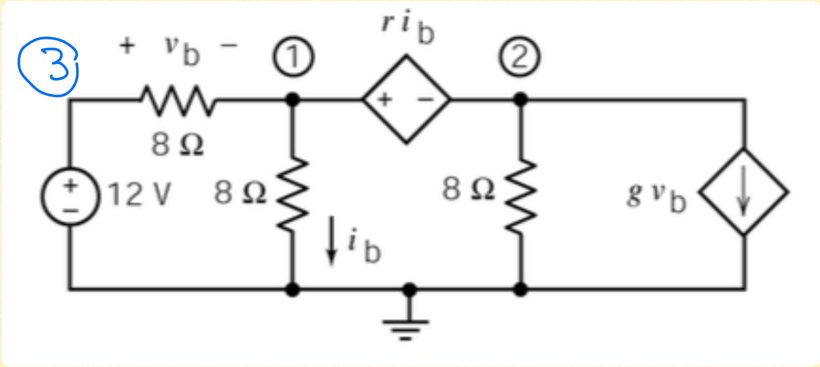
Solution of assignment 2 by Emad Gad



The circuit has 3 nodes other than the reference node. Node 3 is connected to an independent voltage source of 12V which has its other node being the reference node. This fixes the voltage of this node to 12V. Hence, we have

$$v_3 = 12^V$$

We have a dependent voltage source, so this source must be represented in terms of node voltages,

$$r i_b = 3^{(V/A)} * i_b^{(A)}$$

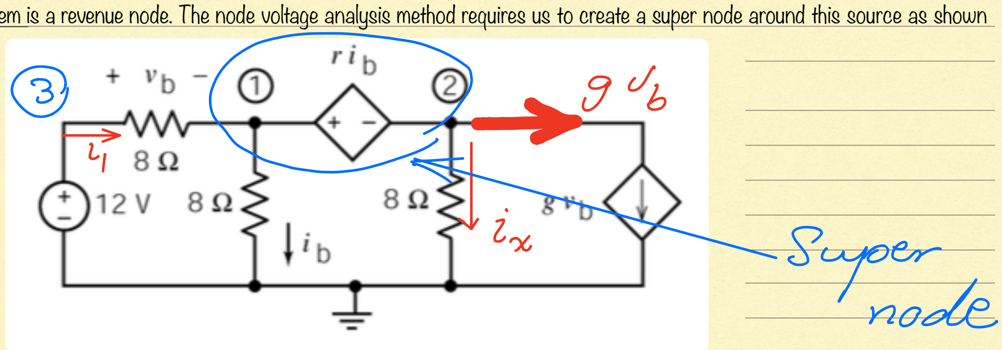
$$= 3 \times \frac{v_1 - 0}{8} = \frac{3}{8} v_1 \quad \text{(Volts)}$$

We also have a dependent current source, so that must also be represented in terms of node voltages. Here is how we do that,

$$g v_b = -0.75 v_b = \frac{-3}{4}(v_3 - v_1) = \frac{-3}{4}(12 - v_1)$$

Now that the dependent voltage sources have been represented by the node voltages, we can treat them **as if** they were **independent** sources, because this how the method of node voltage analysis proceeds.

With that in mind, we see that we have an independent (actually a dependent one that is viewed as independent for now) voltage source connected between two nodes none of them is a revenue node. The node voltage analysis method requires us to create a super node around this source as shown below.



Next to continue, we need to write KCL for each node, except for the node connected to the voltage source whose other is a reference node. In this problem this node 3.so what remains is the super node to write a KCL around.

KCL @ supernode

$$i_1 = i_b + i_x + g v_b$$

$$\frac{v_3 - v_1}{8} = \frac{v_1 - 0}{8} + \frac{v_2 - 0}{8} + \frac{3}{4}(v_1 - 12)$$

$$\frac{12 - v_1}{8} = \frac{v_1}{8} + \frac{v_2}{8} + \frac{6}{8}(v_1 - 12)$$

$$12 - v_1 = v_1 + v_2 + 6v_1 - 72$$

$$\boxed{84 = 8v_1 + v_2} \quad (1)$$

We have one equation in two unknowns. To get the second equation that will lead us to solve for the unknowns, we use the supernode, which states that

$$v_1 - v_2 = r i_b$$

$$v_1 - v_2 = \frac{3}{8} v_1$$

$$8v_1 - 8v_2 = 3v_1$$

$$5v_1 = 8v_2$$

$$\boxed{v_2 = \frac{5}{8} v_1} \quad (2)$$

Substituting from (2) into (1)

$$84 = 8v_1 + \frac{5}{8} v_1 = \frac{69}{8} v_1$$

$$v_1 = \frac{84 \times 8}{69} = 9.74 \text{ Volts}$$

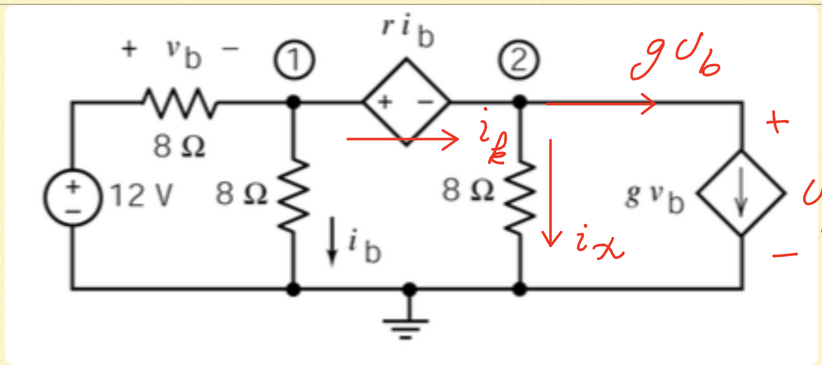
$$v_2 = \frac{5}{8} v_1 = \frac{5 \times 84}{69} = 6.09 \text{ V}$$

