ECE 300
Test #1
Spring Semester, 2004

Desk Copy

wlg Name _____
Each problem 20% AM Section Print (last, first)

This is a closed book, closed notes test. Use engineering paper for your work and work only on one side of your paper. Do not place any work on the exam sheet. Show how you obtain your answers.

(1) You are given the circuit in Figure 1. What must be the value of the resistance, R, for the current, I, to be 0.5 A? Show all steps of your work.

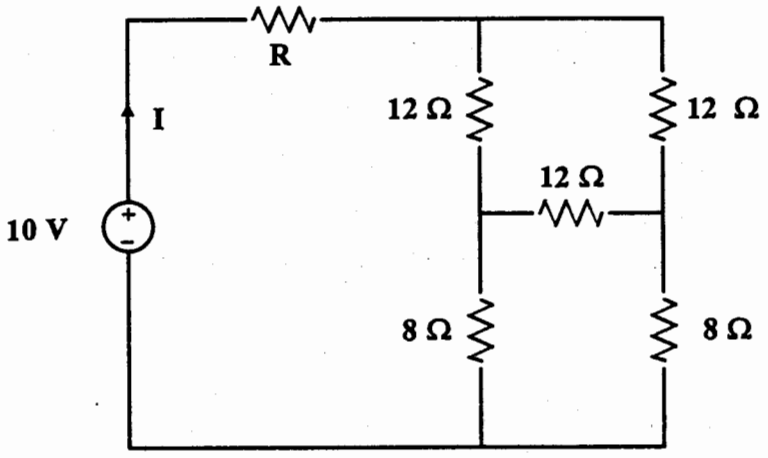


Figure 1: Circuit for problem 1.

(2) You are given the circuit of Figure 2.

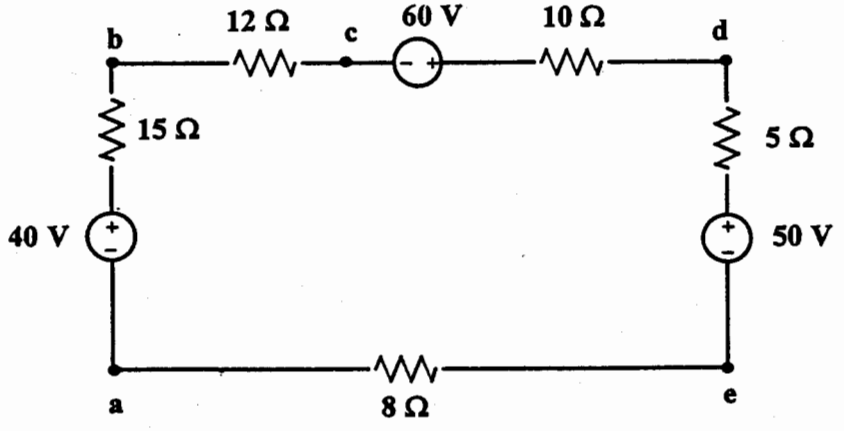


Figure 2: Circuit for problem 2.

Use any method you desire to find V_{ce}. Show your work.

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

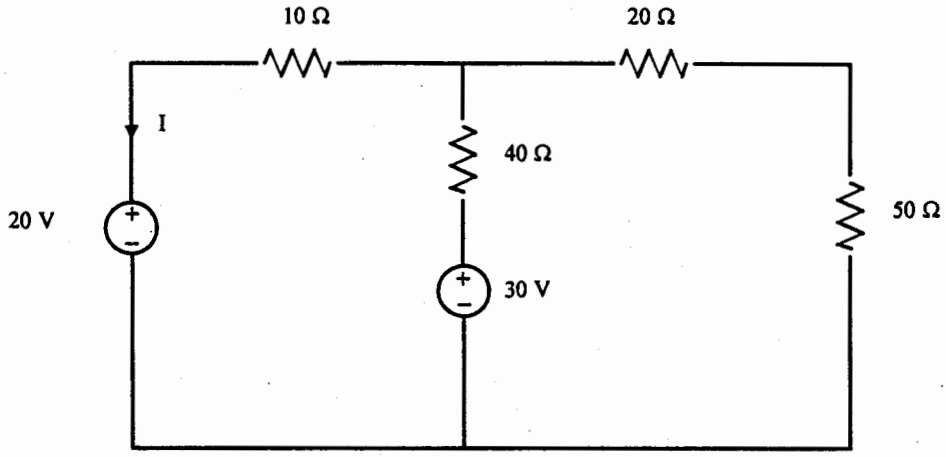


Figure 3: Circuit for problem 3.

