ECE 300
Test #1
Spring Semester, 2005

Desk copy

wlg

Name Green
Print (last, first)

PM Section

You may omit either problem 7 or 8. Circle the one you omit: 7 8

Problem 1 counts 10%. All other problems count 15% each.

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. Find the equivalent resistance, R_{in}, seen looking into the indicated terminals of the circuit in Figure 1.

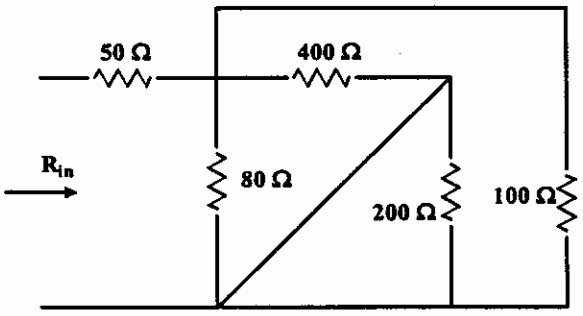


Figure 1: Circuit for problem 1.

2. You are given the circuit of Figure 2.

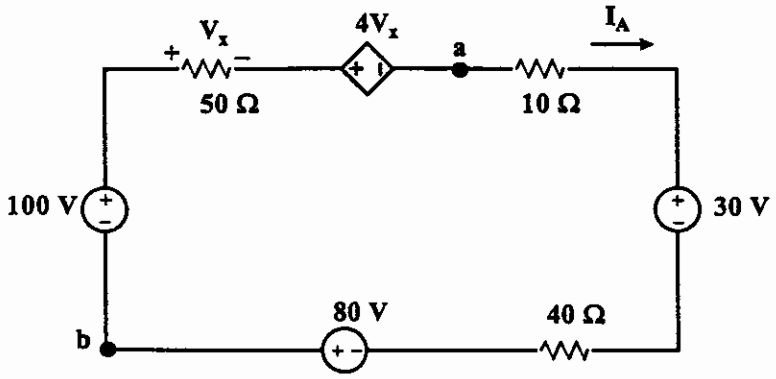


Figure 2: Circuit for problem 2.

(a) Find I_A.
(b) Find V_{ab}.
(c) Find the power supplied by the 30 volt source.
(d) Find the power supplied by the 100 volt source.

3. You are given the circuit of Figure 3. Use the voltage divider rule to determine the value of V_S in order that $V_{out} = 48$ V.

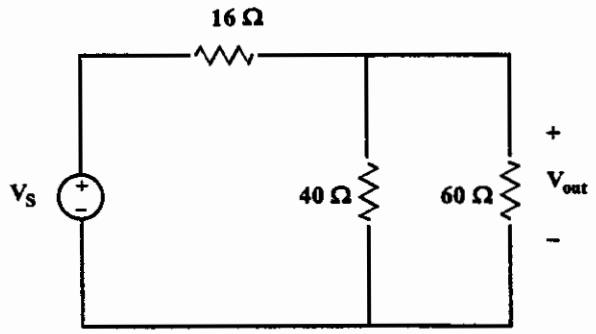


Figure 3: Circuit for problem 3.

4. You are given the circuit of Figure 4. Determine V_{in}.

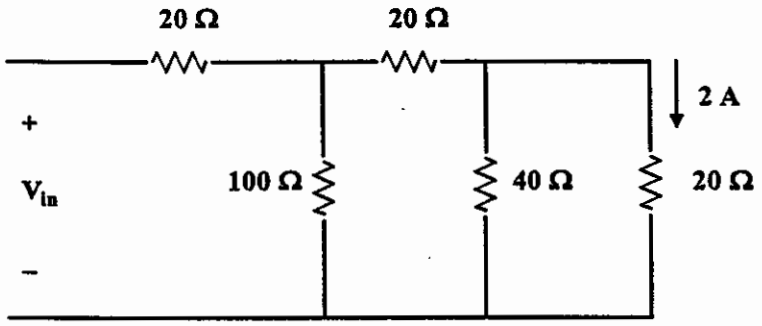


Figure 4: Circuit for problem 4.

