School of Electrical Engineering and Computer Science, University of Ottawa

Circuit Theory I

ELG2138B **Fall 2017**

Problem Set #3

Due: 10/02/2017, 8:30am

No late homework is accepted.

Total 2 problems:

1. (5pts)

P 4.6-8 Determine values of the mesh currents, i_1, i_2, and i_3, in the circuit shown in Figure P 4.6-8.

2.

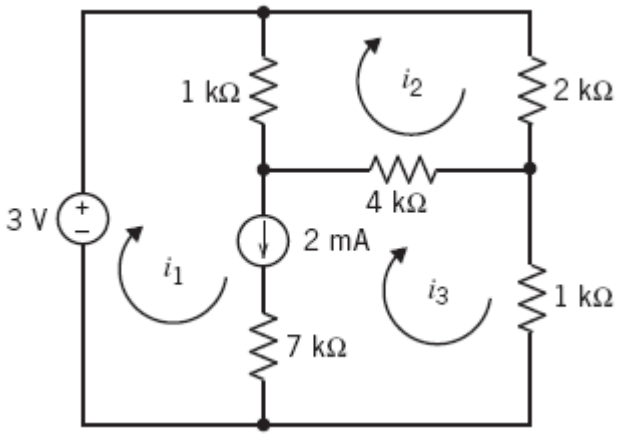


Figure P 4.6-8

Solution: ***Use units of V, mA and kΩ. Express the currents to the supermesh to get***

$$i_1 - i_3 = 2$$

Apply KVL to the supermesh to get

$$4\left(i_3 - i_3\right) + (1)i_3 - 3 + (1)\left(i_1 - i_2\right) = 0 \quad \Rightarrow \quad i_1 - 5i_2 + 5i_3 = 3$$

Apply KVL to mesh 2 to get

$$2i_2 + 4\left(i_2 - i_3\right) + (1)\left(i_2 - i_1\right) = 0 \quad \Rightarrow \quad (-1)i_1 + 7i_2 - 4i_3 = 0$$

Solving, e.g. using MATLAB, gives

$$\begin{bmatrix} 1 & 0 & -1 \\ 1 & -5 & 5 \\ -1 & 7 & -4 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix} \quad \Rightarrow \quad \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 3 \\ 1 \\ 1 \end{bmatrix}$$

P 4.8-2 The circuit shown in Figure P 4.8-2 has two inputs, v_s and i_s, and one output v_o. The output is related to the inputs by the equation

$$v_o = ai_s + bv_s$$

where a and b are constants to be determined. Determine the values a and b by

(a) writing and solving mesh equations and

(b) writing and solving node equations.

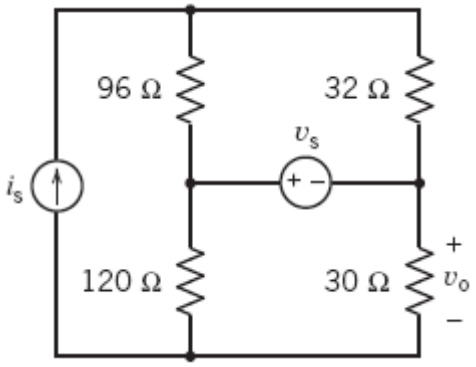
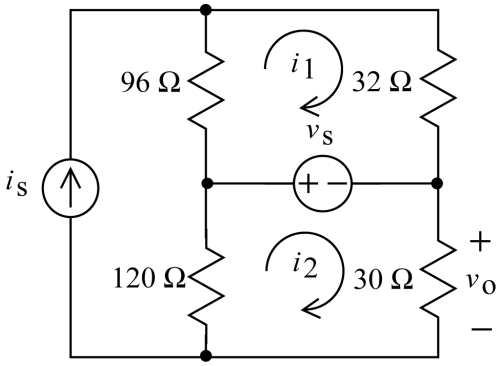


Figure P 4.8-2

Solution:

(a)

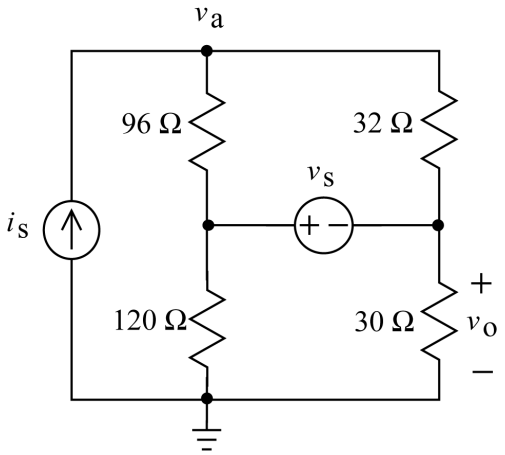


Apply KVL to meshes 1 and 2:

$$32i_1 - v_s + 96\left(i_1 - i_s\right) = 0$$
$$v_s + 30i_2 + 120\left(i_2 - i_s\right) = 0$$
$$150i_2 = +120i_s - v_s$$
$$i_2 = \frac{4}{5}i_s - \frac{v_s}{150}$$
$$v_o = 30i_2 = 24i_s - \frac{1}{5}v_s$$

So $a = 24$ and $b = -.02$.

(b)



Apply KCL to the supernode corresponding to the voltage source to get

$$\frac{v_a - \left(v_s + v_o\right)}{96} + \frac{v_a - v_o}{32} = \frac{v_s + v_o}{120} + \frac{v_o}{30}$$

So

$$i_s = \frac{v_s + v_o}{120} + \frac{v_o}{30} = \frac{v_s}{120} + \frac{v_o}{24}$$

Then

$$v_o = 24i_s - \frac{1}{5}v_s$$

So a = 24 and b = -0.2.