Use any circuit method you desire.

(a) Find the current I.
(b) Find the power absorbed by the 50 ohm resistor.
(c) Find the power supplied by the 20 V source.

(4) Use mesh analysis to determine I_1, I_2, and I_3 in the network of Figure 4.

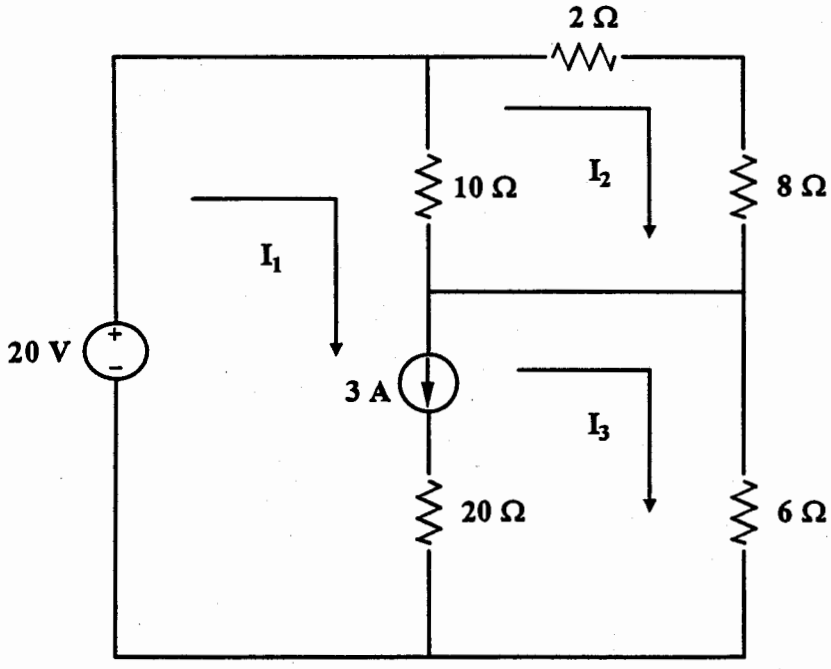


Figure 4: Circuit for problem 4.

(5) You are given the network shown in Figure 5.

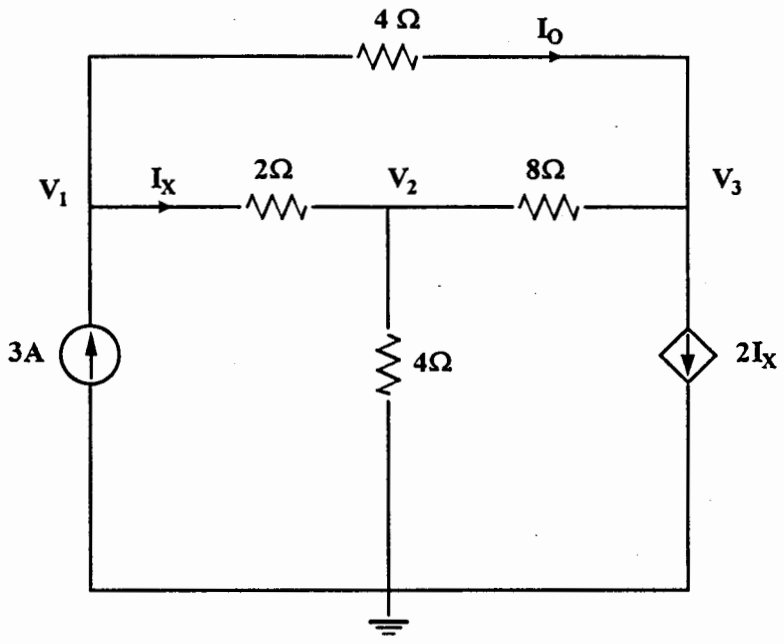
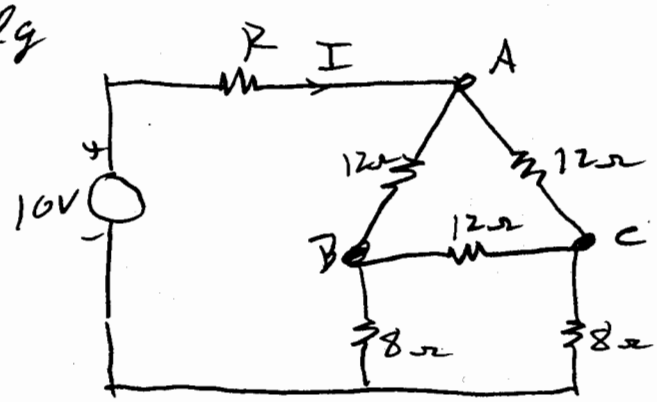