5. You are given the circuit of Figure 5. You are to complete the design of this circuit by placing a voltage source V_s, as shown, and a resistor R_{out}, as shown, so that the output voltage is is 5 V as indicated in the diagram. The voltage source V_s cannot exceed 12 volts.

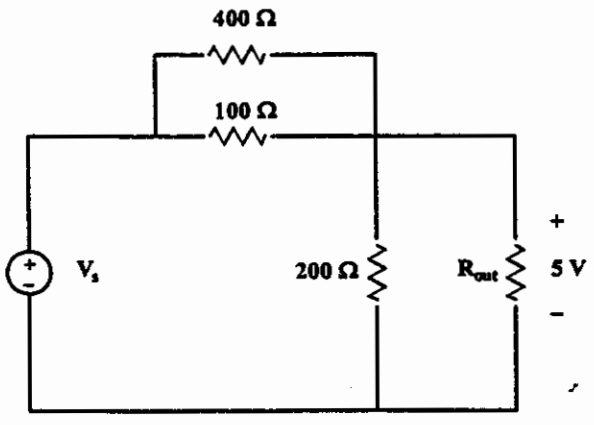


Figure 5: Circuit for problem 5.

6. You are given the circuit shown in Figure 6. Use any method you desire to find I_1, I_2, and I_3.

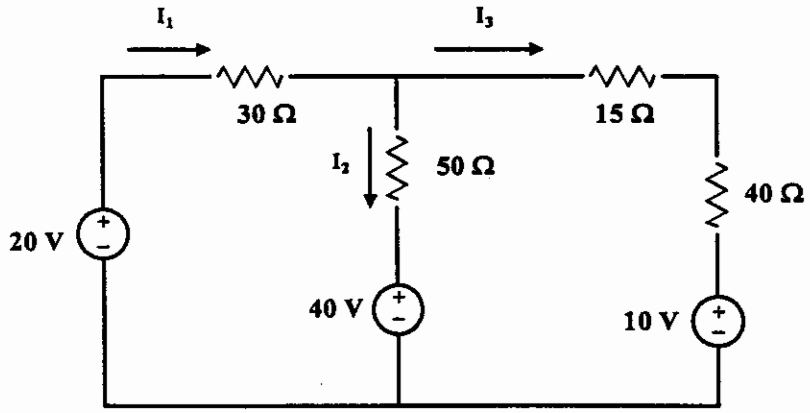


Figure 6: Circuit for problem 6.

7. Use either mesh analysis or nodal analysis to determine how much power is absorbed by the 4 Ω resistor in the circuit of Figure 7.

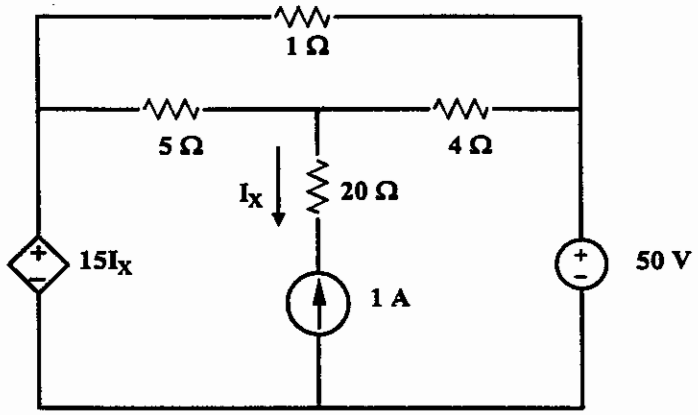


Figure 7: Circuit for problem 7.

