(1)

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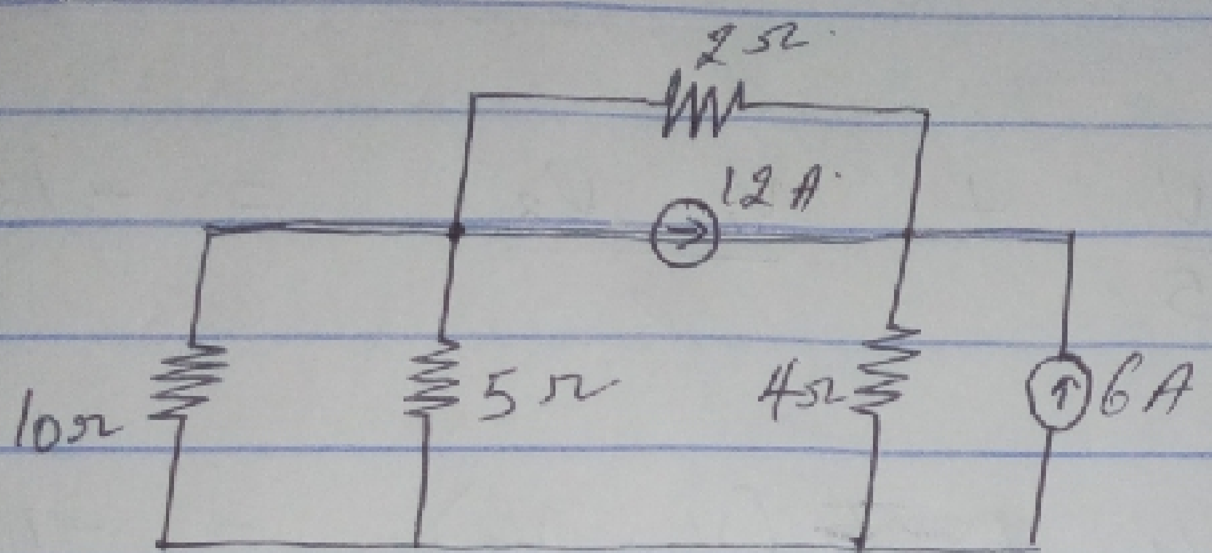
18/Eng 04/080
Electrical / Electronics Engineering
EEE 322 : Circuit Theory II