Figure 5: Circuit for problem 5.

(1) Use nodal analysis to find the voltages V_1, V_2, and V_3.
(2) Find the value of the current I_0, as shown in Figure 5.

Test #1

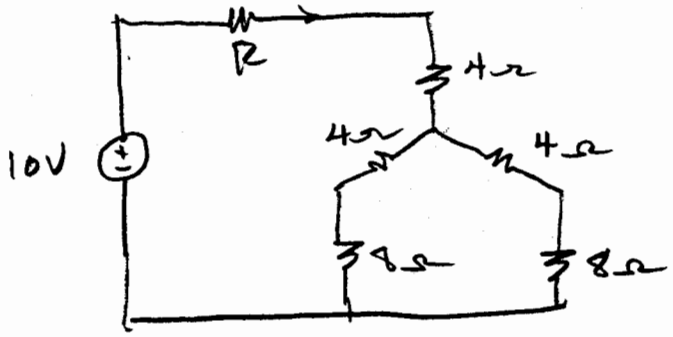
(1) wlg

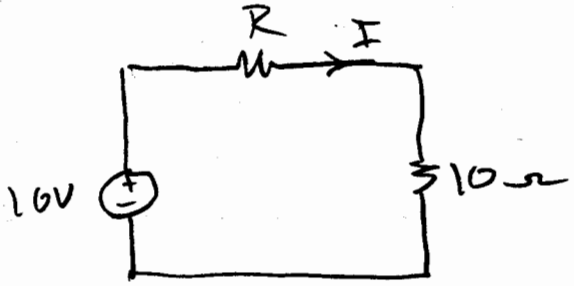


want $I = 0.5A$,
Find R.

Delta to wye at points A-B-C;