8. You are given the circuit of Figure 8. Use either mesh or nodal analysis to find the current I_{10}.

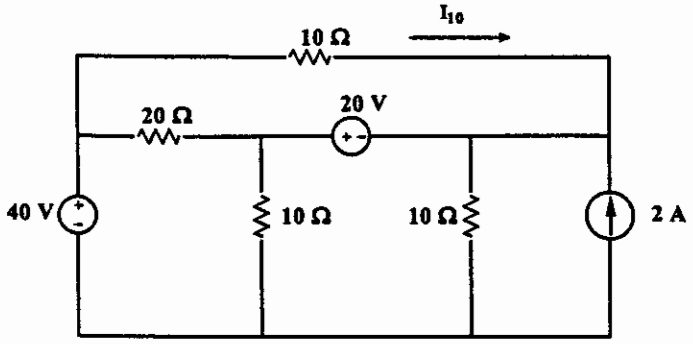
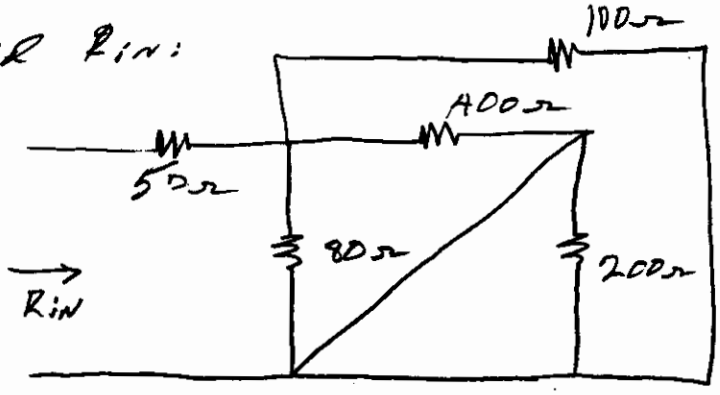


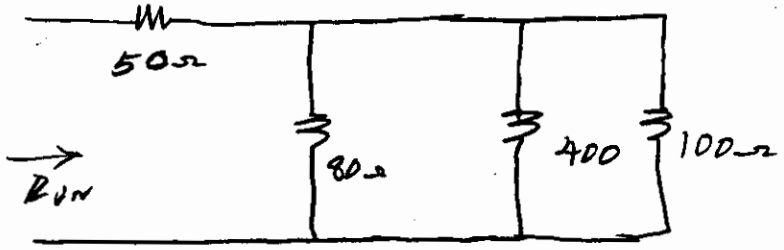
Figure 8: Circuit for problem 8.

Test #1

1) FIND R_{in}:



The 200Ω resistor is shorted out. This leaves



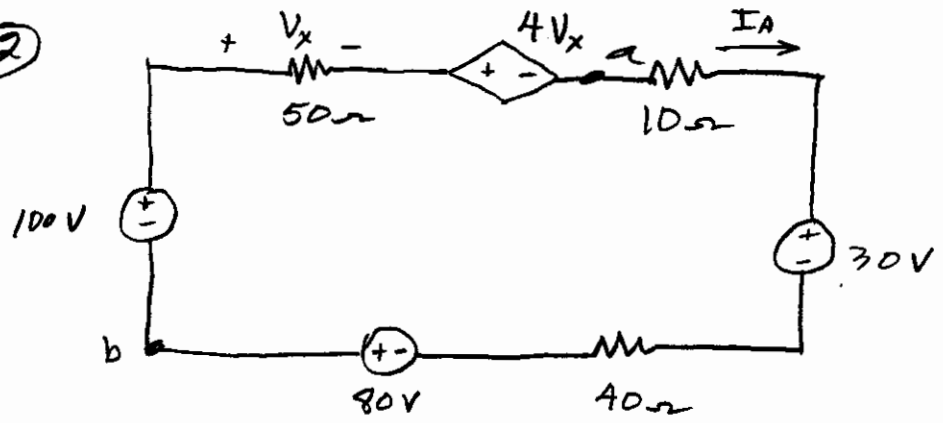
$100 \parallel 400 = 80\Omega$

$80 \parallel 80 = 40\Omega$

$R_{in} = 50 + 40 = 90\Omega$

$\boxed{R_{in} = 90\Omega}$

(2)



