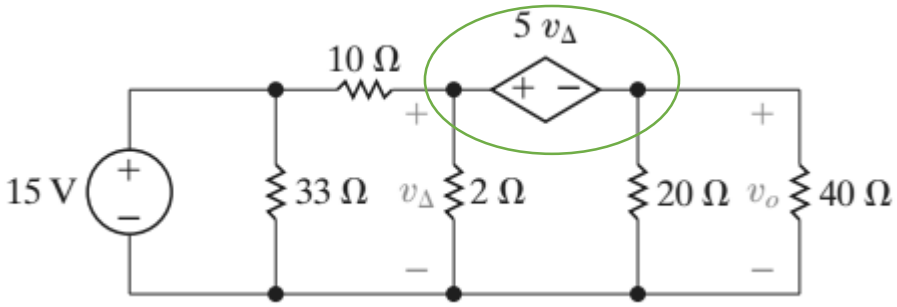
Homwork 2 جواب سوالات

-۲

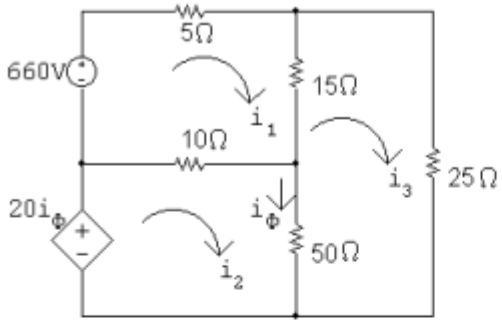


Place $5v_\Delta$ inside a supernode and use the lower node as a reference. Then

$$\frac{v_\Delta - 15}{10} + \frac{v_\Delta}{2} + \frac{v_\Delta - 5v_\Delta}{20} + \frac{v_\Delta - 5v_\Delta}{40} = 0$$