Assignment

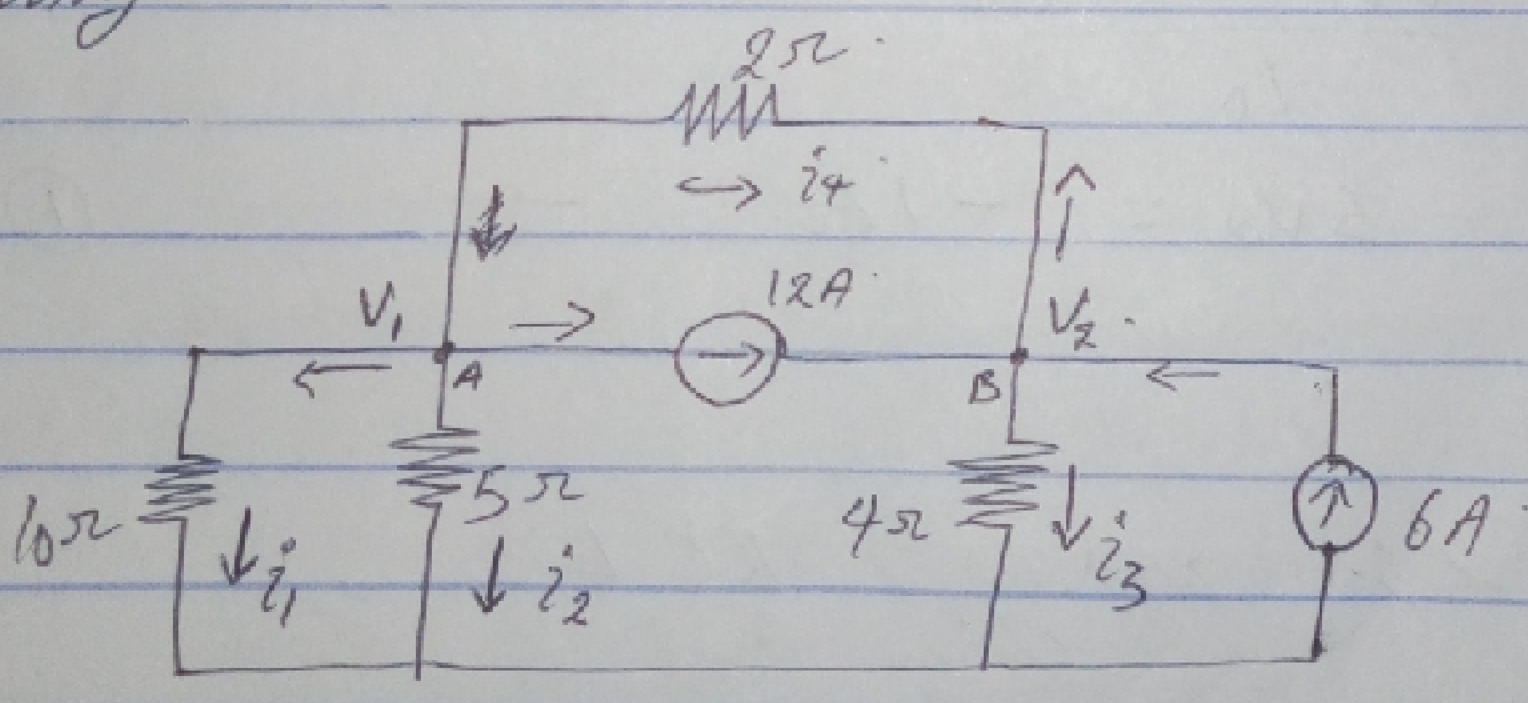
(1)



i) Find the voltages at nodes 1 & 2
ii) Find the current flowing through the four resistors.