(a) FIND I_A, (b) FIND V_{ab}, (c) FIND $P_{sup_{30}}$

(d) FIND $P_{sup_{100}}$

(a)

$$-100 + 50I_A + 4V_x + 10I_A + 30 + 40I_A - 80 = 0$$

but $V_x = 50I_A$, giving

$$-100 + 50I_A + 200I_A + 10I_A + 30 + 40I_A - 80 = 0$$

$$300I_A = 150$$

$$\boxed{I_A = 0.5\ A}$$

(b) $-V_{ab} - 4(50 \times 0.5) - 50 \times 0.5 + 100 = 0$

$$V_{ab} = 100 - 25 - 100 = -25\ V$$

$$\boxed{V_{ab} = -25\ V}$$

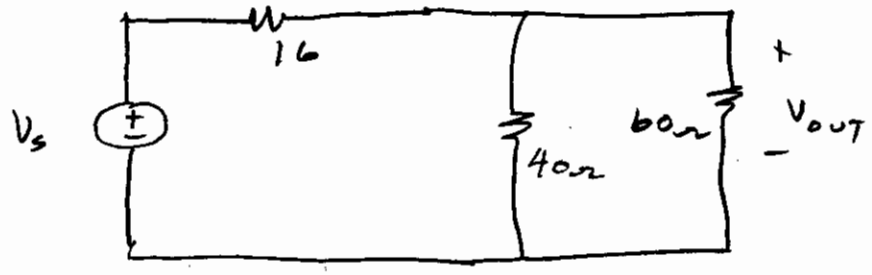
(c) $P_{sup_{30V}} = -30 \times 0.5 = -15\ W$

$$\boxed{P_{sup_{30}} = -15\ W}$$

(d) $P_{sup_{100V}} = 100 \times 0.5 = 50\ W$

$$\boxed{P_{sup_{100}} = 50\ W}$$

(3) Use voltage divider to find V_{out}.



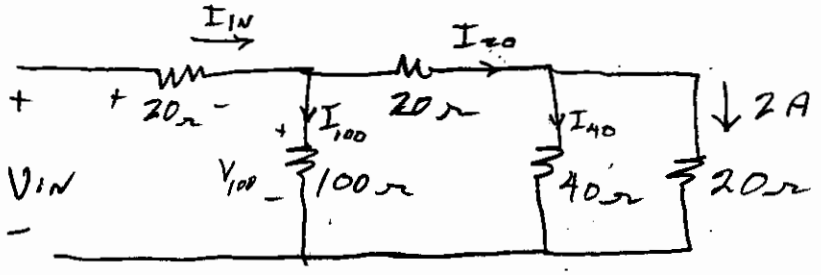
$$40 \| 60 = \frac{40 \times 60}{40 + 60} = 24\Omega$$

$$V_{OUT} = 48 = \frac{V_s \times 24}{24 + 16} = \frac{V_s \cdot 24}{40}$$

$$24 V_s = 40 \times 48$$

$$\boxed{V_o = 80\,V}$$

(4) FIND V_{IN}:



$$I_{40} = \frac{40V}{40} = 1\ A$$

$$I_{20} = I_{40} + 2 = 3\ A$$

$$V_{100} = 3 \times 20 + 1 \times 40 = 100\ V$$

$$I_{100} = \frac{V_{100}}{100} = \frac{100}{100} = 1\ A$$

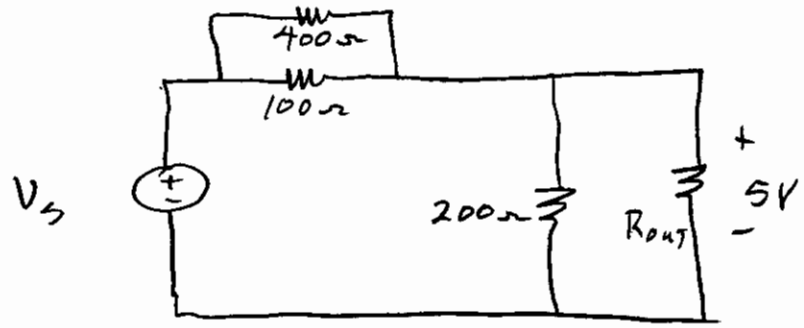
$$I_{IN} = I_{100} + I_{20} = 1 + 3 = 4\ A$$

$$V_{IN} = I_{IN} \times 20 + V_{100}$$

$$V_{IN} = 4 \times 20 + 100$$

$$\boxed{V_{IN} = 180\ V}$$

(5) For the following circuit, determine (find) V_s and R_{out} so that the output voltage is 5 volts.