For each $R_1 = \frac{12 \times 12}{12+12+12} = 4\Omega$





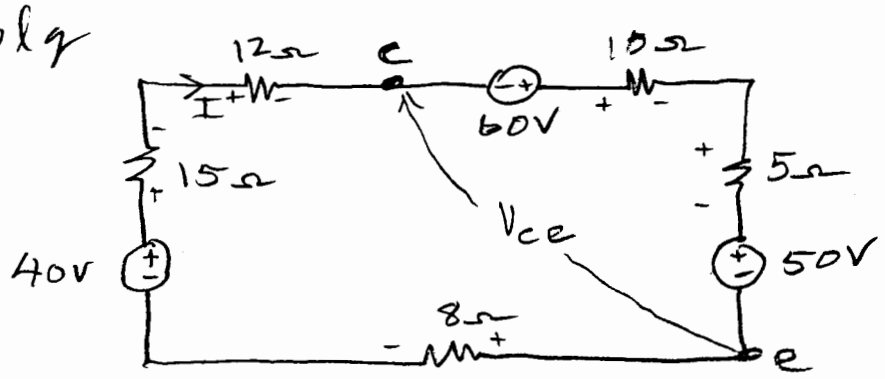
$$I = 0.5 = \frac{10V}{R+10}$$

$$0.5R + 5 = 10$$

$$.5R = 5$$

$$\boxed{R = 10\Omega}$$

(2) wlg



$$-40-60+50+50I=0$$

$$50I = 50$$

$$I = 1\,A$$

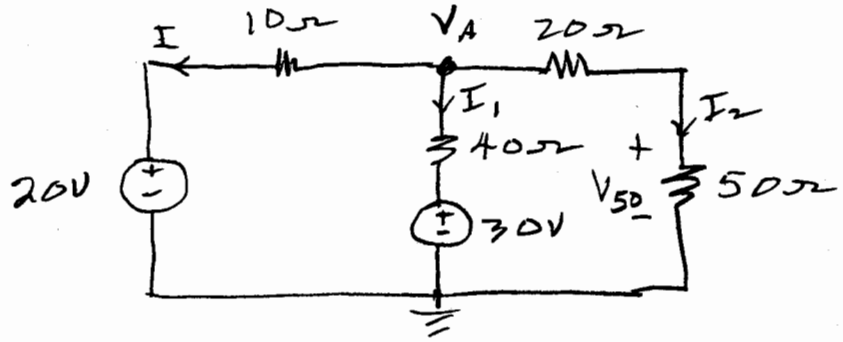
$$8I - 40 + 15I + 12I + V_{ce} = 0$$

$$V_{ce} = 40 - I(35)\Big|_{I=1A}$$

$$V_{ce} = 40 - 35$$

$$\boxed{V_{ce} = +5\,V}$$

(3) wlg: By Nodal Analysis.



$$\frac{V_A - 20}{10} + \frac{V_A - 30}{40} + \frac{V_A}{70} = 0$$

$$.1V_A - 2 + 0.025V_A - 0.75 + .014286V_A$$

$$0.1393\,V_A = 2.75$$

$$V_A = 19.74\ V$$

(a) $$I = \frac{V_A - 20}{10} = \frac{19.74 - 20}{10} = -0.026\ A$$

(b) $$V_{50} = \frac{(V_A)50}{50+20}$$ Voltage division

$$V_{50} = \frac{(19.74)50}{70} = 14.1\ V$$

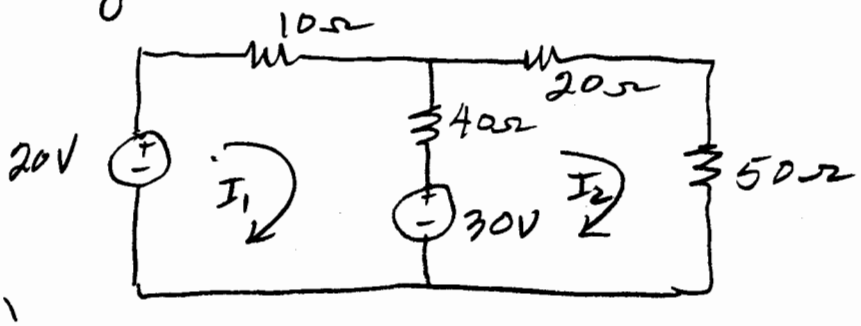
$$P_{50} = \frac{V_{50}^2}{50} = \frac{(14.1)^2}{50} = 3.98\ W$$

$$P_{50} = 3.98\ W$$

(c) $$P_{sup_{20}} = -I \times 20 = -(-0.026)20$$

$$P_{sup_{20}} = 0.52\ W$$

13) wlg : Mesh Analysis



mesh 1

$$-20 + 10I_1 + (I_1 - I_2)40 + 30 = 0$$

$$\boxed{50I_1 - 40I_2 = -10} \quad \#1$$

mesh 2.