Soln

redrawing



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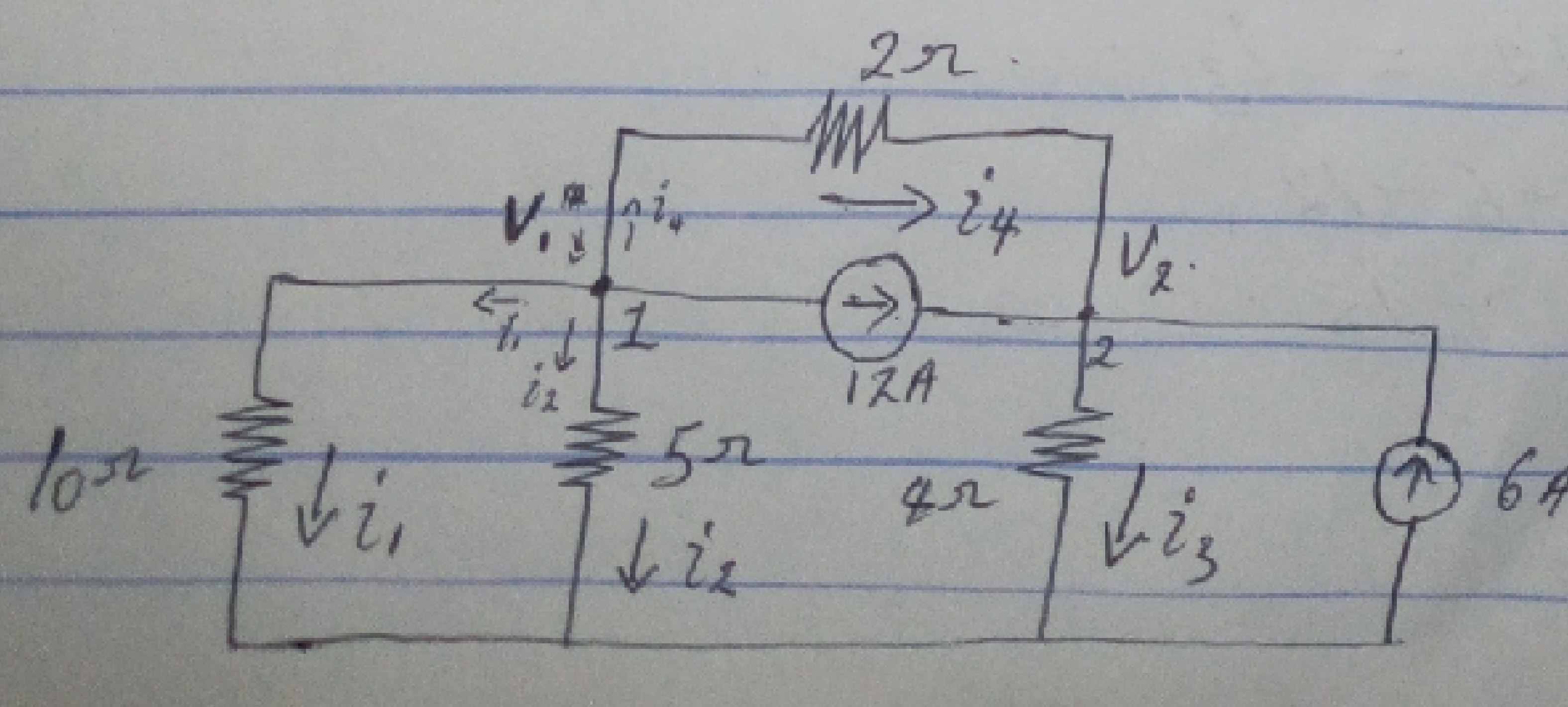


(2)

from node 1; using KCL $(i_1 + i_2 + i_4 + 12 = 0)$

$i_1 + i_2 + i_4 = -12\,A$

$\Rightarrow$

$$i_1 = \frac{V_1 - 0}{10} = \frac{V_1}{10}$$

$$i_2 = \frac{V_1 - 0}{5} = \frac{V_1}{5}$$

$$i_4 = \frac{V_1 - V_2}{2}$$

$$\Rightarrow \frac{V_1}{10} + \frac{V_1}{5} + \frac{V_1 - V_2}{2} = -12.$$

$$\equiv \frac{V_1}{10} + \frac{2V_1}{10} + \frac{5(V_1 - V_2)}{10} = -12.$$

$$\Rightarrow \frac{V_1 + 2V_1 + 5V_1 - 5V_2}{10} = -12.$$

$$\Rightarrow \frac{8V_1 - 5V_2}{10} = -12$$

$$\Rightarrow 8V_1 - 5V_2 = -120 \quad \text{——— (1)}$$

from node 2; using KCL

$i_4 + 6 + 12 = i_3$

$i_4 - i_3 = -6 - 12$

$i_4 - i_3 = -18.$

$$i_4 = \frac{V_1 - V_2}{2}$$

(3)

Pg (3)

$$i_3 = \frac{V_2 - 0}{4} = \frac{V_2}{4}$$

$$\Rightarrow \frac{V_1 - V_2}{2} - \frac{V_2}{4} = -18$$

$$= \frac{2(V_1 - V_2)}{4} - \frac{V_2}{4} = -18$$

$$\Rightarrow \frac{2V_1 - 2V_2 - V_2}{4} = -18$$

$$\Rightarrow \frac{2V_1 - 3V_2}{4} = -18$$

$$\Rightarrow 2V_1 - 3V_2 = -72 \quad \text{——— (2)}$$

$$8V_1 - 5V_2 = -120$$
$$2V_1 - 3V_2 = -72$$

using calculator to solve simultaneously, we get;

