# Solutions to Exam #1

## Test A

## ECE 300

## Spring Semester, 2006

University of Tennessee, Knoxville, TN
ECE Department

Test A

(1) You are given the circuit of Figure 1.
(a) Find $V_{eb}$.
(b) Find the power supplied by the 15 V source.

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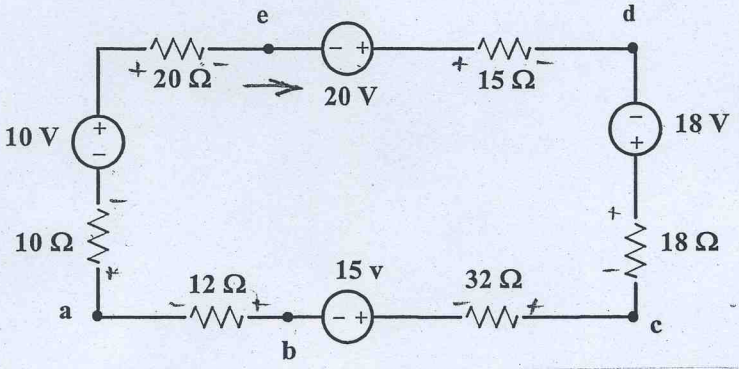


Assume I as shown. Use default sign convention. Start from "a"

(a)

$$10I - 10 + 20I - 20 + 15I - 18 + 18I + 32I + 15 + 12I = 0$$

$$107I = 33$$

$$I = \frac{33}{107} = 0.308\ A$$

$$-V_{eb} - 20I + 10 - 10I - 12I = 0$$

$$V_{eb} = -42I + 10 =$$

$$\boxed{V_{eb} = -2.94\ V}$$

(b) $P_{sup\ 15V} = -15 \times I = -4.62\ W$ (being charged)

A

(2) You are given the circuit shown in Figure 2. Find the voltage $V_s$.

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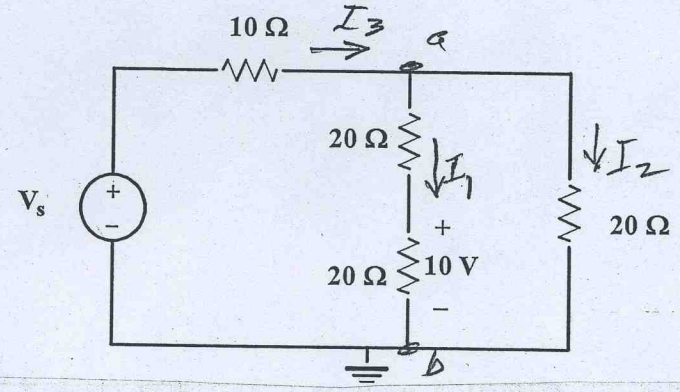


From the diagram, using ohm's law

$$I_1 = \frac{10}{20} = 0.5\,A$$

$$V_{ab} = 40\,I = 20V$$

$$I_2 = \frac{20}{20} = 1\,A$$

$$I_3 = I_1 + I_2 = 1.5\,A$$

$$V_s = 10\,I_3 + 20$$

$$\boxed{V_s = 35\,V}$$

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(3) You are given the circuit of Figure 3. Find the resistance $R_{eq}$.

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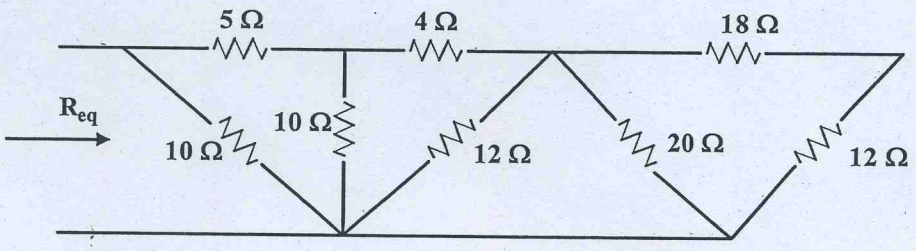


