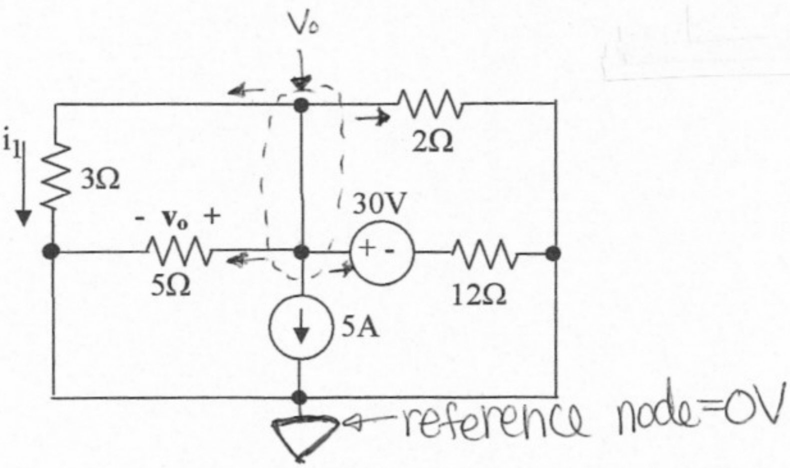
UNIVERSITY OF UTAH
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

ECE 1270 HOMEWORK #3 Summer 2007

1. Use node-voltage method to find i_1 and v_o.



1. Assign reference node. (Typically to node with most branches connected to it)

2. Assign node voltage to nodes where 3 or more wires are connected.

3. Write current summation eq. for unknow node:

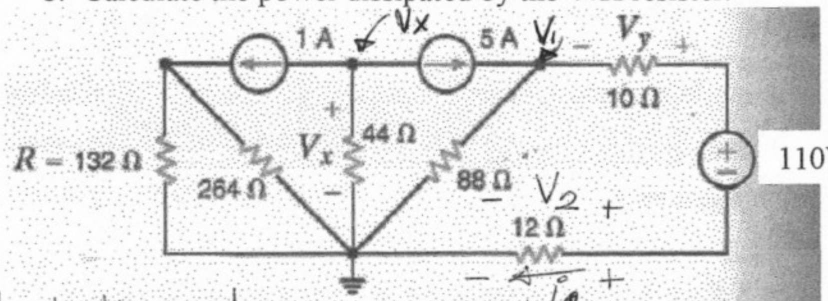
$$\frac{V_o}{3} + \frac{V_o}{5} + 5 + \frac{V_o - 30}{12} + \frac{V_o}{2} = 0$$

$$V_o\left(\frac{1}{3} + \frac{1}{5} + \frac{1}{12} + \frac{1}{2}\right) = \frac{30}{12} - 5$$

$$\therefore \boxed{V_o = \frac{-150}{67}} \implies i_1 = \frac{V_o}{3} = \frac{150}{67(3)} = \boxed{\frac{50}{67} A}$$

Note: The terms in above eq. are of the form: voltage of the node we are at with (+) sign, subtract voltage at neighboring node. We divide V-drop by the total R between nodes to find current.

2. a. Use the node-voltage method to find V_x and V_y.
   b. Calculate the power dissipated by the 44Ω resister.



a. Node-V at Vx node:

$$1 + \frac{V_x}{44} + 5 = 0$$

$$\frac{V_x}{44} = -6$$

$$V_x = \boxed{-264V}$$

Node-V at V_1 node:

$$-5 + \frac{V_1}{88} + \frac{V_1 - 110}{(10+12)} = 0$$

$$V_1\left(\frac{1}{88} + \frac{1}{22}\right) = +5 + \left(\frac{110}{22}\right)$$

$$V_1 = 176V$$

$$+V_1 + V_y - 110 - i_2(12) = 0 \quad \text{where } i_2 = \frac{(V_1 - 110)}{22}$$

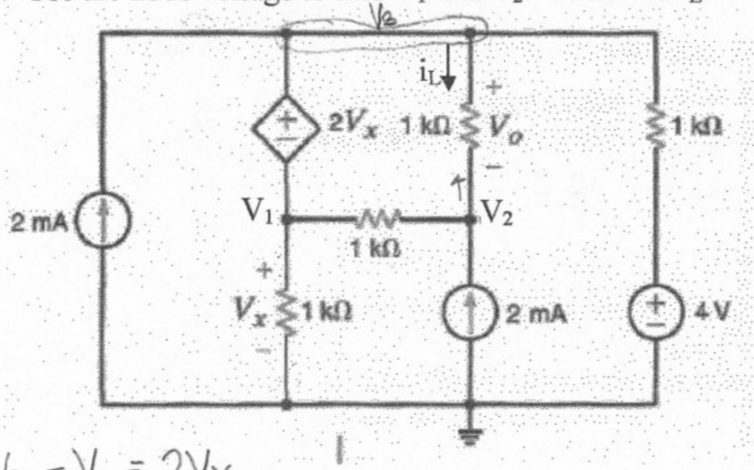
$$+V_1 + V_y - 110 - \frac{(V_1 - 110)12}{22} = 0$$