$$12v_\Delta = 60; \qquad v_\Delta = 5\,\text{V}$$

$$v_o = v_\Delta - 5v_\Delta = -4(5) = -20\,\text{V}$$



$$660 = 30i_1 - 10i_2 - 15i_3$$

$$20i_\phi = -10i_1 + 60i_2 - 50i_3$$

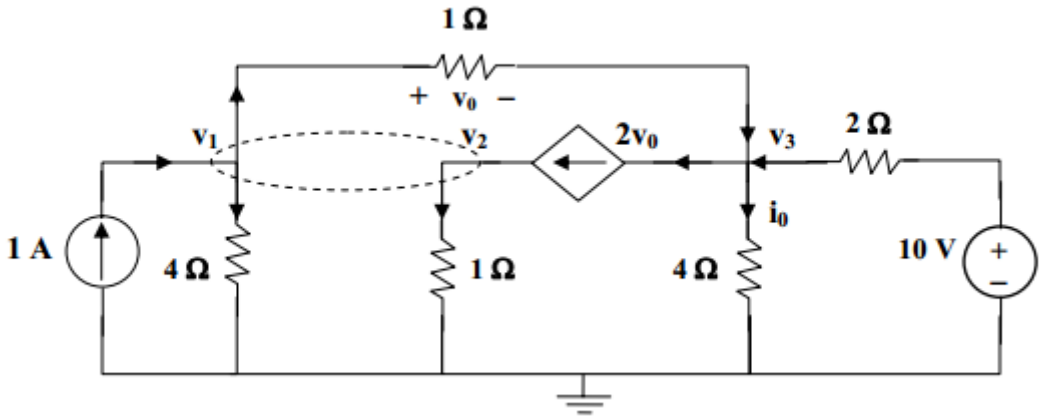
$$0 = -15i_1 - 50i_2 + 90i_3$$

$$i_\phi = i_2 - i_3$$

Solving, $i_1 = 42$ A; $i_2 = 27$ A; $i_3 = 22$ A; $i_\phi = 5$ A

$$20i_\phi = 100\,\text{V}$$

$$p_{20i_\phi} = -100i_2 = -100(27) = -2700\,\text{W}$$



At the supernode,

$$1 + 2v_0 = \frac{v_1}{4} + \frac{v_2}{1} + \frac{v_1 - v_3}{1} \qquad (1)$$

But $v_o = v_1 - v_3$. Hence (1) becomes,

$$4 = -3v_1 + 4v_2 + 4v_3 \qquad (2)$$

At node 3,

$$2v_o + \frac{v_3}{4} = v_1 - v_3 + \frac{10 - v_3}{2}$$

or

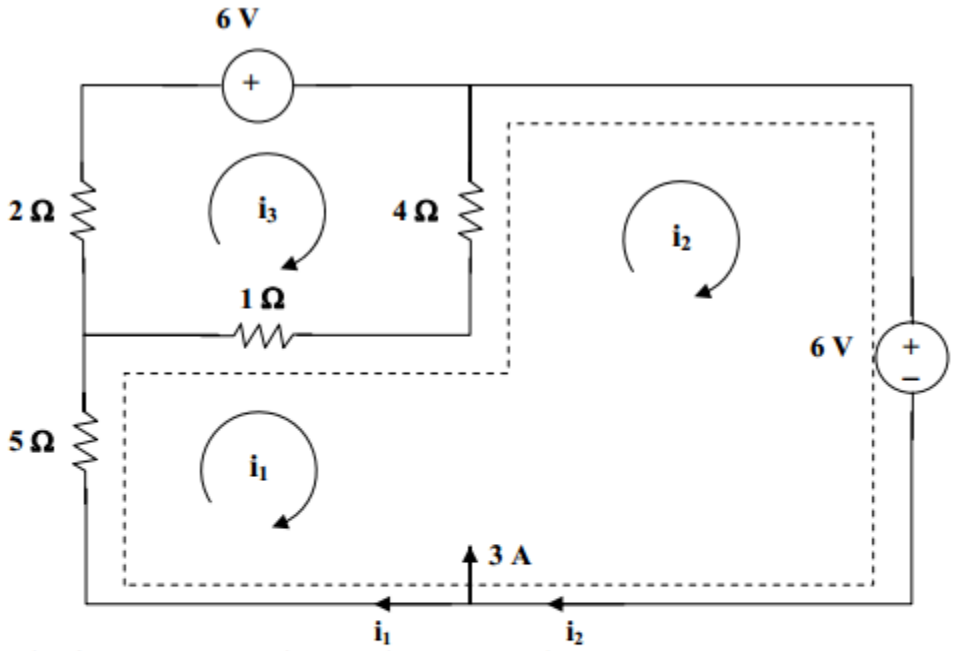
$$20 = 4v_1 + 0v_2 - v_3 \qquad (3)$$

At the supernode, $v_2 = v_1 + 4i_o$. But $i_o = \frac{v_3}{4}$. Hence,

$$v_2 = v_1 + v_3 \qquad (4)$$

Solving (2) to (4) leads to,

$$v_1 = \underline{\mathbf{4.97V}},\ v_2 = \underline{\mathbf{4.85V}},\ v_3 = \underline{\mathbf{-0.12V}}.$$



Loop 1 and 2 form a supermesh. For the supermesh,

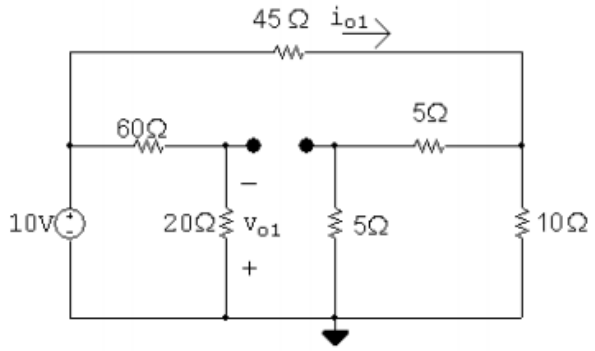
$$6i_1 + 4i_2 - 5i_3 + 12 = 0 \qquad (1)$$

For loop 3, $$-i_1 - 4i_2 + 7i_3 + 6 = 0 \qquad (2)$$

Also, $$i_2 = 3 + i_1 \qquad (3)$$

Solving (1) to (3), $i_1 = -3.067$, $i_3 = -1.3333$; $i_o = i_1 - i_3 =$ **-1.7333 A**

