Solutions to Exam #1

Test B

ECE 300

Spring Semester, 2006

University of Tennessee, Knoxville, TN
ECE Department

Test B

(1) You are given the circuit of Figure 1.
(a) Find the voltage V_{fb}.
(b) Find the power supplied by the 10 V source.

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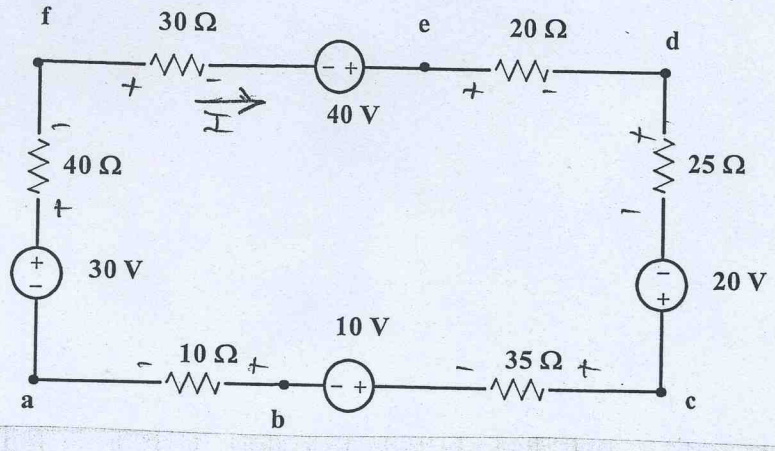

(a)

Assume I as shown. Use default sign convention. Write KVL, cw starting at "f" using drops.

$$30I - 40 + 20I + 25I - 20 + 35I + 10 + 10I - 30 + 40I = 0$$

$$160I = 80$$

$$I = 0.5\,A$$

Start at "f", cw, Σ drops $= 0$

$$+V_{fb} + 10I - 30 + 40I = 0$$

$$V_{fb} = 30 - 50I = 30 - 50 \times .5 = 30 - 25$$

$$\boxed{V_{fb} = 5\,V}$$

(b) $P_{sup}_{10V} = -10I = -5\,W$

$$\boxed{P_{sup}_{10V} = -5\,W}$$

(2) You are given the circuit of Figure 2. Find the voltage V_x.

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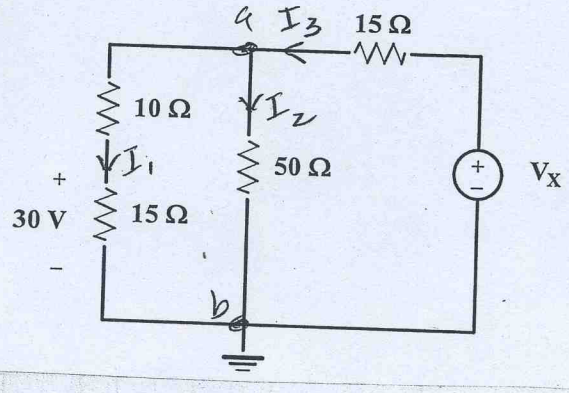

By Ohm's Law;

$$I_1 = \frac{30}{15} = 2A$$

$$V_{ab} = 2 \times 25 = 50V$$

$$I_2 = \frac{50}{50} = 1A$$

KVC $\quad I_3 = I_1 + I_2 = 3A$

KVL $\quad V_x = 15 I_3 + V_{ab}$

$$V_x = 45 + 50$$

$$\boxed{V_x = 95V}$$

B

(3) You are given the circuit shown in Figure 3. Find the resistance, R_{eq}.

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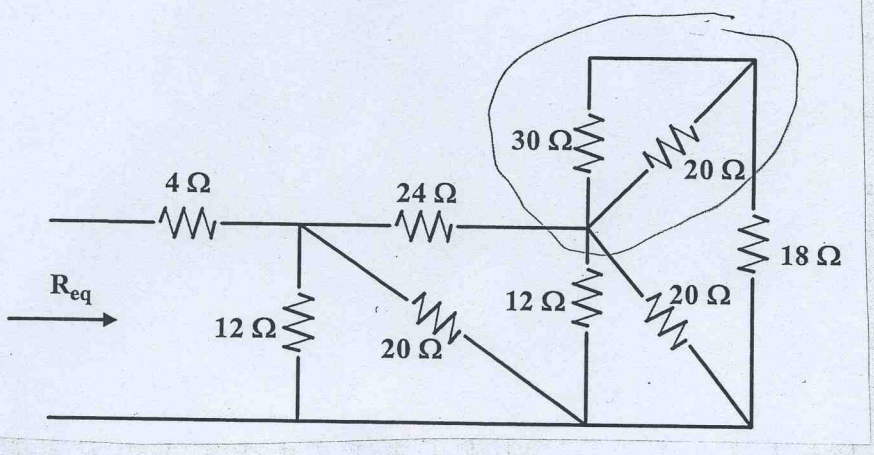

