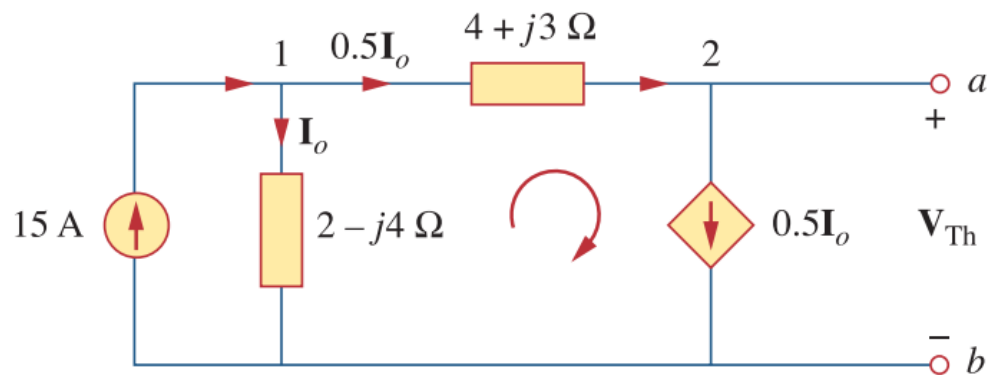
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Thevenin and Norton Equivalent Circuits



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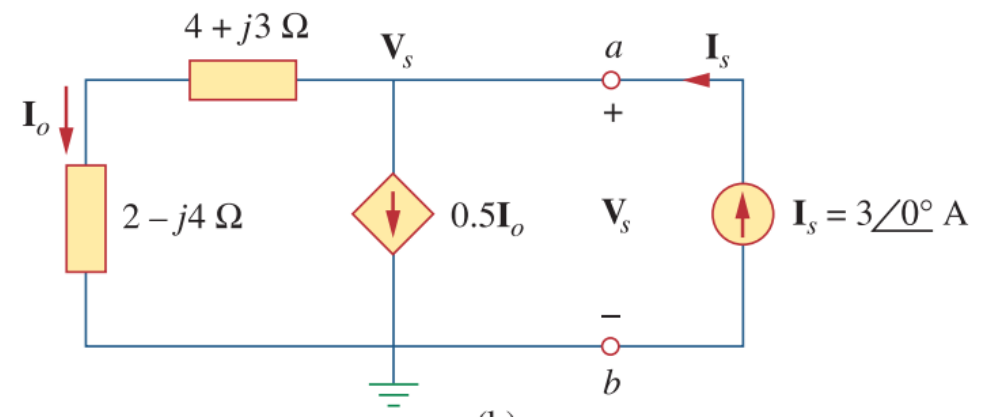
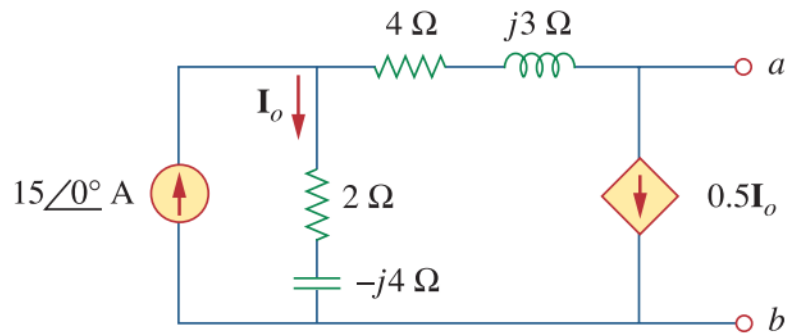
Thevenin and Norton Equivalent Circuits



