Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG223 Circuit Theory I

Fall 07-08

<u>Instructors:</u>

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Midterm EXAMINATION

Nov. 20, 2007

Duration : 100 minutes

Number of Problems: 4

Good Luck

STUDENT'S	
NUMBER	
NAME	
SURNAME	
GROUP NO	

Problem		**Points**
1		25
2		25
3		25
4		25
TOTAL		100

1. Find v_0 in the circuit in Fig. P1 using nodal analysis. (25 pts.)

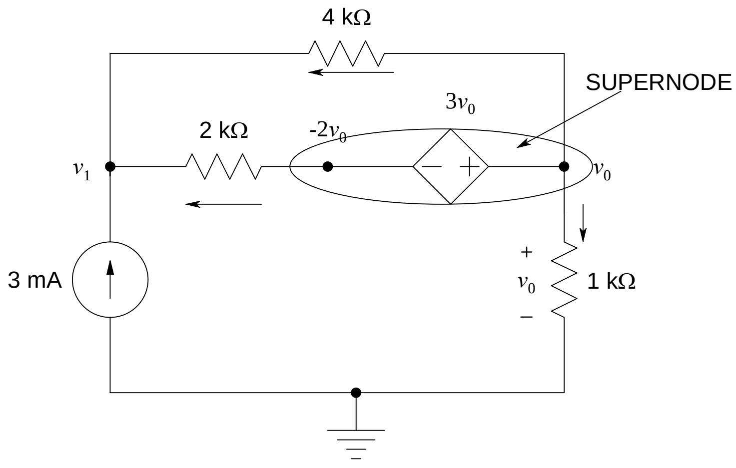


Figure P1

KCL at v_1 :

$$-\frac{v_0 - v_1}{4k} - \frac{-2v_0 - v_1}{2k} - 3m = 0$$

Multiply both sides by $4k$ yields:

$$-v_0 + v_1 + 4v_0 + 2v_1 = 12$$

$$3v_1 + 3v_0 = 12 \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

KCL at the SUPERNODE:

$$\frac{v_0}{1k} + \frac{v_0 - v_1}{4k} + \frac{-2v_0 - v_1}{2k} = 0$$

Multiply both sides by $4k$ yields:

$$4v_0 + v_0 - v_1 - 4v_0 - 2v_1 = 0$$

$$-3v_1 + v_0 = 0 \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

By summing up Eq.(1) and (2) gives:

$$\boxed{v_0 = 3 \text{ V}}$$

2. Use mesh analysis to find v in the circuit in Fig.P2. (25 pts.)

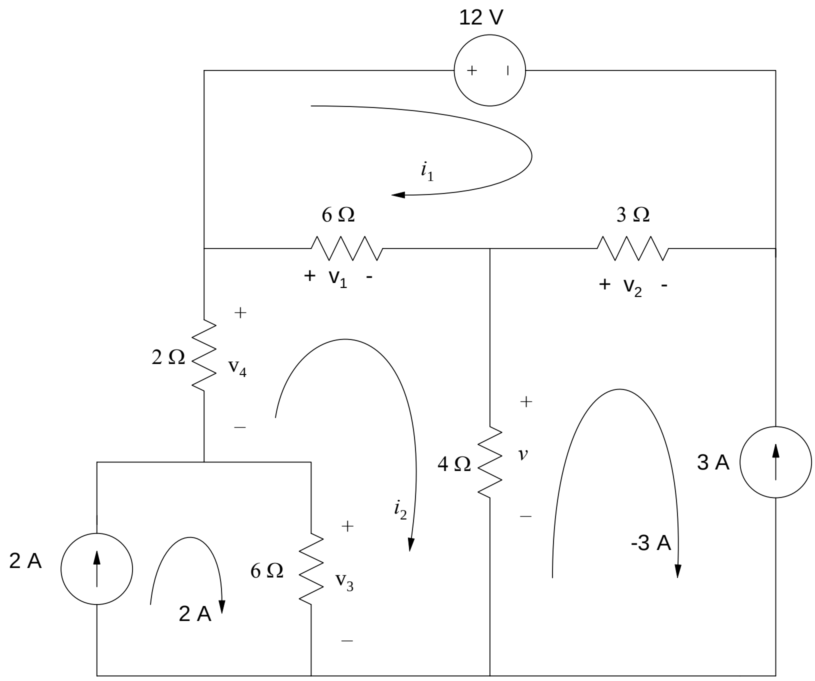


Figure P2

KVL around i_1 :

$$12 - v_2 - v_1 = 0$$
$$-3(-3 - i_1) - 6(i_2 - i_1) = -12$$
$$9i_1 - 6i_2 = -21 \text{.............}(1)$$

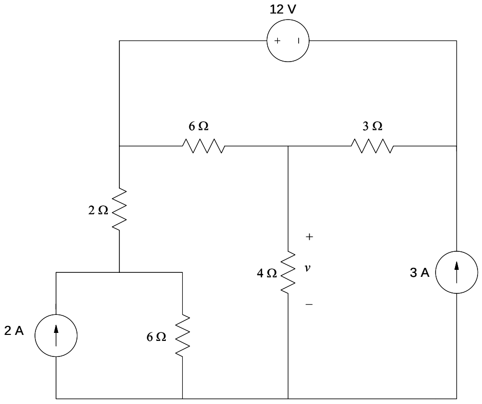
KVL around i_2 :

