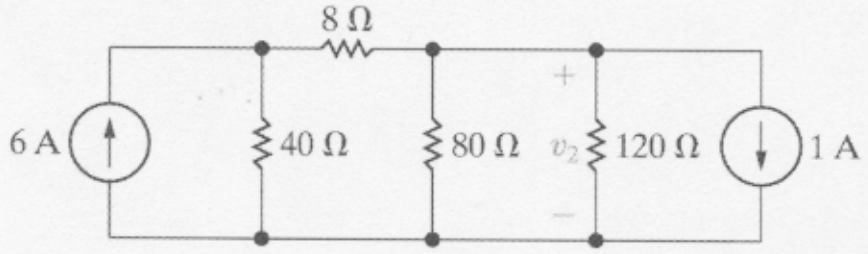
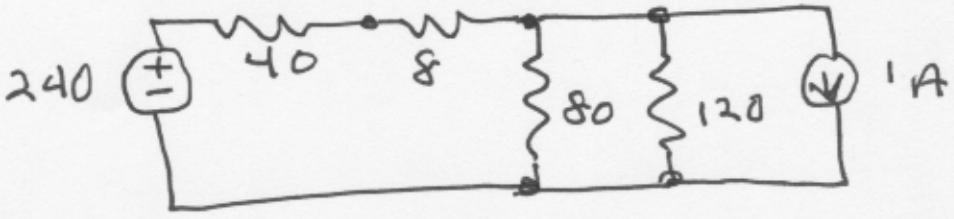
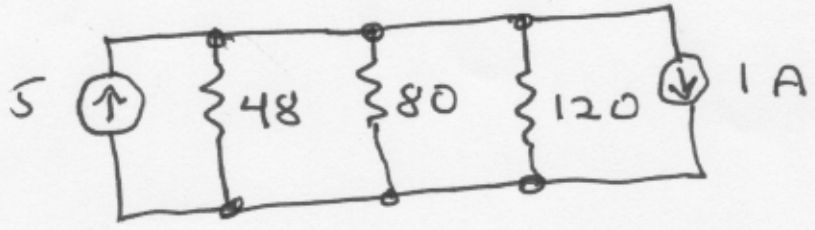
ELEN 50 W-17 Mid-term II

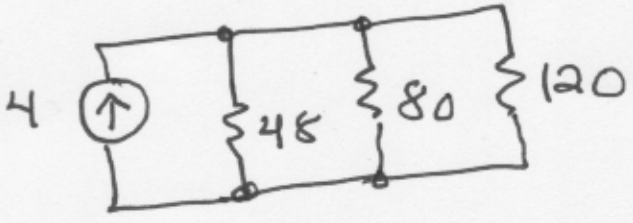
(2/24/2017)

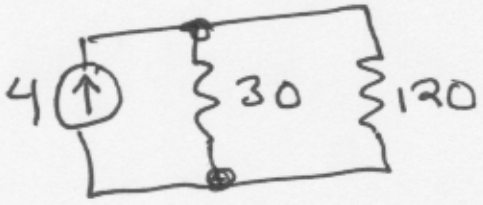
1. Use source transforms to calculate v2 in this circuit:





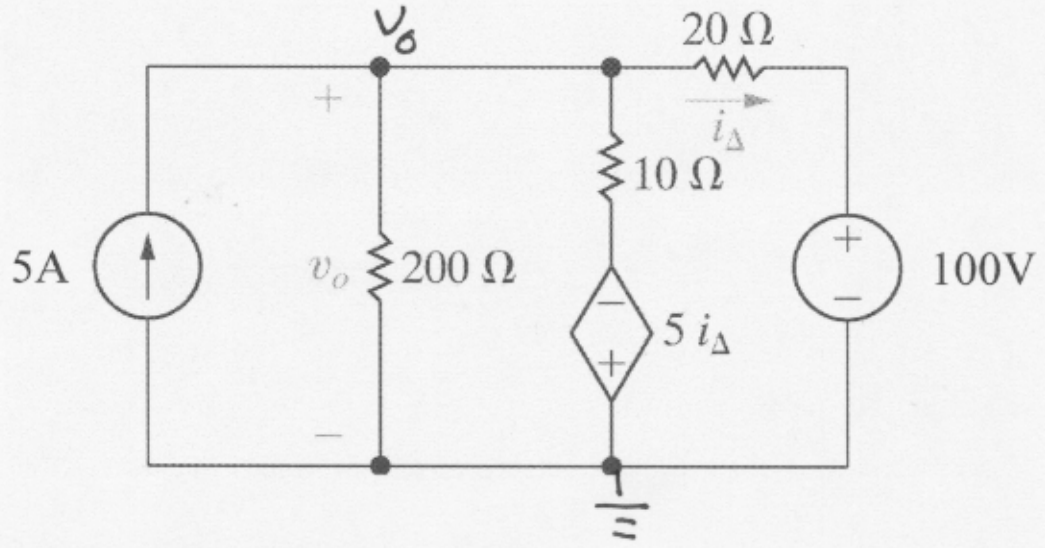






$V_2 = 4(24) = 96\,V$

2. Use the node voltage method to solve for v0 in this circuit. How many essential nodes are present? Indicate your choice of reference node in the diagram.



writing KCL for the top node:

$$-5 + \frac{V_o}{200} + \frac{V_o + 5i_\Delta}{10} + \frac{V_o - 100}{20} = 0$$

$$i_\Delta = \frac{V_o - 100}{20} \qquad \therefore \frac{V_o + 5i_\Delta}{10} = \frac{V_o}{10} + \frac{5V_o}{200} + \frac{500}{200}$$

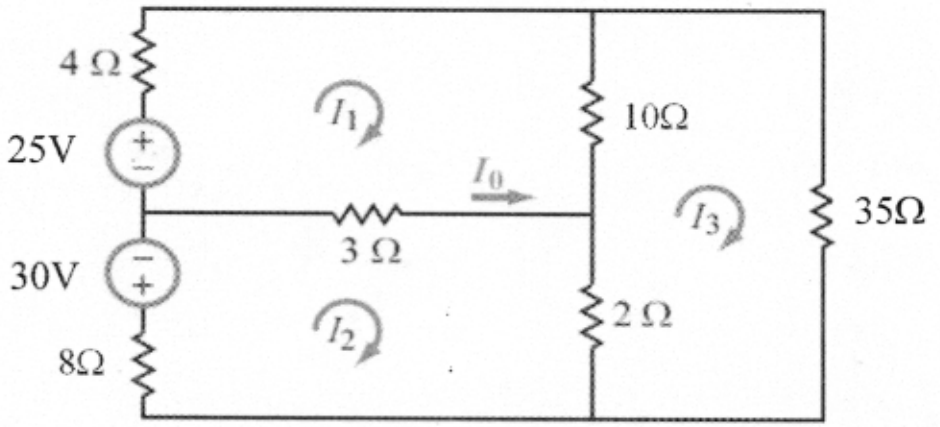
so

$$-1000 + V_o + 20V_o + 5V_o - 500 + 10V_o - 1000 = 0$$

$$36V_o = 2500$$

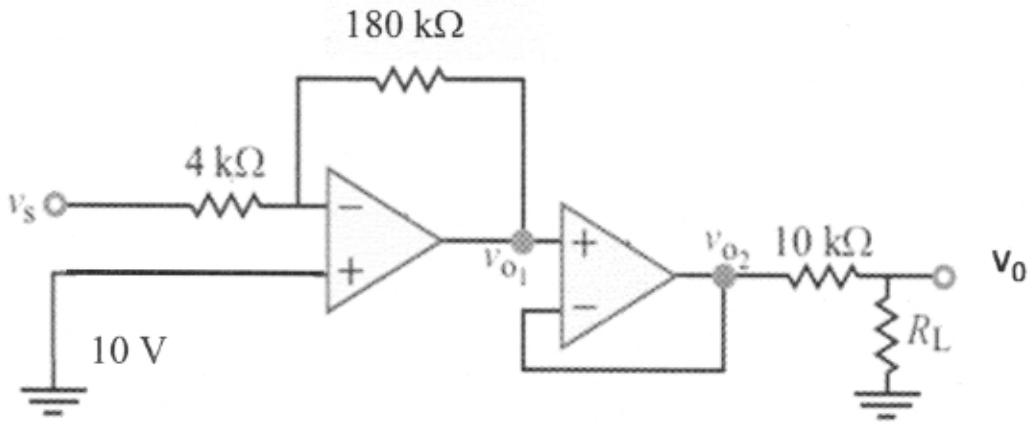
$$V_o = 69.444$$

3. Write the matrix equation describing the mesh currents, I_1, I_2, and I_3 in terms of the source voltages and resistances using mesh current analysis by inspection. You don't need to solve the matrix equation for the mesh currents.



