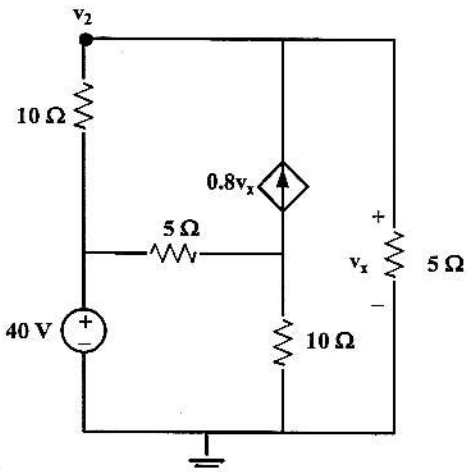
ECE 300
Spring Semester, 2007
Test #1

wlg Test A **Name** wlg
Print (last, first)

Work the exam on your own engineering paper. Work on one side of your paper only. Attach your work to the back of this exam sheet and staple in the top left hand corner. Each problem 20%.

(1) You are given the circuit of Figure 1. Use any method to find the voltage v_2.



At node V_2:

$$\frac{V_2 - 40}{10} + \frac{V_2}{5} - 0.8V_2 = 0$$

note: $V_x = V_2$

$$V_2 - 40 + 2V_2 - 8V_2 = 0$$

$$5V_2 = -40$$

$$\boxed{V_2 = -8\,V}$$

Test A

Figure 1: Circuit for problem 1.

(2) Use any method to find the voltage V_{ab} in the circuit of Figure 2.

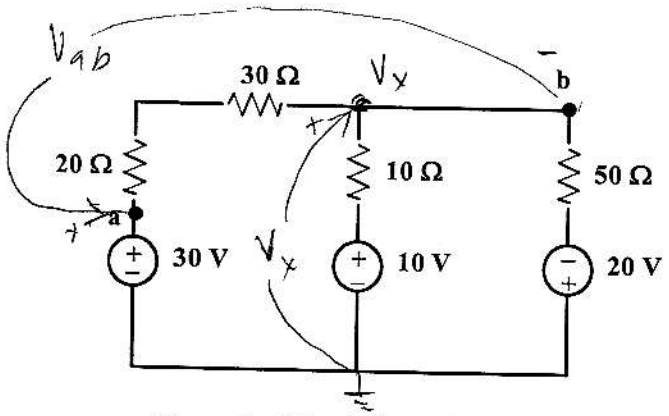


Figure 2: Circuit for problem 2.

Solve for the node voltage, V_x

$$\frac{V_x - 30}{50} + \frac{V_x - 10}{10} + \frac{V_x + 20}{50} = 0$$

$$V_x - 30 + 5V_x - 50 + V_x + 20 = 0$$

$$7V_x = 60$$

$$V_x = 8.57\ V$$

Applying KVL

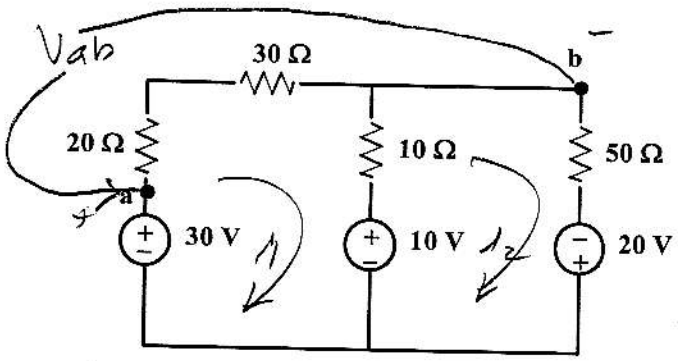
$$V_{ab} - 30 + V_x = 0$$

$$V_{ab} = 30 - V_x = 30 - 8.57$$

$$\boxed{V_{ab} = 21.43\ V}$$

Test A

(2) Use any method to find the voltage V_{ab} in the circuit of Figure 2.