$$\text{Current } i_1 = \frac{v_3 - v_1}{8} = \frac{12 - 9.74}{8} = 0.28 \text{ A}$$

$$\text{current } i_b = \frac{v_1}{8} = \frac{9.74}{8} = 1.22 \text{ A}$$

$$\text{Current } i_x = \frac{v_2}{8} = \frac{6.09}{8} = 0.76 \text{ A}$$

To find the current in the dependent voltage source, we give this current a name and a direction as shown below



Writing a KCL around node 2, we get

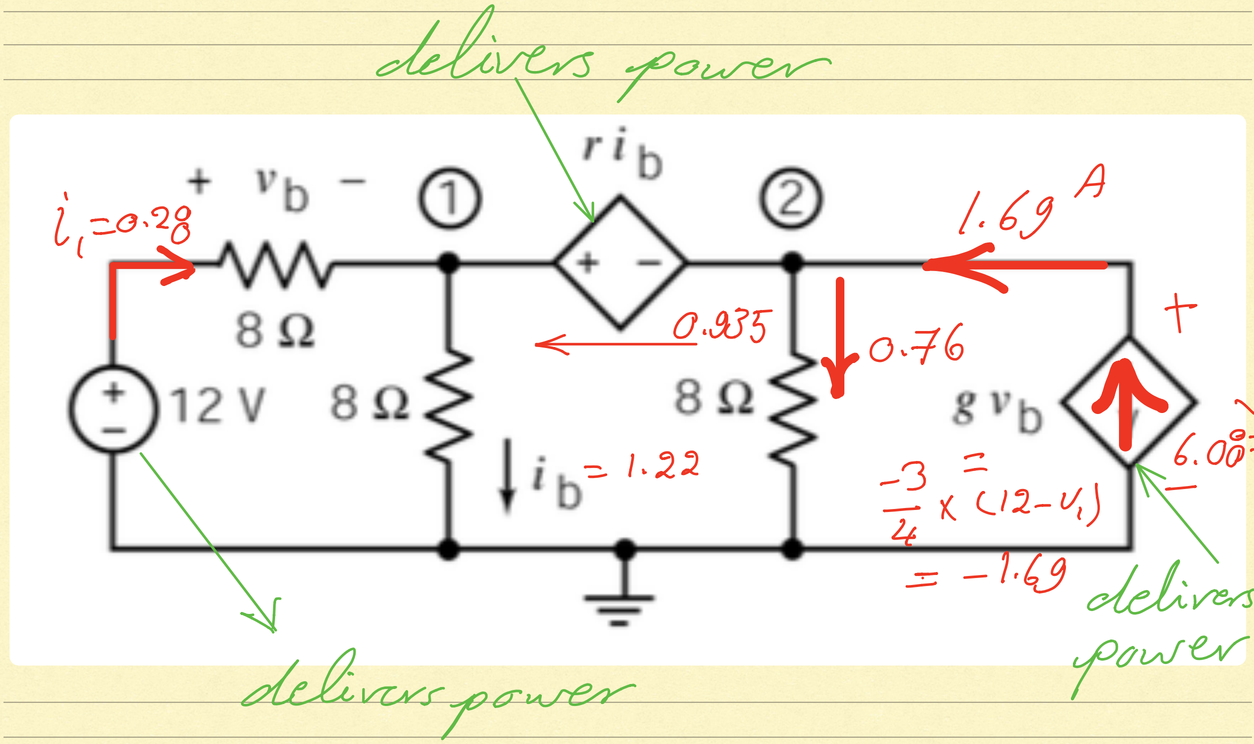
$$i_k = i_x + g v_b$$

$$= 0.76 + \frac{-3}{4}(12 - 9.74)$$

$$= 0.76 - 1.6965 = -0.935 \text{ A}$$

This means that the current flows in the opposite direction to the direction assumed above.

We also note that the voltage across the dependent current source is equal to $v_1 = 9.74$



To verify that that the net power delivered equals the net power absorbed in the circuit, you may want to create an EXCEL sheet to add the power from each element. The power delivered is indicated by -1, and it occurs in the element that has its current flowing from the negative voltage to the positive voltage. This may (or may not) happen in the sources. The power absorbed is in the elements where the current flows from the positive to the negative terminal, and this kind (absorbed) of power is indicated by +1..

Element	Current	Voltage	Power	Type of power		V1	V2	ib
12 V source	0.282608696	12	3.391304	-1	delivered	9.73913	6.086957	1.217391
Dependent voltage source	0.934782609	3.652174	3.413989	-1	delivered			
Dependent current source	1.695652174	6.086957	10.32136	-1	delivered			
R1	0.282608696	2.26087	0.638941	1	absorbed			
R2	1.217391304	9.73913	11.85633	1	absorbed			
R3	0.760869565	6.086957	4.63138	1	absorbed			
Net power				0				

net power is zero, as expected.