$$-30 + (I_2 - I_1)40 + 70I_2 = 0$$

$$\boxed{-40I_1 + 110I_2 = 30} \quad \#2$$

From #1 & #2

$$I_1 = 0.0256 \text{ A}$$

$$\therefore \quad I = -0.026 \text{ A}$$

$$I_2 = 0.282 \text{ A}$$

(a) $\boxed{I = -0.026 \text{ A}}$

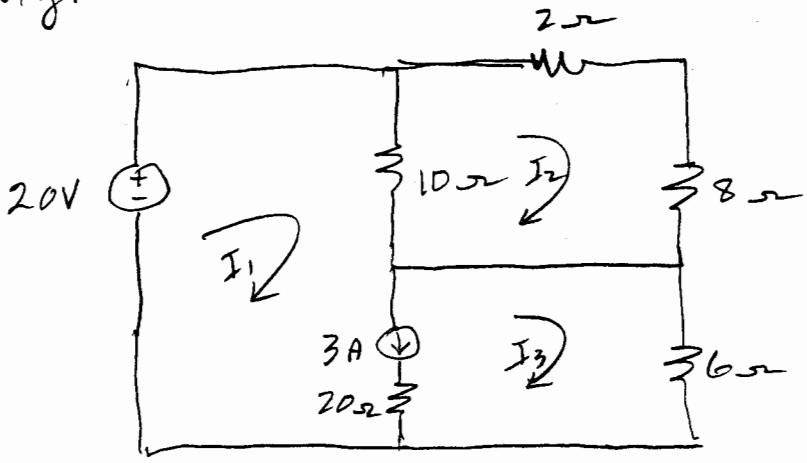
(b) $P_{50} = I_2^2 \times 50 = (.282)^2 50$

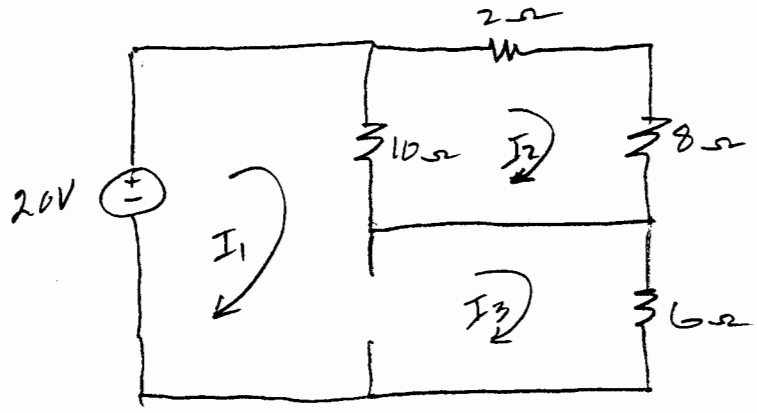
$$\boxed{P_{50} = 3.98 \text{ W}}$$

(c) $P_{sup_{20}} = 20I_1 = -20I = 0.512 \text{ W}$

$$\boxed{P_{sup_{20}} = 0.512 \text{ W}}$$

(4) wlg:





$$0I_1 + 10I_2 + 6I_3 = 20$$

$$-10I_1 + 20I_2 + 0I_3 = 0$$

$$I_1 + 0I_2 - I_3 = 3$$

$$\begin{bmatrix} 0 & 10 & 6 \\ -10 & 20 & 0 \\ 1 & 0 & -1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 20 \\ 0 \\ 3 \end{bmatrix}$$

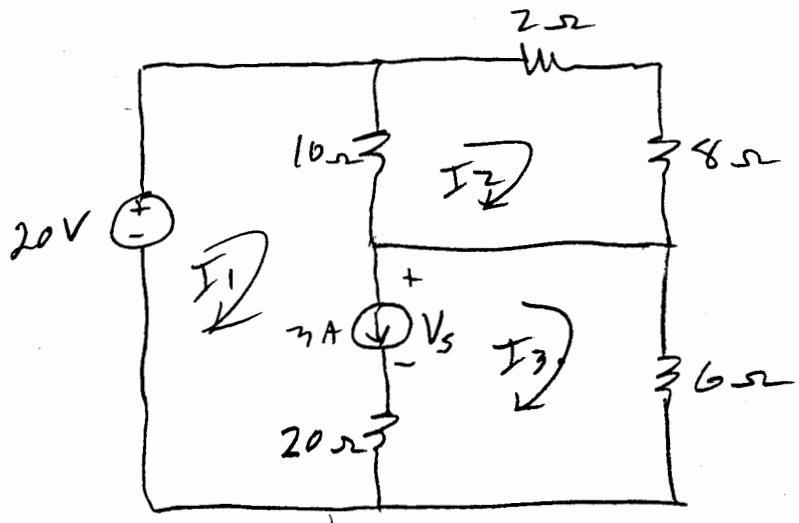
$I_1 = 3.45\ A = 38/11$

$I_2 = 1.73\ A = 19/11$

$I_3 = 0.45\ A = 5/11$

(4) wlg: Alternate solution use voltage Across current source.