* Starting at the right hand side you have 20//30 which gives 12 Ω.
* The 12Ω is in series with 18Ω giving 30 Ω.
* The 30Ω is then in parallel with 20Ω giving 12Ω.
* The 12Ω is in // with 12Ω, giving 6Ω.
* The 6Ω is in series with 24Ω giving 30 Ω.
* The 30Ω is in parallel with 20Ω giving 12Ω.
* The 12Ω is in // with 12Ω giving 6Ω.
* The 6Ω is in series with 4Ω giving

$$R_q = 10\ \Omega$$

(4) You are given the circuit shown in Figure 4. Find the ratio of V_o/V_s (which is the gain).

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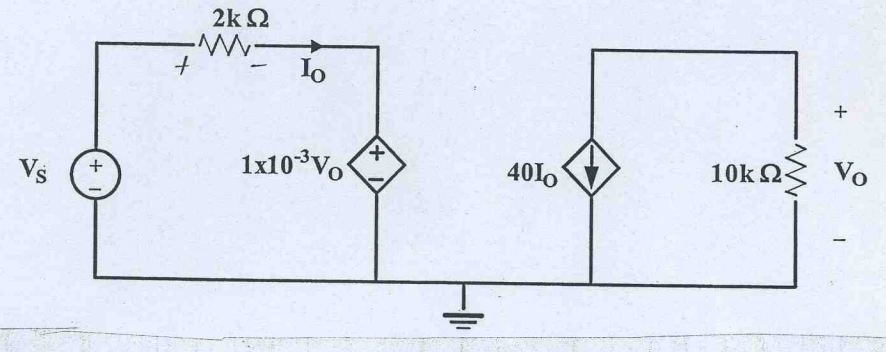

On the right side:

$$V_o = -(400K)I_o \qquad (\#1)$$

On the left side,

$$-V_s + (2K)I_o + K^{-1}V_o = 0$$

$$2K I_o = V_s - K^{-1}V_o$$

$$I_o = \frac{V_s - K^{-1}V_o}{2K} \qquad (\#2)$$

Substitute (#2) into (#1)

$$V_o = -400K\left[\frac{V_s - K^{-1}V_o}{2K}\right]$$

$$= -200\left[V_s - K^{-1}V_o\right]$$

$$V_o = -200V_s + 0.2V_o$$

$$.8V_o = -200V_s$$

$$\boxed{\frac{V_o}{V_s} = -250}$$

B Test

(5) You are given the circuit shown in Figure 5. Use nodal analysis to find V_1 and V_2.

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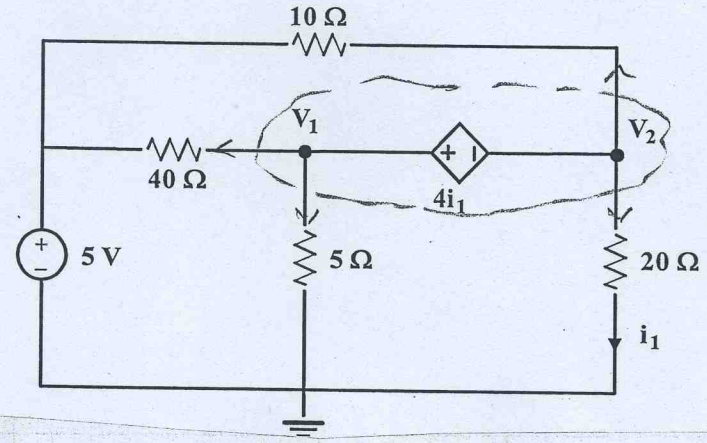


We have a super node as indicated above. For the super node we write the following equation.