$V_1 = 0\,V$ & $V_2 = 24\,V$

$\therefore$, $V_1 = 0\,V$ & $V_2 = 24\,V$ //

$$\therefore i_1 = \frac{V_1}{10} = \frac{0}{10}$$

$$= 0\,A$$

$$i_2 = \frac{V_1}{5} = \frac{0}{5}$$

$$= 0A$$

$$i_3 = \frac{V_2}{4} = \frac{24}{4}$$

$$= 6A$$

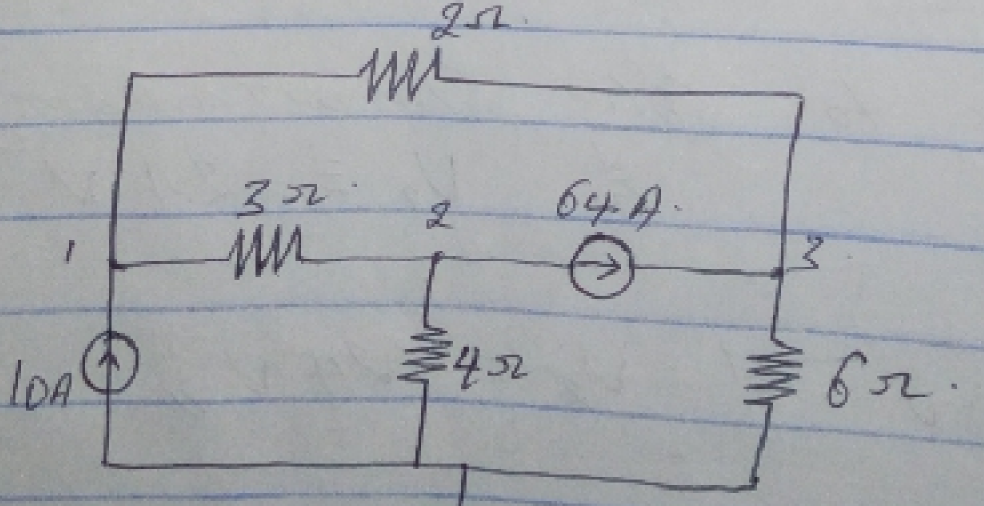
$$i_4 = \frac{V_1 - V_2}{2} = \frac{0 - 24}{2}$$

$$= -12A$$

$\therefore$ $V_1 = 0v$, $V_2 = 24v$

$i_1 = 0A$, $i_2 = 0A$, $i_3 = 6A$ & $i_4 = -12A$ //

(2)



find the Voltages at nodes 1 2 & 3.