Set up the problem as follows



Constraint Eq: $I_1 - I_3 = 3$

Write 3 mesh equations.

mesh #1

$$10(I_1 - I_2) + V_s + 20(I_1 - I_3) = 20$$

$$30I_1 - 10I_2 - 20I_3 + V_s = 20$$

mesh #2

$$-10I_1 + 20I_2 + 0I_3 + 0V_s = 0$$

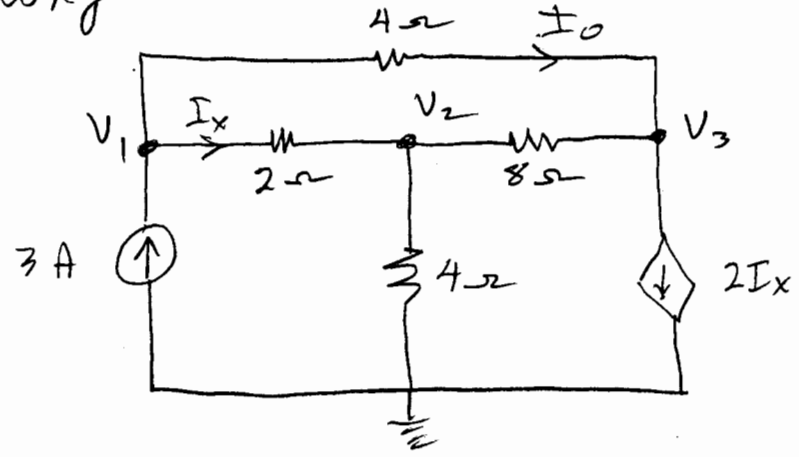
mesh #3

$$-20I_1 + 0I_2 + 26I_3 - V_s = 0$$

$$\begin{bmatrix} 30 & -10 & -20 & 1 \\ -10 & 20 & 0 & 0 \\ -20 & 0 & 26 & -1 \\ 1 & 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ V_x \end{bmatrix} = \begin{bmatrix} 20 \\ 0 \\ 0 \\ 3 \end{bmatrix}$$

$I_1 = 3.45A$, $I_2 = 1.73A$, $I_3 = 0.45A$, $V_s = -57.27V$

(5) wlg



At V_1

$$\frac{V_1 - V_2}{2} + \frac{V_1 - V_3}{4} = 3$$

OR

$$2V_1 - 2V_2 + V_1 - V_3 = 12$$

$$\boxed{3V_1 - 2V_2 - V_3 = 12}$$ ✓

At V_2

$$\frac{V_2 - V_1}{2} + \frac{V_2 - V_3}{8} + \frac{V_2}{4} = 0$$

OR $\quad 4V_2 - 4V_1 + V_2 - V_3 + 2V_2 = 0$

$$\boxed{-4V_1 + 7V_2 - V_3 = 0}$$

At V_3

$$\frac{V_3 - V_2}{8} + \frac{V_3 - V_1}{4} + \frac{2(V_1 - V_2)}{2} = 0$$

$$V_3 - V_2 + 2V_3 - 2V_1 + 8V_1 - 8V_2$$

$$\boxed{6V_1 - 9V_2 + 3V_3 = 0}$$

$$\begin{bmatrix} 3 & -2 & -1 \\ -4 & 7 & -1 \\ 6 & -9 & 3 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 12 \\ 0 \\ 0 \end{bmatrix}$$

$\boxed{V_1 = 4.8\ V}$ $\boxed{V_2 = 2.4\ V}$ $\boxed{V_3 = -2.4\ V}$

#5 wkg cont.

$$I_0 = \frac{V_1 - V_3}{4}$$

$$= \frac{4.8 - (-2.4)}{4}$$

$$I_0 = \frac{7.2}{4}$$

$$\boxed{I_0 = 1.8\ A}$$