Another solution using mesh

By inspection

$$\begin{bmatrix} 60 & -10 \\ -10 & 60 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 20 \\ 30 \end{bmatrix}$$

$I_1 = 0.4286\ A$

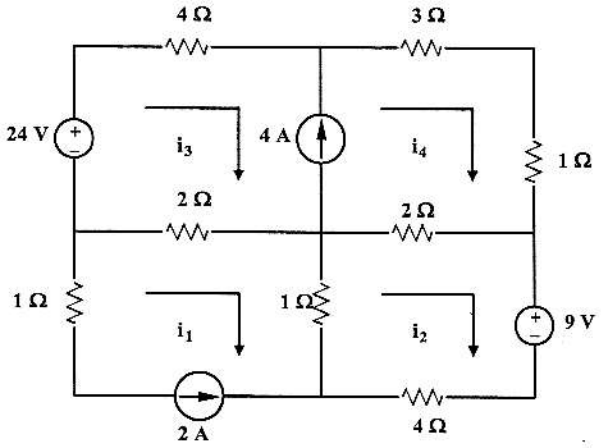
$Vab - 0.4286(20+30) = 0$

$Vab = 21.43\ V$

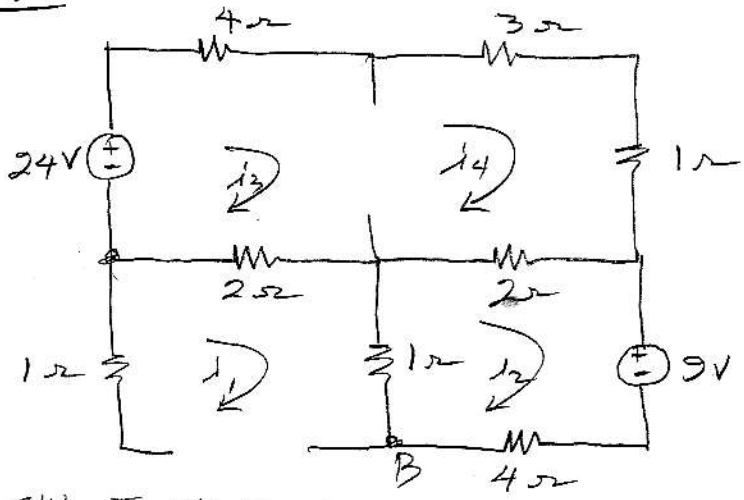
Test A

(3) You are given the circuit of Figure 3.

(a) Use mesh analysis to find the currents i_1, i_2, i_3 and i_4.
(b) How much power is supplied by the 9 V source?
(c) How much power is dissipated by the 3 Ω resistor?



Redraw



At A, cw Σ drops $= 0$

$$-24 + 4i_3 + 4i_4 + 2(i_4 - i_2) + 2(i_3 - i_1) = 0$$

$$-2i_1 - 2i_2 + 6i_3 + 6i_4 = 24$$

At B, cw Σ drops $= 0$

$$1(i_2 - i_1) + 2(i_2 - i_4) + 9 + 4i_2 = 0$$

$$-i_1 + 7i_2 + 0i_3 - 2i_4 = -9$$

Problem #3 continued

Constraint 1

$$i_1 = -2A$$

$$\boxed{1i_1 + 0i_2 + 0i_3 + 0i_4 = -2}$$

Constraint 2

$$i_4 - i_3 = 4$$

$$\boxed{0i_1 + 0i_2 - i_3 + i_4 = 4}$$

$$\begin{bmatrix} -2 & -2 & 6 & 6 \\ -1 & 7 & 0 & -2 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{bmatrix} 24 \\ -9 \\ -2 \\ 4 \end{bmatrix}$$