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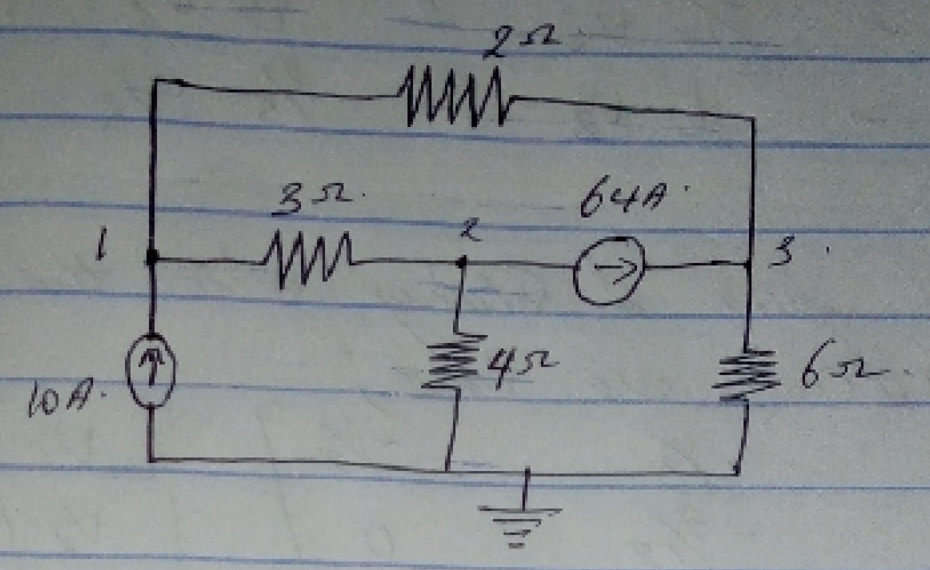
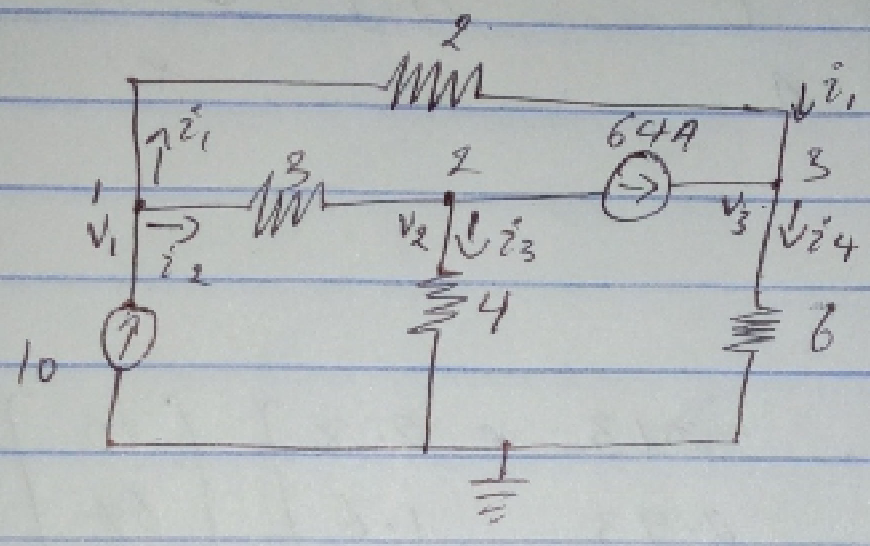
(2)



Soln



@ node 1; using KCL : $10 = i_1 + i_2$

$$10 = \frac{V_1 - V_3}{2} + \frac{V_1 - V_2}{3}$$

@ node 2; using KCL : $i_2 = 64 + i_3$

$$\frac{V_1 - V_2}{3} = 64 + \frac{V_2}{4}$$

@ node 3; using KCL : $i_4 = 64 + i_1$

$$\frac{V_3}{6} = 64 + \frac{V_1 - V_3}{2}$$

Simplifying the equations we'll have;

(6)

$$10 = \frac{5}{6} V_1 - \frac{1}{3} V_2 - \frac{1}{2} V_3$$

$$64 = \frac{1}{3} V_1 - \frac{7}{12} V_2 + 0 V_3$$

$$64 = -\frac{1}{2} V_1 - 0 V_3 + \frac{2}{3} V_3$$

Using matrix form & solving with the aid of Matcad, we have;

$$\begin{bmatrix} 10 \\ 64 \\ 64 \end{bmatrix} = \begin{bmatrix} 5/6 & -1/3 & -1/2 \\ 1/3 & -7/12 & 0 \\ -1/2 & 0 & 2/3 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$b = A \quad x$$