$$\frac{V_1 - 5}{40} + \frac{V_1}{5} + \frac{V_2 - 5}{10} + \frac{V_2}{20} = 0$$

$\times 40$

$$V_1 - 5 + 8V_1 + 4V_2 - 20 + 2V_2 = 0$$

$$\boxed{9V_1 + 6V_2 = 25}$$

Constraint Eq.

$$V_1 - 4i_1 - V_2 = 0 \qquad i_1 = \frac{V_2}{20}$$

$$V_1 - \frac{4V_2}{20} - V_2 = 0$$

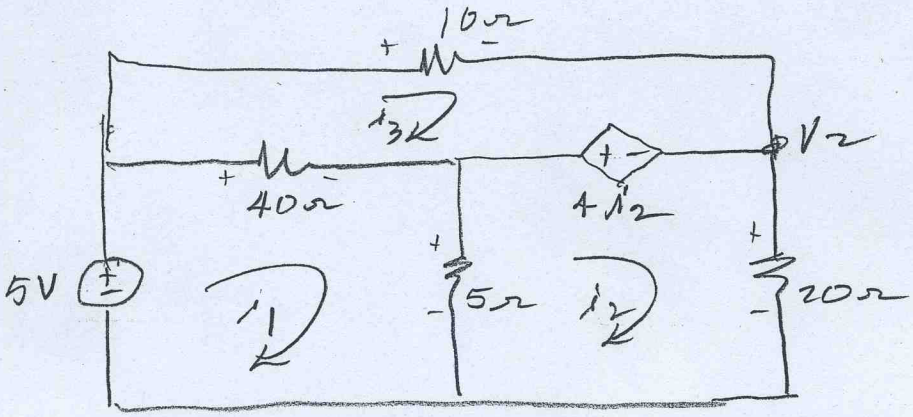
$$5V_1 - V_2 - 5V_2 = 0$$

$$\boxed{5V_1 - 6V_2 = 0}$$

$$\begin{bmatrix} 9 & 6 \\ 5 & -6 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 25 \\ 0 \end{bmatrix}$$

$\boxed{V_1 = 1.79\ V}$, $\boxed{V_2 = 1.49\ V}$

B - Team Mesh
#5



$$45i_1 - 5i_2 - 40i_3 = 5$$

$$10i_3 - 4i_2 - 40(i_1 - i_3) = 0$$

$$-40i_1 - 4i_2 + 50i_3 = 0$$

$$-5(i_1 - i_2) + 4i_2 + 20i_2 = 0$$

$$-5i_1 + 5i_2 + 24i_2 = 0$$

$$-5i_1 + 29i_2 + 0i_3 = 0$$

$$\begin{bmatrix} 45 & -5 & -40 \\ -40 & -4 & 50 \\ -5 & 29 & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 5 \\ 0 \\ 0 \end{bmatrix}$$

$i_1 = 0.432A$, $i_2 = 0.074A$, $i_3 = 0.351A$

$V_1 = 5(i_1 - i_2) = 5(.432 - .074)$

$V_1 = 1.79\,V$ check

$V_2 = 20 \times i_2 = 20 \times .074 = 1.48\,V$ check

(6) You are given the circuit of Figure 6. Use mesh analysis to find the current I_o.