$$100 \parallel 400 = \frac{100 \times 400}{100 + 400} = 80\,\Omega$$

$$200 \parallel R_{OUT} = \frac{200\,R_{OUT}}{200 + R_{OUT}}$$

Assume $V_s = 10\ V$

$$5 = \frac{10 \times \left(\frac{200\,R_{OUT}}{200 + R_{OUT}}\right)}{80 + \frac{200\,R_{OUT}}{200 + R_{OUT}}}$$

$$5 = \frac{2000\,R_{OUT}}{16000 + 80\,R_{OUT} + 200\,R_{OUT}}$$

$$80{,}000 + 400\,R_{OUT} + 1{,}000\,R_{OUT} = 2000\,R_{OUT}$$

$$600\,R_{OUT} = 80{,}000$$

$$R_{OUT} = 133.33\,\Omega$$

It can be shown that the general eq is

$$V_s = \frac{400}{R_{OUT}} + 7 \quad \left\| R_{OUT} = \frac{80{,}000}{200V_s - 1400} \right.$$

(6) By Branch analysis

$$-20 + 30I_1 + 50I_2 + 40 = 0$$

$$30I_1 + 50I_2 + 0I_3 = -20$$

$$-40 - 50I_2 + 55I_3 + 10 = 0$$

$$0I_1 - 50I_2 + 55I_3 = 30$$

$$I_1 - I_2 - I_3 = 0$$

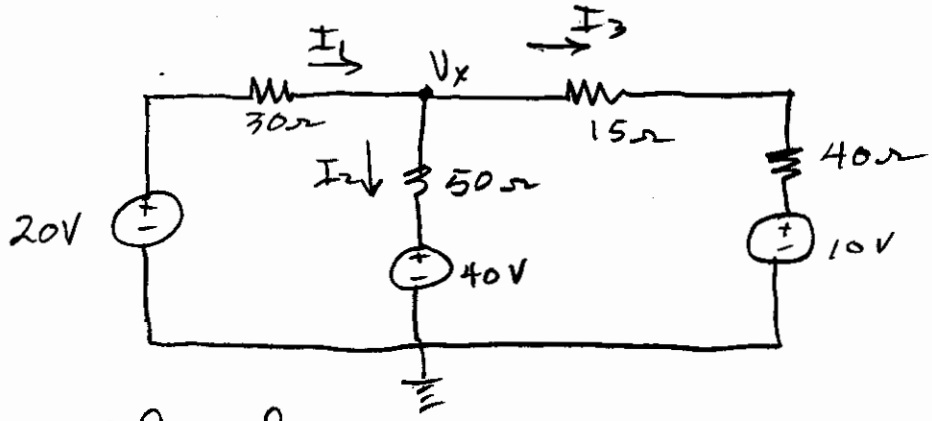
$$\begin{bmatrix} 30 & 50 & 0 \\ 0 & -50 & 55 \\ 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} -20 \\ 30 \\ 0 \end{bmatrix}$$

$$I_1 = -0.1017\ A$$

$$I_2 = -0.337\ A$$

$$I_3 = 0.2373\ A$$

(6) Find I_1, I_2, I_3. Use any method.