$$V_y = 110 - V_1 + \frac{(V_1 - 110)12}{22}$$

$$V_y = \boxed{-30V}$$

b. power $= V_x \cdot i_{44} = V_x \cdot \frac{V_x}{44} = \frac{V_x^2}{44} = \boxed{+1{,}584\ W}$

3. Use the node voltage to find V_1 and V_2. Then find i_L.



(super node) $\Rightarrow V_3 - V_1 = 2V_x$

$V_1 = V_x$

$\therefore \; V_3 - V_x = 2V_x$

$V_3 = 3V_x$

$$-2m + \frac{V_x}{1k} + \frac{(V_x - V_2)}{1k} + \frac{V_3 - V_2}{1k} + \frac{(V_3 - 4)}{1k} = 0$$

$$① \; -2m + \frac{2V_x}{1k} - \frac{V_2}{1k} + \frac{3V_x}{1k} - \frac{V_2}{1k} + \frac{3V_x}{1k} + \frac{-4}{1k} = 0$$

$$② \; \frac{(V_2 - V_1)}{1k} - 2m - \frac{V_o}{1k} = 0$$

Combine ① and ②

$8V_x - 2V_2 = 6$

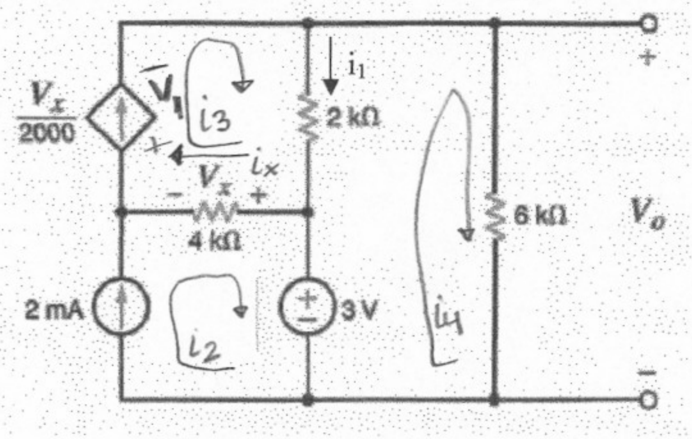
$-4V_x + 2V_2 = 2$

$\therefore \; V_x = 2V \Rightarrow V_1 = V_x = \boxed{2V}$

$V_2 = \boxed{5V}$

$i_L = \frac{V_o}{1k} = \boxed{1mA}$

4. a. Use the mesh-current method to find i_1.
   b. Find the power dissipated by the dependent current source.



· Label currents in each square

· Identify squares with currents in the outside branch and set equal to mesh current:

① $i_3 = \frac{V_x}{2000}$ { Need to rewrite dependent variable in terms of mesh currents ⇒

② $V_x = 4K(i_x) = 4K(i_3 - i_2)$ }

$i_2 = 2mA$

· Take Voltage loop ⇒

$+3 + i_1(2K) - i_4(6K) = 0$

where $i_1 = (i_3 - i_4)$

$\therefore\ +3 + i_3(2K) - i_4(2K) - i_4(6K) = 0$

③ $3 + i_3(2K) - i_4(8K) = 0$

⇒ plug ② into ①: $2K\,i_3 = 4Ki_3 - 4Ki_2$

$4Ki_2 = 2Ki_3$

$2i_2 = i_3 \Rightarrow i_3 = 2(2m) = 4mA$

Using $i_3 = 4mA$ into ③:

$$+3 + 4m(2K) - i_4(8K) = 0$$

$$\therefore \quad i_4(8K) = 3 + 8 = 11$$

$$i_4 = \frac{11}{8K}\ A$$

· want $i_1 = (i_3 - i_4) = 4m - \frac{11}{8K} A = \frac{32}{8K} - \frac{11}{8K} = \boxed{\frac{21}{8K}\ A}$

b. Need voltage across current, V_1

· Taking a V loop ⇒

$$+3 - V_1 - i_4(6K) = 0$$

$$V_1 = 3 - \frac{11}{8K}(6K) = 3 - 8.25 = -5.25V$$

power $\stackrel{?}{=} V_1 * i_3 = -(5.25)(4m) = \boxed{-21mW}$

producing or generating power