$$15 = \mathbf{I}_o + 0.5\mathbf{I}_o \Rightarrow \mathbf{I}_o = 10 \text{ A}$$

$$-\mathbf{I}_o(2 - j4) + 0.5\mathbf{I}_o(4 + j3) + \mathbf{V}_{Th} = 0$$

$$\mathbf{V}_{Th} = 55 \angle -90^\circ \text{ V}$$

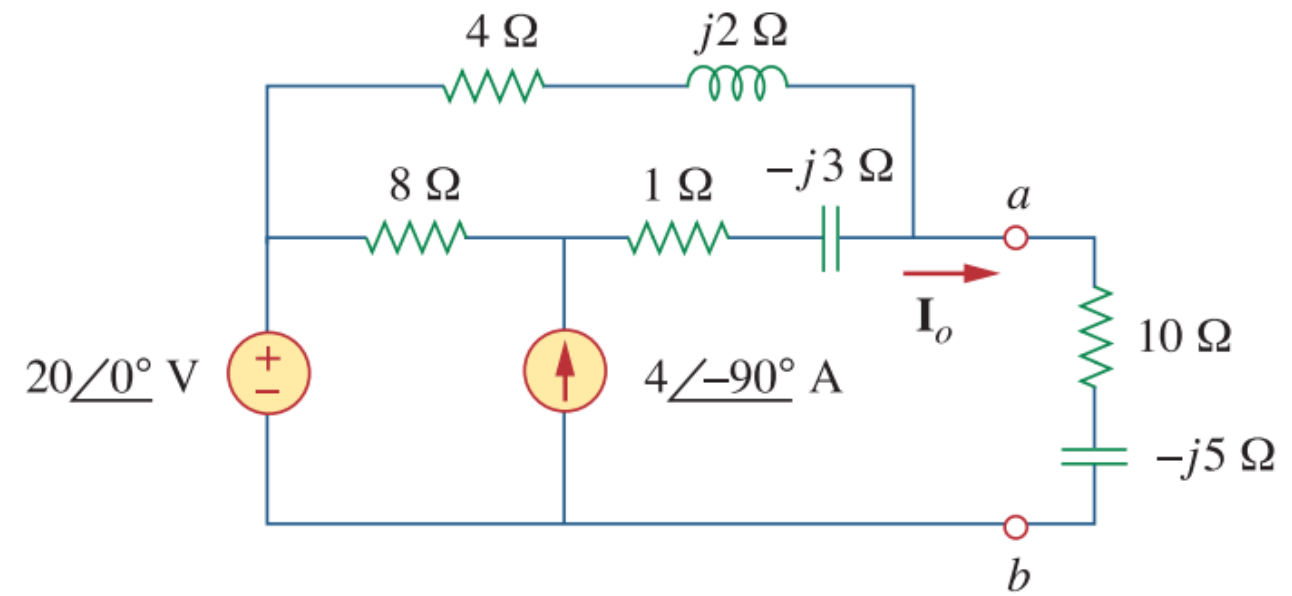


$$3 = \mathbf{I}_o + 0.5\mathbf{I}_o \Rightarrow \mathbf{I}_o = 2 \text{ A}$$

$$\mathbf{V}_s = \mathbf{I}_o(4 + j3 + 2 - j4) = 2(6 - j)$$

$$\mathbf{Z}_{Th} = \frac{\mathbf{V}_s}{\mathbf{I}_s} = \frac{2(6 - j)}{3} = 4 - j0.6667 \Omega$$

10.6

Thevenin and Norton
Equivalent Circuits

10.6

Thevenin and Norton
Equivalent Circuits

$$Z_{th} = (4 + 2j) \parallel (9 - 3j) = 3.176 + j0.706$$

$$V_{th} = V_{@20V} + V_{@4A} \text{ (superposition)}$$

$$V_{@20V} = 20 \text{ V}$$

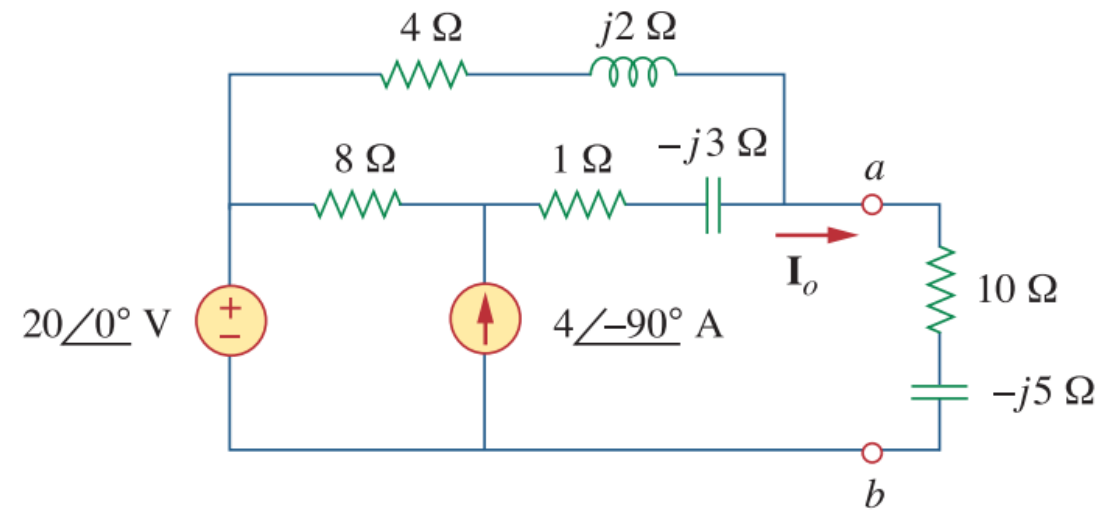
$$V_{@4A} \rightarrow I_{@8\Omega} = I_{@8\Omega} = 4 \angle -90^\circ * \frac{1 - 3j + 2j + 4}{8 + 1 - 3j + 2j + 4} = -0.188 - j1.553 \text{ A}$$

$$I_{@4+2j\Omega} = 4 \angle -90^\circ * \frac{8}{8+1-3j+2j+4} = 0.188 - j2.447 \text{ A}$$

$$V_{@4A} = I_{@4+2j\Omega} * (4 + 2j) = 0.188 - j2.447 \text{ A} * (4 + 2j) = 5.647 - j9.4118$$

$$V_{th} = 20 + 5.647 - j9.4118 = 25.647 - j9.4118$$

$$I_o = \frac{V_{th}}{Z_{th} + Z_{Load}} = \frac{25.647 - j9.4118}{3.176 + j0.706 + 10 - j5} = 1.97 - j0.07228 = 1.97 \angle -2.1^\circ \text{ A}$$



Answer: $Z_N = 3.176 + j0.706 \Omega$, $I_N = 8.396 \angle -32.68^\circ \text{ A}$,
 $I_o = 1.9714 \angle -2.10^\circ \text{ A}$.