By nodal analysis:

$$\frac{V_x - 20}{30} + \frac{V_x - 40}{50} + \frac{V_x - 10}{55} = 0$$

Multiply through by 55:

$$1.833V_x - 36.67 + 1.1V_x - 44 + V_x - 10 = 0$$

$$3.933V_x = 90.67$$

$$V_x = 23.05$$

$$I_2 = \frac{V_x - 40}{50} = \frac{23.05 - 40}{50} = -0.339\ A$$

$$\boxed{I_2 = -0.339\ A}$$

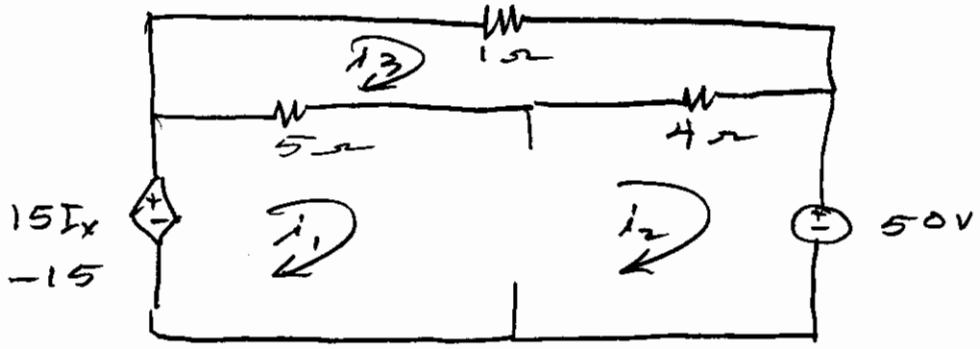
$$I_3 = \frac{V_x - 10}{55} = \frac{23.05 - 10}{55} = 0.2373\ A$$

$$\boxed{I_3 = 0.2373\ A}$$

$$I_1 = I_2 + I_3 = -.339 + .2373$$

$$\boxed{I_1 = -0.101\ A}$$

(7) By mesh analysis



$I_x = -1$ $\qquad$ $\boxed{i_1 - i_2 = -1}$

$15 + 5(i_1 - i_3) + 4(i_2 - i_3) + 50 = 0$

$\boxed{5i_1 + 4i_2 - 9i_3 = -65}$

$\boxed{-5i_1 - 4i_2 + 10i_3 = 0}$

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

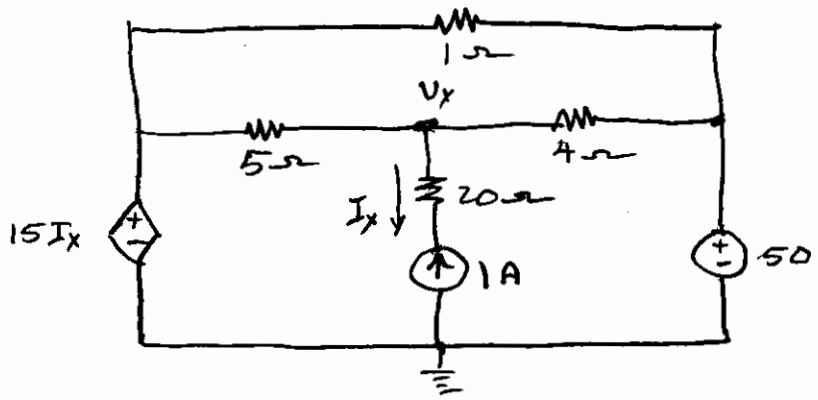
$i_1 = -72.67\,A$, $i_2 = -71.67\,A$, $i_3 = -65A$