At the right side we have 30Ω in parallel with 20Ω

$$\frac{30 \times 20}{30+20} = 12\,\Omega$$

Then we have 12Ω in parallel with 12Ω, giving

$$\frac{12 \times 12}{12+12} = 6\,\Omega$$

Then we have 6Ω in series with 4Ω, giving $6+4 = 10\,\Omega$

Then we have 10Ω in parallel with 10Ω, giving

$$\frac{10 \times 10}{10+10} = 5\,\Omega$$

Then we have 5Ω in series with 5Ω giving $5+5 = 10\,\Omega$

Then we have 10Ω in parallel with 10Ω giving $\boxed{R_{eq} = 5\,\Omega}$

A

(4) You are given the circuit of Figure 4. Find the gain $v_o/v_s$.

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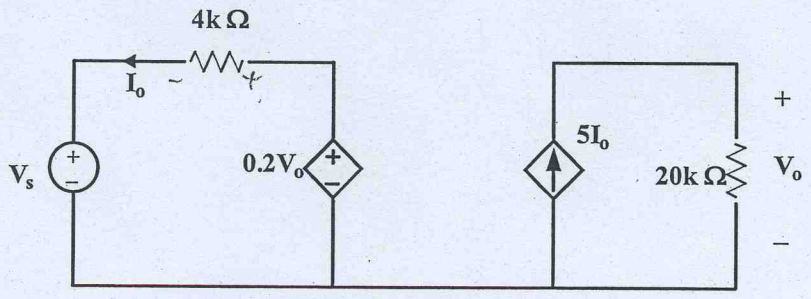


$V_o = (20k)(5I_o)$ (#1) (at the right side)

On the left;

$$-V_s - 4kI_o + 0.2V_o = 0$$

so $$4kI_o = 0.2V_o - V_s$$

$$I_o = \frac{0.2V_o - V_s}{4k} \quad (\#2)$$

Substitute (#2) into (#1)

$$V_o = 20k \times 5\left[\frac{0.2V_o - V_s}{4k}\right] = 25\left[0.2V_o - V_s\right]$$

$$V_o = 5V_o - 25V_s$$

$$-4V_o = -25V_s$$

$$\boxed{\frac{V_o}{V_s} = 6.25}$$

A

(5) You are given the circuit of Figure 5. Use mesh analysis to find the current $I_o$.

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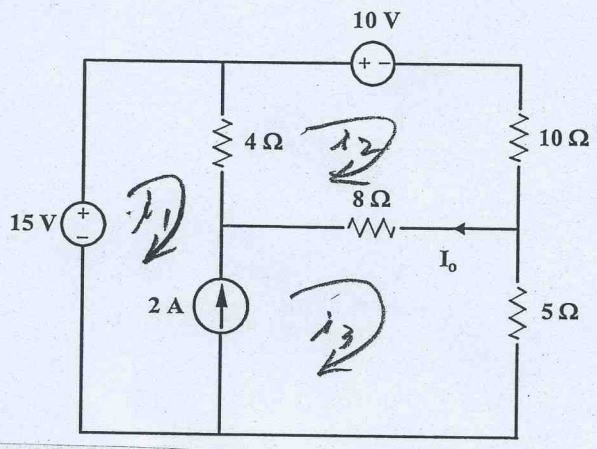
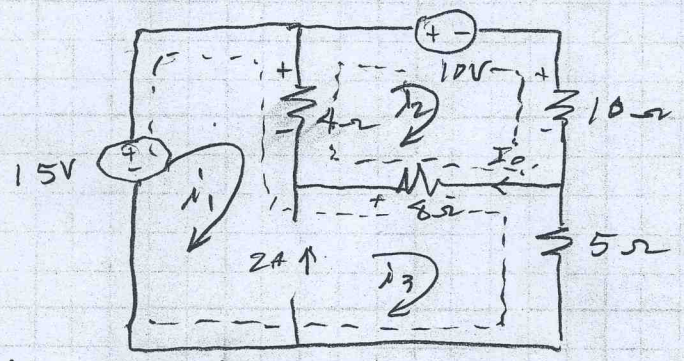



Assign mesh currents as shown above. Redraw the circuit with the current inactive, as such.