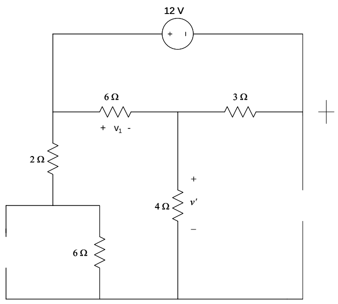
$$v_1 + v - v_3 - v_4 = 0$$
$$6(i_2 - i_1) + 4(i_2 + 3) - 6(2 - i_2) - 2(-i_2) = 0$$
$$-6i_1 + 18i_2 = 0 \text{.................}(2)$$

Multiplying Eq.(1) by 3 and summing up with (2) gives:

$$21i_1 = -63$$
$$\boxed{i_1 = -3 \text{ A}} \quad \therefore \quad \boxed{i_2 = -1 \text{ A}}$$
$$v = 4(i_2 + 3)$$
$$\boxed{v = 8 \text{ V}}$$

3. Solve Problem 2 using superposition. (25 pts.)





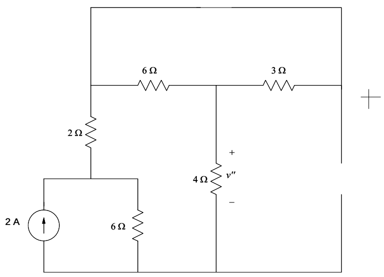
2, 6, and $4\,\Omega$ resistors are in series and the series combination of these resistors is in parallel with $6\,\Omega$ resistor. (2+6+4)//6 = $4\,\Omega$
By using voltage division principle

v_1 can be calculated as

$$v_1 = 12\frac{4}{7} = \frac{48}{7}\ \text{V}$$

and

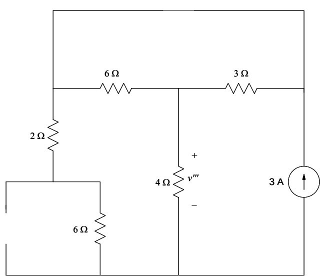
$$v' = -v_1\frac{4}{4+8} = -\frac{16}{7}\ \text{V}$$



6 Ω and $3\,\Omega$ resistors are in parallel
6//3=$2\,\Omega$
By using current division principle, the current flowing through $4\,\Omega$ resistor is

$$i = 2\frac{6}{6+8} = \frac{12}{14}\text{A}$$

$$v'' = 4i = \frac{24}{7}\ \text{V}$$



6 Ω and $3\,\Omega$ resistors are in parallel
6//3=$2\,\Omega$
By using current division principle we can calculate the current flowing through $4\,\Omega$ resistor.

$$i = 3\frac{8}{8+6} = \frac{24}{14}\text{A}$$

$$\therefore v''' = 4i = \frac{48}{7}\text{V}$$

$$v = v' + v'' + v''' = -\frac{16}{7} + \frac{24}{7} + \frac{48}{7} = 8\text{V}$$

Find the Thevenin equivalent looking into terminals *a-b* of the circuit in Fig. P4 and solve for i_x. (25 pts.)

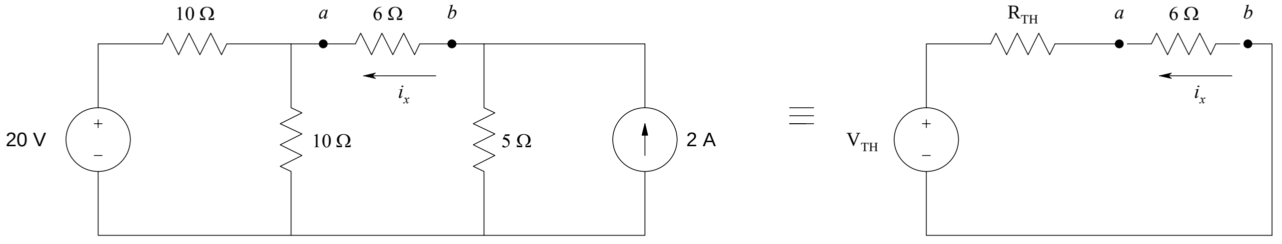
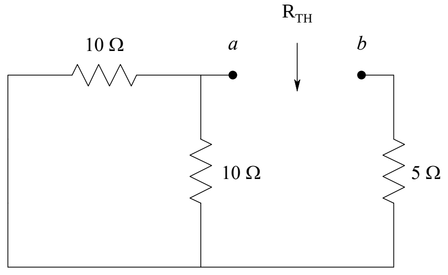


Figure P4

In order to find R_{TH}, all independent source values are set to zero.

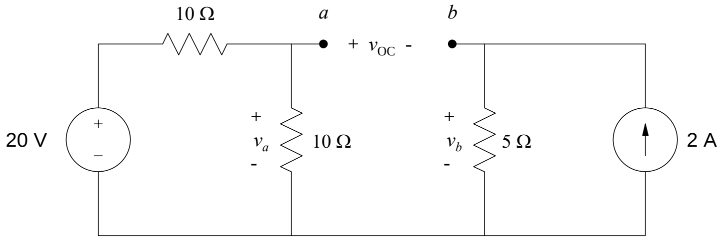
⇒ All independent voltage sources are replaced by short circuits.

⇒ All independent current sources are replaced by open circuits.



$$R_{TH} = (10//10) + 5 = 10\Omega$$

For V_{TH}, open circuit voltage v_{OC} will be found between terminals $a-b$.



$$v_{OC} = v_a - v_b$$

where

$$v_a = 20\frac{10}{10+10} = 10 \text{ V}$$

(using voltage division principle)

and

$$v_b = 2 \times 5 = 10 \text{ V}$$

$$v_{OC} = 0 \text{ V} = V_{TH}$$

$$i_x = \frac{V_{TH}}{R_{TH} + 6} = \frac{0}{16} = 0 \text{ A}$$