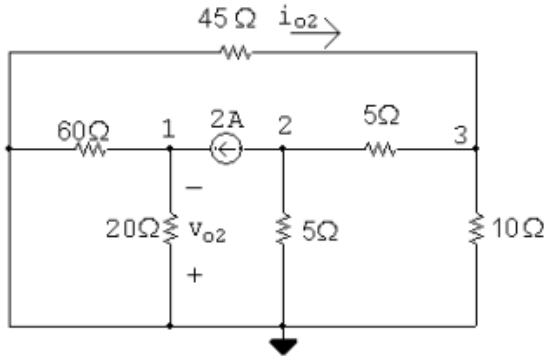
Voltage source acting alone:



$$i_{o1} = \frac{10}{45 + (5+5)\|10} = \frac{10}{45+5} = 0.2\,\text{A}$$

$$v_{o1} = \frac{20}{20+60}(-10) = -2.5\,\text{V}$$

Current source acting alone:



$$\frac{v_2}{5} + 2 + \frac{v_2 - v_3}{5} = 0$$

$$\frac{v_3}{10} + \frac{v_3 - v_2}{5} + \frac{v_3}{45} = 0$$

Solving, $v_2 = -7.25\ \text{V} = v_{o2}$; $\qquad v_3 = -4.5\,\text{V}$

$$i_{o2} = -\frac{v_3}{45} = -0.1\,\text{A}$$

$$i_{20} = \frac{60 \| 20}{20}(2) = 1.5\,\text{A}$$

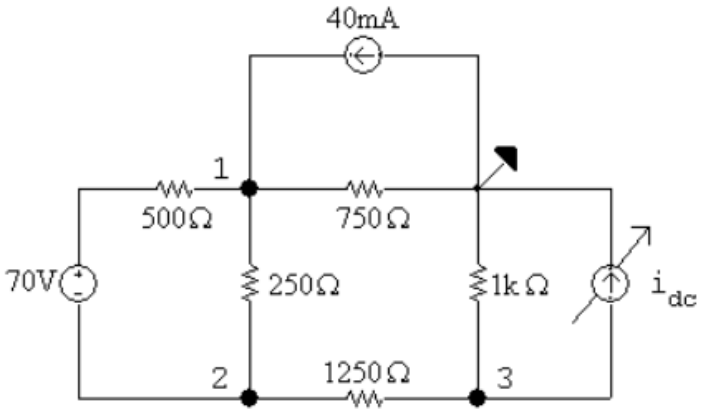
$$v_{o2} = -20 i_{20} = -20(1.5) = -30\,\text{V}$$

$$\therefore \quad v_o = v_{o1} + v_{o2} = -2.5 - 30 = -32.5\,\text{V}$$

$$i_o = i_{o1} + i_{o2} = 0.2 + 0.1 = 0.3\,\text{A}$$

[a] The mesh-current method does not directly involve the voltage drop across the 40 mA source. Instead, use the node-voltage method and choose the reference node so that a node voltage is identical to the voltage across the 40 mA source.

[b]



Since the 40 mA source is developing 0 W, v_1 must be 0 V.

Since v_1 is known, we can sum the currents away from node 1 to find v_2 thus:

$$\frac{0-(70+v_2)}{500}+\frac{0-v_2}{250}+\frac{0}{750}-0.04=0$$

$$\therefore \quad v_2=-30\,\text{V}$$

Now that we know v_2 we sum the currents away from node 2 to find v_3; thus:

$$\frac{v_2+70-0}{500}+\frac{v_2-0}{250}+\frac{v_2-v_3}{1250}=0$$

$$\therefore \quad v_3=-80\,\text{V}$$

Now that we know v_3 we sum the currents away from node 3 to find i_{dc}; thus:

$$\frac{v_3}{1000}+\frac{v_3-v_2}{1250}+i_{\text{dc}}=0$$

$$\therefore \quad i_{\text{dc}}=0.12=120\ \text{mA}$$