Write the two mesh equations:

$$-15 + 4(i_1 - i_2) + 8(i_3 - i_2) + 5i_3 = 0$$

OR

$$\boxed{4i_1 - 12i_2 + 13i_3 = 15} \quad (\#1)$$

AROUND MESH 2

$$-4(i_1 - i_2) + 10 + 10i_2 - 8(i_3 - i_2) = 0$$

$$\boxed{-4i_1 + 22i_2 - 8i_3 = -10} \quad (\#2)$$

Constraint Equation:

$$i_3 - i_1 = 2$$

$$\boxed{-i_1 + 0i_2 + i_3 = 2} \quad (\#3)$$

A

#5 (continued)



From (#1), (#2) (#3)

$$\begin{bmatrix} 4 & -12 & 13 \\ -4 & 22 & -8 \\ -1 & 0 & 1 \end{bmatrix} \begin{bmatrix} i_1' \\ i_2' \\ i_3' \end{bmatrix} = \begin{bmatrix} 15 \\ -10 \\ 2 \end{bmatrix}$$

$i_1' = -0.739\,A$, $i_2' = -0.130\,A$, $i_3' = 1.26\,A$

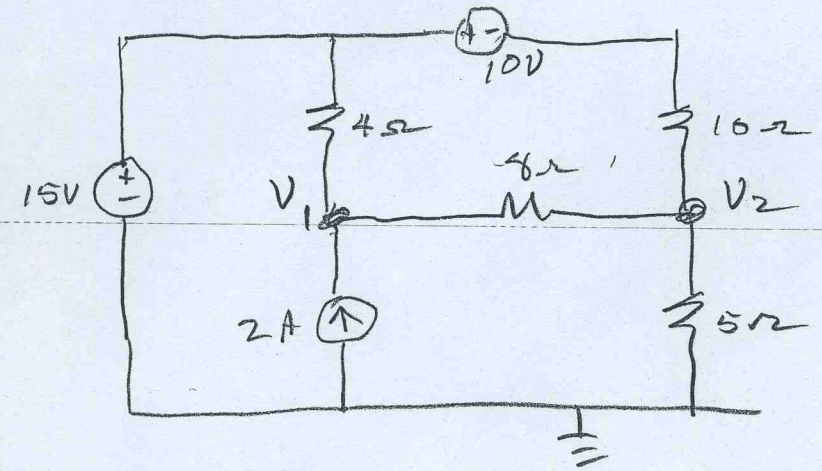
$I_0 = i_2' - i_3'$

$I_0 = -0.13 - 1.26$

$I_0 = -1.39\,A$

Test A

# 5 Nodal Analysis




At $V_1$

$$\frac{V_1 - 15}{4} + \frac{V_1 - V_2}{8} - 2 = 0$$

$$2V_1 - 30 + V_1 - V_2 = 16$$

$$\boxed{3V_1 - V_2 = 46}$$

At $V_2$

$$\frac{V_2 - V_1}{8} + \frac{V_2 + 10 - 15}{10} + \frac{V_2}{5} = 0$$

x 40

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

$$\boxed{-5V_1 + 17V_2 = 20}$$

$$V_1 = 17.43V, \quad V_2 = 6.3V$$

$$I_0 = \frac{V_2 - V_1}{8} = \frac{6.3 - 17.43}{8} = -1.39A$$

check

A

(6) You are given the circuit of Figure 6. Use nodal analysis to find $v_1$ and $v_2$.