$i_2 - i_3 = (-71.67 + 65) = -6.67$

$|i_4| = 6.67$

$P_4 = 6.67^2 \times 4 = 177.95\,W$ $\qquad$ done

(7) By nodal analysis Find pwr, 4Ω resistor



$$\frac{V_x - 15I_x}{5} + \frac{V_x - 50}{4} - 1 = 0$$

$$I_x = -1$$

40

$$\frac{V_x + 15}{5} + \frac{V_x - 50}{4} - 1 = 0$$

20 cd

$$4V_x + 60 + 5V_x - 250 - 20 = 0$$

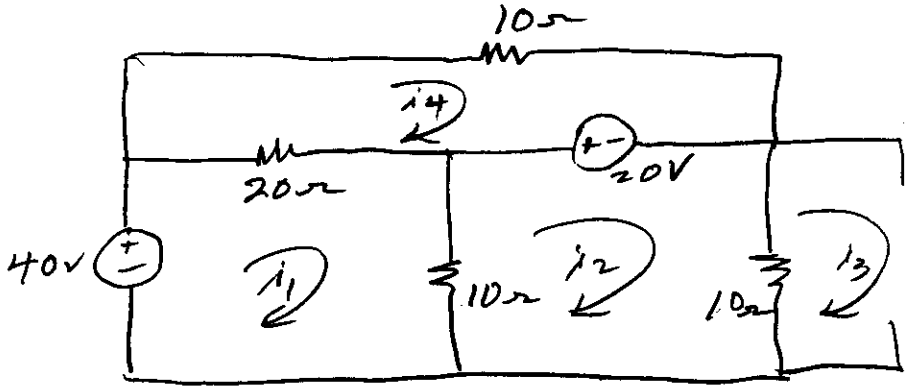
$$9V_x = 210$$

$$V_x = 23.33$$

$$P_{4\Omega} = \frac{(V_x - 50)^2}{4} = \frac{(23.33 - 50)^2}{4}$$

$$\boxed{P_{4\Omega} = 177.82\ W}$$

(8) mesh analysis



$i_3 = -2$

$$\begin{bmatrix} 30 & -10 & 0 & -20 \\ -10 & 20 & -10 & 0 \\ 0 & 0 & 1 & 0 \\ -20 & 0 & 0 & 30 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{bmatrix} 40 \\ -20 \\ -2 \\ -20 \end{bmatrix}$$

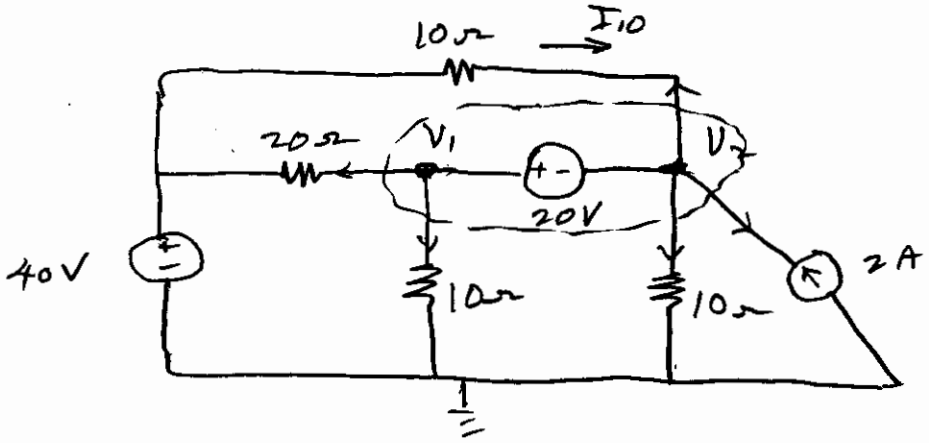
$i_1 = 2.86A \qquad i_2 = -0.571A$

$i_3 = -2A \qquad i_4 = 2.571A$

$I_{10} = i_4 = 2.571A$

check

(8.) By nodal analysis. FIND I_{10}



$$\frac{V_1 - 40}{20} + \frac{V_1}{10} + \frac{V_2}{10} - 2 + \frac{V_2 - 40}{10} = 0$$

20 common

$$V_1 - 40 + 2V_1 + 2V_2 - 40 + 2V_2 - 80 = 0$$

$$\boxed{3V_1 + 4V_2 = 160}$$

constraint

$$V_1 - 20 - V_2 = 0$$

$$\boxed{V_1 - V_2 = 20}$$

$$V_1 = 34.29\,V \qquad V_2 = 14.29\,V$$

$$I_{10} = \frac{40 - V_2}{10} = \frac{40 - 14,29}{10}$$

$$\boxed{I_{10} = 2.57\,A}$$