$i_1 = -2\,A$ $\quad$ $i_2 = -0.55A$

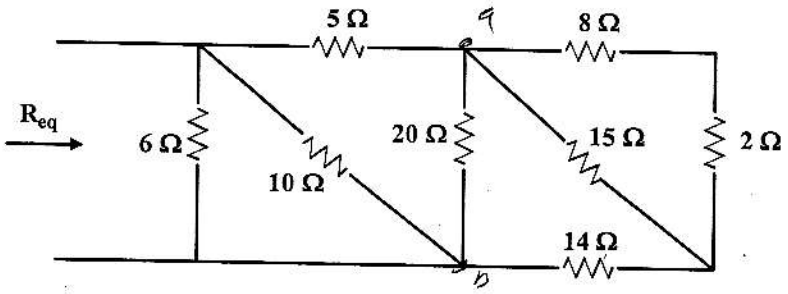
$i_3 = -0.425A$ $\quad$ $i_4 = 3.58\,A$

1b) $P_{supply} = -i_2 \times 9 = .55 \times 9 = 4.95W$

1c) $P_{3\Omega} = i_4^2 \times 3 = (3.58)^2 \times 3 = 38.45W$

Test A

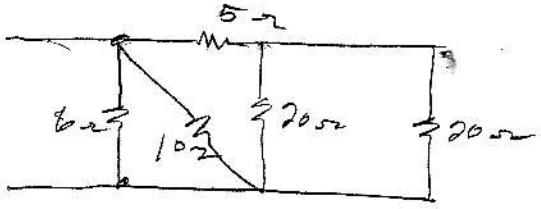
(4) Find R_{eq} for the circuit of Figure 4.



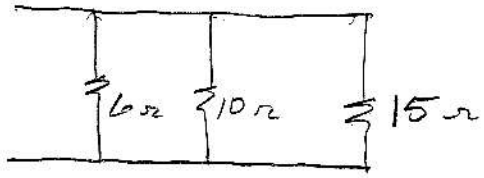
Working right to left

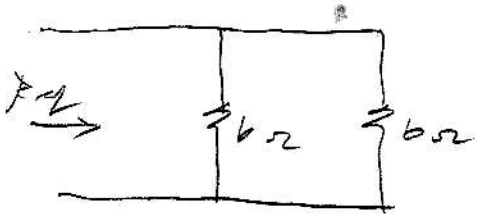
$$10 \parallel 15 = \frac{10 \times 15}{10 + 15} = 6\ \Omega$$

Right of a-b then $6 + 14 = 20\ \Omega$



then



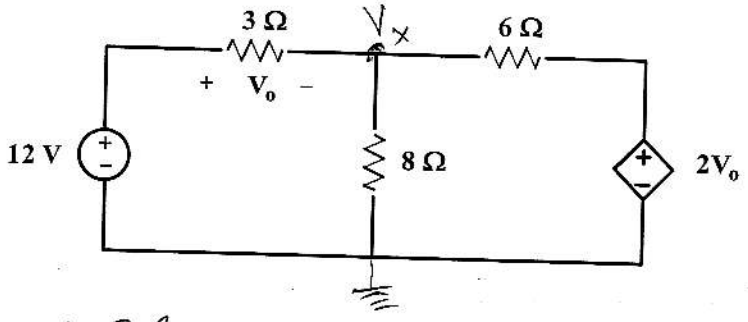


$R_{eq} = 6 \parallel 6$

$$\boxed{R_{eq} = 3\ \Omega}$$

Test A

(5) Use any method of your choice to answer the following questions about the circuit of Figure 5.
(a) Determine the voltage V_o as shown in Figure 5.
(b) How much power is absorbed by the 8 Ω resistor shown in Figure 5.



Using Nodal At V_x

$$\frac{V_x - 12}{3} + \frac{V_x}{8} + \frac{V_x - 2V_o}{6} = 0$$

but $V_o = 12 - V_x$

so

$$24\left(\frac{V_x - 12}{3} + \frac{V_x}{8} + \frac{V_x - 2(12 - V_x)}{6} = 0\right)$$

$$8V_x - 96 + 3V_x + 12V_x = 96$$

$$23V_x = 192$$

$$V_x = 8.35\ V$$

$$\therefore V_o = 12 - 8.35 = 3.65\ V$$

(a) $V_o = 3.65\ V$

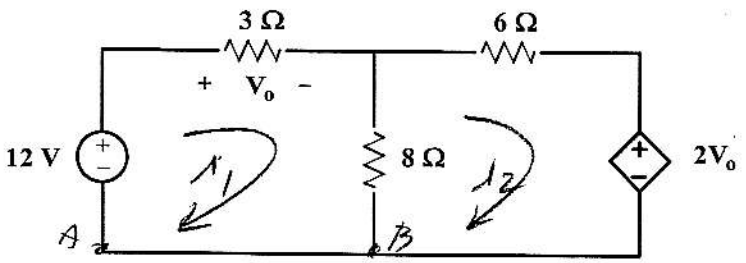
(b) $P_8 = \frac{V_x^2}{8} = \frac{8.35^2}{8} = 8.72\ W$