$$\begin{bmatrix} 17 & -3 & -10 \\ -3 & 13 & -2 \\ -10 & -2 & 47 \end{bmatrix} \begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix} = \begin{pmatrix} 25 \\ -30 \\ 0 \end{pmatrix}$$

4. This circuit contains two ideal op amps. (a.) describe briefly what each amplifier stage does (b.) obtain an expression for the output voltage, v_o in terms of vs and R_L



- The first stage is an inverting amplifier: writing KCL at the inverting node:

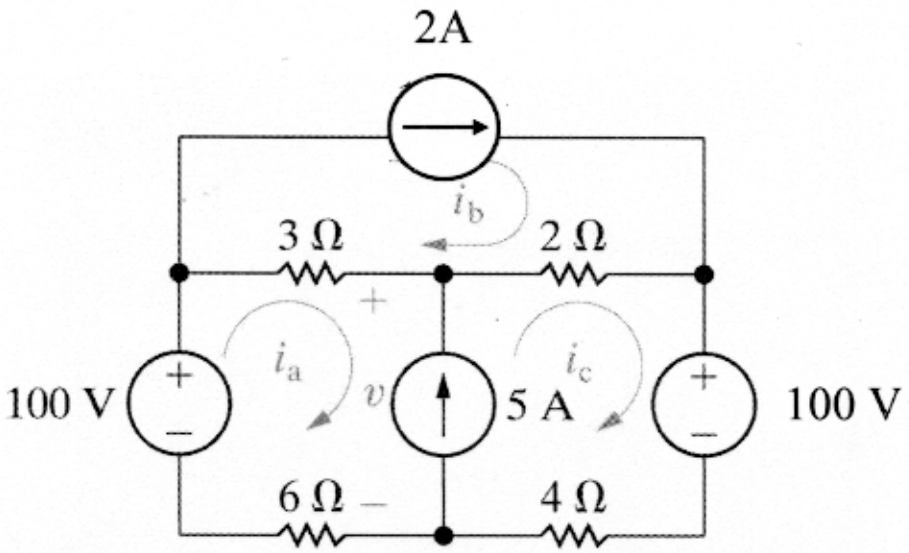
$$\frac{v_n - v_s}{4K} = \frac{v_{o1} - v_n}{180K} \qquad v_n = v_p = 0 \text{ (because } v_p \text{ is ground)}$$

$$\text{so} \quad -\frac{v_s}{4K} = \frac{v_{o1}}{180K} \qquad \text{so } v_{o1} = -45\, v_s$$

- the second stage is a follower so $v_{o2} = v_{o1}$
- finally, the 10K & R_L form a voltage divider

$$\text{so} \quad v_o = \frac{R_L}{10K + R_L} v_{o2} = \frac{R_L}{10K + R_L}\left[-45\, v_s\right]$$

5. Solve this circuit by finding mesh currents ia, ib, and ic using the mesh current method. Is there a supermesh present? How many mesh current equations will have to be solved?



The circuit has a supermesh involving mesh a & mesh b

Also, we already know $i_b = 2A$ So, writing the single supermesh equation for the circuit:

$$-100 + 3(i_a - i_b) + 2(i_c - i_b) + 100 + 4i_c + 6i_a = 0$$

$$3i_a - 6 + 2i_c - 4 + 4i_c + 6i_a = 0$$

$$9i_a + 6i_c - 10 = 0$$

for the supermesh $i_c - i_a = 5$

so $15i_a = -20 \Rightarrow$ $i_a = -\frac{20}{15} = -1.333A$

$i_c = 5 + i_a = 3.667A$