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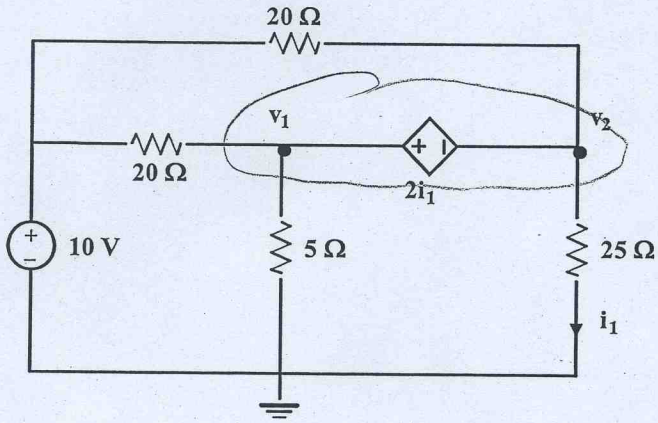



A supernode is present as shown:

We have;

$$\frac{V_1 - 10}{20} + \frac{V_1}{5} + \frac{V_2 - 10}{20} + \frac{V_2}{25} = 0$$

$$.05V_1 - 0.5 + .2V_1 + .05V_2 - 0.5 + 0.04V_2 = 0$$

$$\boxed{.25V_1 + 0.09V_2 = 1}$$

Constraint

$$V_1 - 2i_1 - V_2 = 0 \qquad i_1 = \frac{V_2}{25} = .04V_2$$

$$V_1 - .08V_2 - V_2 = 0$$

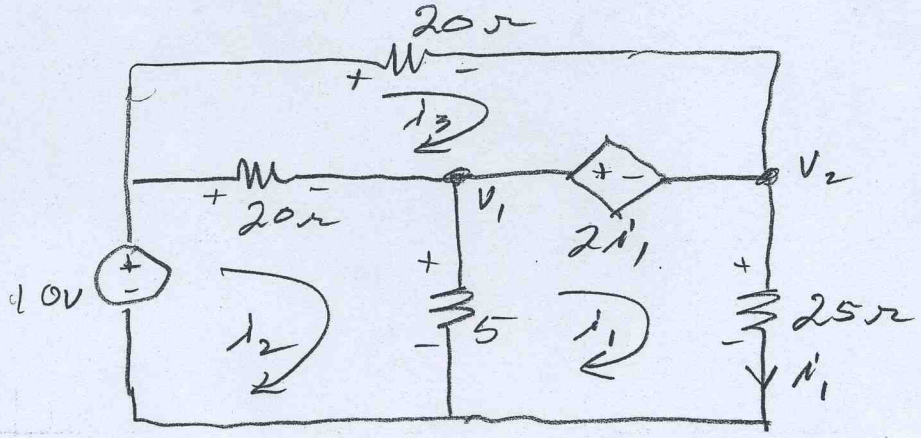
$$\boxed{V_1 - 1.08V_2 = 0}$$

$$\boxed{V_1 = 3V} \qquad \boxed{V_2 = 2.78V}$$

Test (A)
#6

# Mesh Analysis

For checking




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

$$\boxed{-5i_1 + 25i_2 - 20i_3 = 10}$$

$$-5(i_2 - i_1) + 2i_1 + 25i_1 = 0$$

$$\boxed{32i_1 - 5i_2 + 0i_3 = 0}$$

$$-20(i_2 - i_3) + 20i_3 - 2i_1 = 0$$

$$\boxed{-2i_1 - 20i_2 + 40i_3 = 0}$$

$$\begin{bmatrix} -5 & 25 & -20 \\ 32 & -5 & 0 \\ -2 & -20 & 40 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix}$$

$i_1 = 0.111$ $\quad i_2 = 0.711$, $\quad i_3 = 0.361$

$V_2 = 25 i_1 = 2.78\ V$ check

$V_1 = (i_2 - i_1)5 = 3\ V$ check