$P_8 = 8.72\ W$

Test A

(5) By mesh

(5) Use any method of your choice to answer the following questions about the circuit of Figure 5.
(a) Determine the voltage V_o as shown in Figure 5.
(b) How much power is absorbed by the 8 Ω resistor shown in Figure 5.



At A, cw, $\sum$ drops = 0

$$-12 + 3i_1 + 8(i_1 - i_2) = 0$$

$$11i_1 - 8i_2 = 12$$

At B, cw, $\sum$ drops = 0

$$8(i_2 - i_1) + 6i_2 + 2V_o = 0$$

$$V_o = 3i_1$$

$$8(i_2 - i_1) + 6i_2 + 2(3i_1) = 0$$

$$-2i_1 + 14i_2 = 0$$

$$\begin{bmatrix} 11 & -8 \\ -2 & 14 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 12 \\ 0 \end{bmatrix}$$

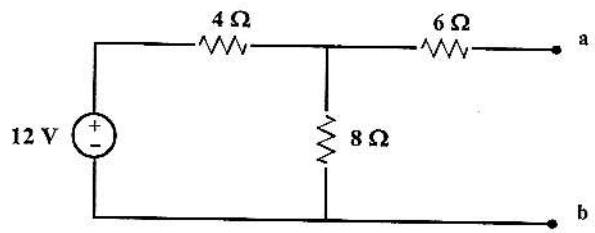
$i_1 = 1.217$ A, $i_2 = 0.1739$ A

(a) $V_o = 3i_1 = 3.65$ V ok

(b) $P_8 = (i_1 - i_2)^2 \times 8 = 8.71$ W ok

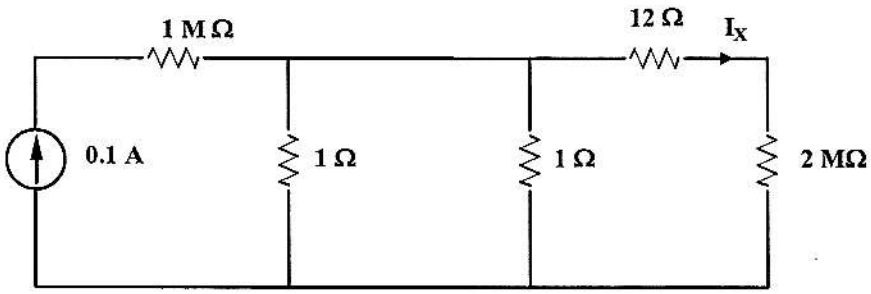
(6) This problem is for extra credit. Part (a) is for 1 point. Part (b) is for 1 point. There is no partial credit given. In each case, the answer is either correct or not correct.

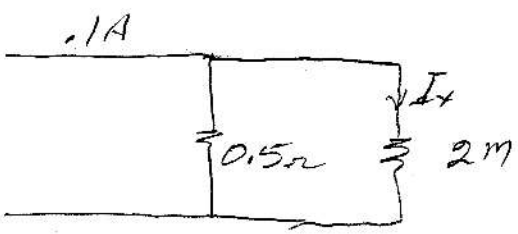
(a) Find the voltage V_{ab} indicated in the diagram of Figure 6 (a)



$$V_{ab} = \frac{12 \times 8}{4 + 8} = 8\ V$$

(b) Give the value of the current I_X in the 12 Ω resistor, up to the second significant decimal place, for the circuit shown Figure 6b.





$$I_x = \frac{0.1 \times .5}{2} \approx 2.5 \times 10^{-8}\ A$$

$I_x = 0$ for 2 significant digits.