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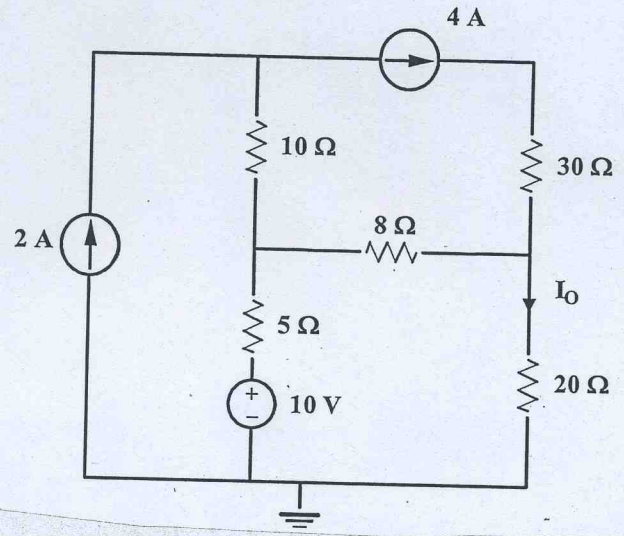
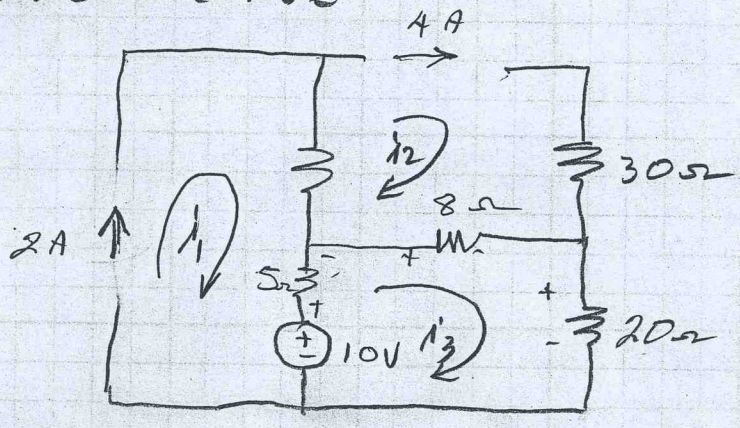


Redraw the circuit with the 4A and 2A source inactive



Around mesh 3:

$$-10 + 5(i_3 - i_1) + 8(i_3 - i_2) + 20i_3 = 0$$

$$\boxed{-5i_1 - 8i_2 + 33i_3 = 10} \quad (\#1)$$

Constraint #1

$$\boxed{i_1 = 2A}$$

Constraint #2

$$\boxed{i_2 = 4A}$$

Back to (#1)

$$-10 - 32 + 33i_3 = 10$$

$$\boxed{i_3 = 1.58\,A}$$

$$I_o = i_3 = 1.58\,A$$

5/5

B-Text
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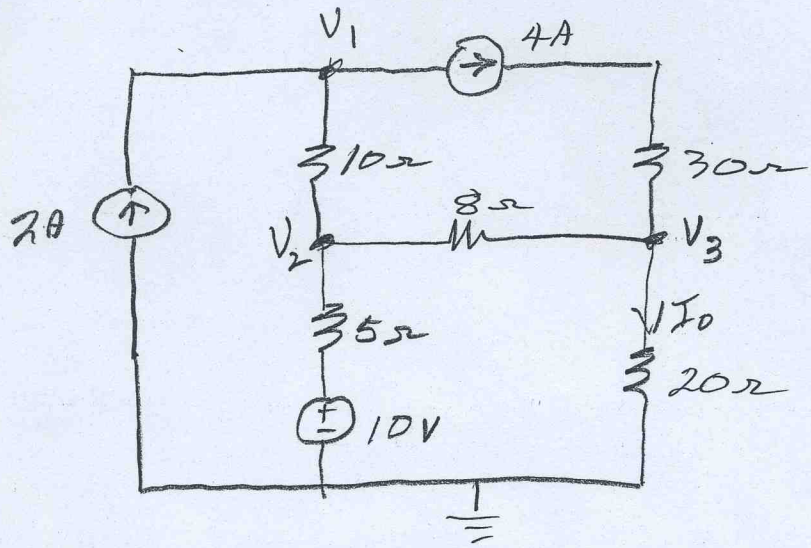
Nodal Analysis



At V_1

$$\frac{V_1 - V_2}{10} + 4 - 2 = 0$$

$$V_1 - V_2 + 0V_3 = -20$$

At V_2

$$\frac{V_2 - V_1}{10} + \frac{V_2 - V_3}{8} + \frac{V_2 - 10}{5} = 0 \quad \times 40$$

$$4V_2 - 4V_1 + 5V_2 - 5V_3 + 8V_2 = 80$$

$$-4V_1 + 17V_2 - 5V_3 = 80$$

At V_3

$$\frac{V_3 - V_2}{8} + \frac{V_3}{20} - 4 = 0 \quad \times 40$$

$$5V_3 - 5V_2 + 2V_3 = 160$$

$$0V_1 - 5V_2 + 7V_3 = 160$$

$$V_3 = 31.52\,V$$

$$I_0 = \frac{31.52}{20} = 1.58\,A \quad \text{check}$$