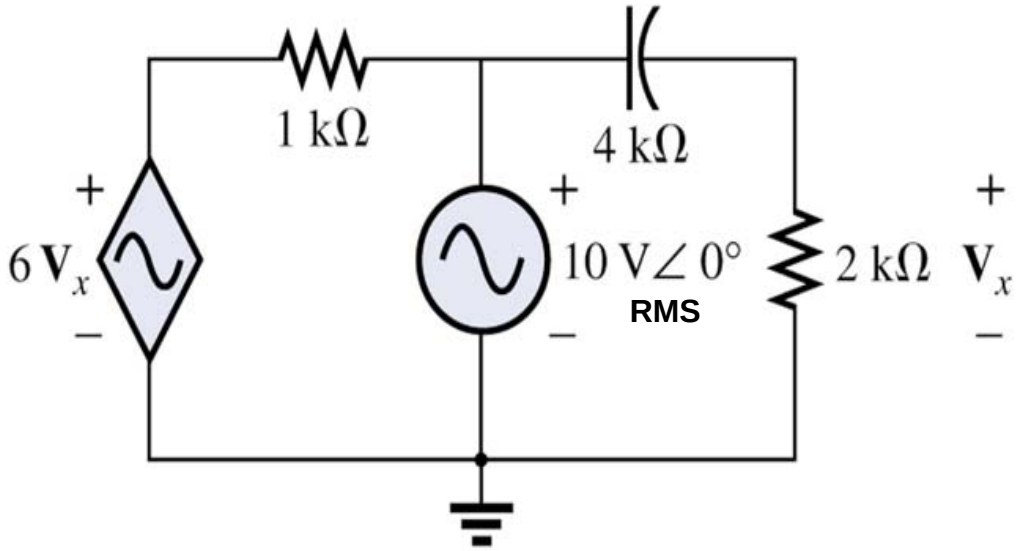
ICP – MESH Analysis w/Dependent Voltage Source



Find:

- The current through each resistor

Check:

- KVL on the LHS or RHS

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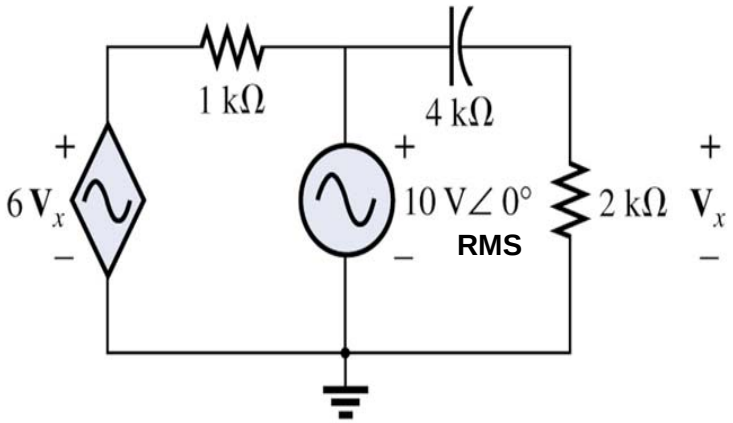
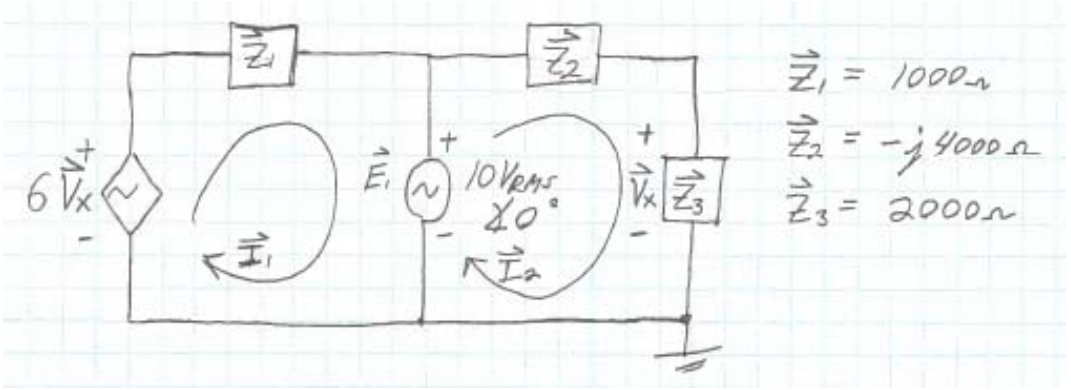


Redraw and assign loop currents CW:



Loop 1: $6\vec{V}_x - \vec{I}_1\vec{Z}_1 - \vec{E}_1 = 0$

But $\vec{V}_x = \vec{I}_2\vec{Z}_3$

$\therefore 6\vec{I}_2\vec{Z}_3 - \vec{I}_1\vec{Z}_1 = \vec{E}_1$

OR $-\vec{I}_1\vec{Z}_1 + 6\vec{Z}_3\vec{I}_2 = \vec{E}_1$ (1)

Loop 2: $\vec{E}_1 - \vec{I}_2\vec{Z}_2 - \vec{I}_2\vec{Z}_3 = 0$

OR $0\vec{I}_1 + (\vec{Z}_2 + \vec{Z}_3)\vec{I}_2 = \vec{E}_1$ (2)

SUBSTITUTING VALUES YIELDS:

$-1000\vec{I}_1 + 12{,}000\vec{I}_2 = 10\angle 0^\circ$ (1)

$0\vec{I}_1 + (2000 - j4000)\vec{I}_2 = 10\angle 0^\circ$ (2)

$AX = B$

$\therefore X = A^{-1} \cdot B = \begin{bmatrix} 24.1\text{mA}_{RMS} \angle 85.2^\circ \\ 2.24\text{mA}_{RMS} \angle 63.4^\circ \end{bmatrix} \begin{matrix} \vec{I}_1 \\ \vec{I}_2 \end{matrix}$

NP

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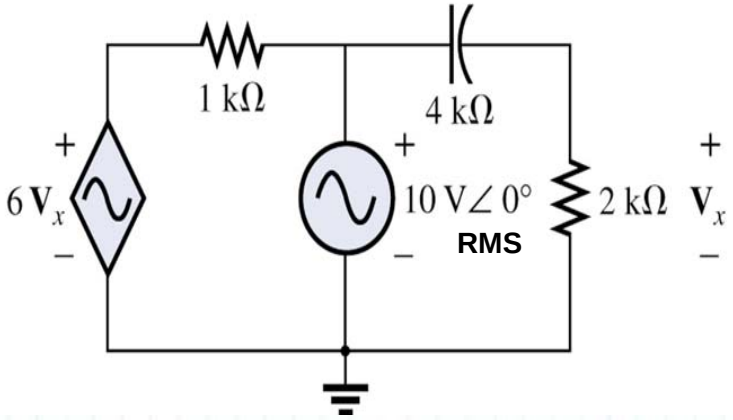

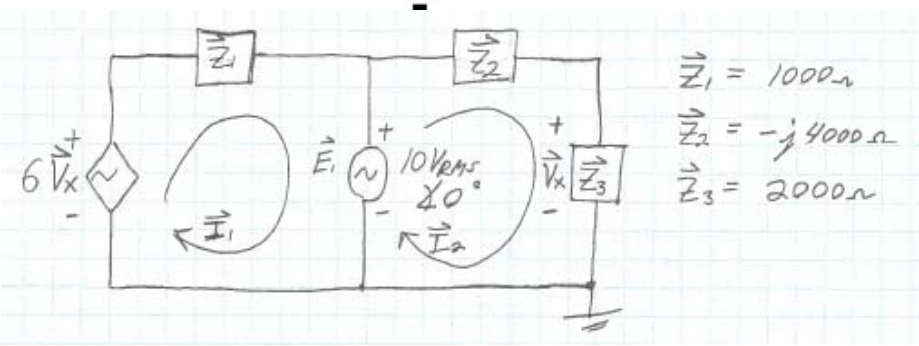

$AX = B$

$\therefore X = A^{-1} \cdot B = \begin{bmatrix} 24.1\,mA_{RMS} \angle 85.2^\circ \\ 2.24\,mA_{RMS} \angle 63.4^\circ \end{bmatrix} \begin{matrix} \leftarrow \vec{I}_1 \\ \leftarrow \vec{I}_2 \end{matrix}$

LHS CHECK

$6\vec{V}_x - \vec{I}_1 \vec{Z}_1 \overset{?}{=} \vec{E}_1$

BUT $\vec{V}_x = \vec{I}_2 \vec{Z}_3 = 4.48\,V_{RMS} \angle 63.4^\circ$

So we have:

$6(4.48\,V_{RMS} \angle 63.4^\circ) - 24.1\,V_{RMS} \angle 85.2^\circ \overset{?}{=} 10\,V_{RMS} \angle 0^\circ$

$10.02\,V_{RMS} \angle 0.11^\circ \cong 10\,V_{RMS} \angle 0^\circ$ ✓

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