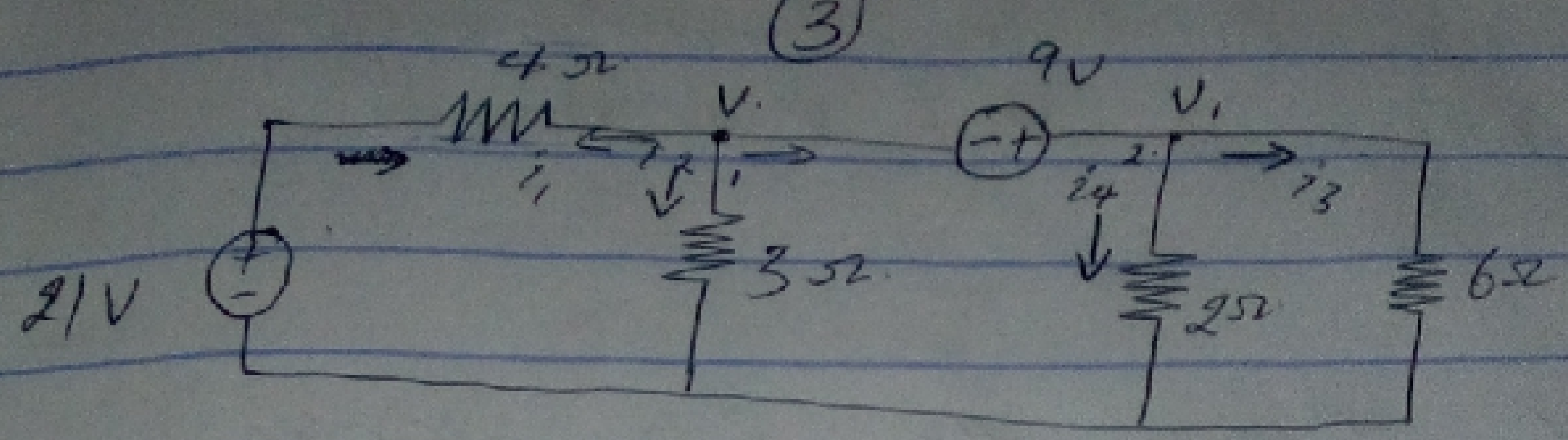
$$x = A^{-1} b$$

$$A^{-1} b = \begin{bmatrix} 3.73 & -2.13 & 2.8 \\ 2.13 & -2.93 & 1.6 \\ 2.8 & -1.6 & 3.6 \end{bmatrix} \begin{bmatrix} 10 \\ 64 \\ 64 \end{bmatrix}$$

$$x = \begin{bmatrix} 80 \\ -64 \\ 156 \end{bmatrix}$$

$\therefore V_1 = 80V, \quad V_2 = -64V \quad \& \quad V_3 = 156V$

(3)



$$2 \parallel 6 = \frac{2 \times 6}{2+6} = 1.5$$

Find the current through the 3 & 2 resistor.

Soln..

Using KCL @ node 1.

$$i_1 + i_2 + i_3 + i_4 = 0$$

$$\rightarrow \frac{V-21}{4} + \frac{V}{3} + \frac{V_1}{6} + \frac{V_1}{2} = 0$$

$$\Rightarrow \frac{3(V-21) + 4V + 2V_1 + 6V_1}{12} = 0$$

$$\rightarrow \frac{3V - 63 + 4V + 2V_1 + 6V_1}{12} = 0$$

$$\rightarrow 7V + 8V_1 - 63 = 0$$

$$7V + 8V_1 = 63 \quad \text{—— (1)}$$

using KVL for loop 1.

$$\rightarrow -V - 9 + V_1 = 0$$

$$-V + V_1 = 9 \quad \text{—— (2)}$$

$$7V + 8V_1 = 63$$

$$-V + V_1 = 9$$

using Calculator to solve simultaneously,
$V = -0.6V$, $V_1 = 8.4V$

* the Current through the 3Ω resistor;
using nodal analysis.

$$I_{3\Omega} = \frac{V - 0}{3}$$

$$= \frac{-0.6 - 0}{3} = \frac{-0.6}{3}$$

$$\therefore I_{3\Omega} = -0.2 A$$ ans 1

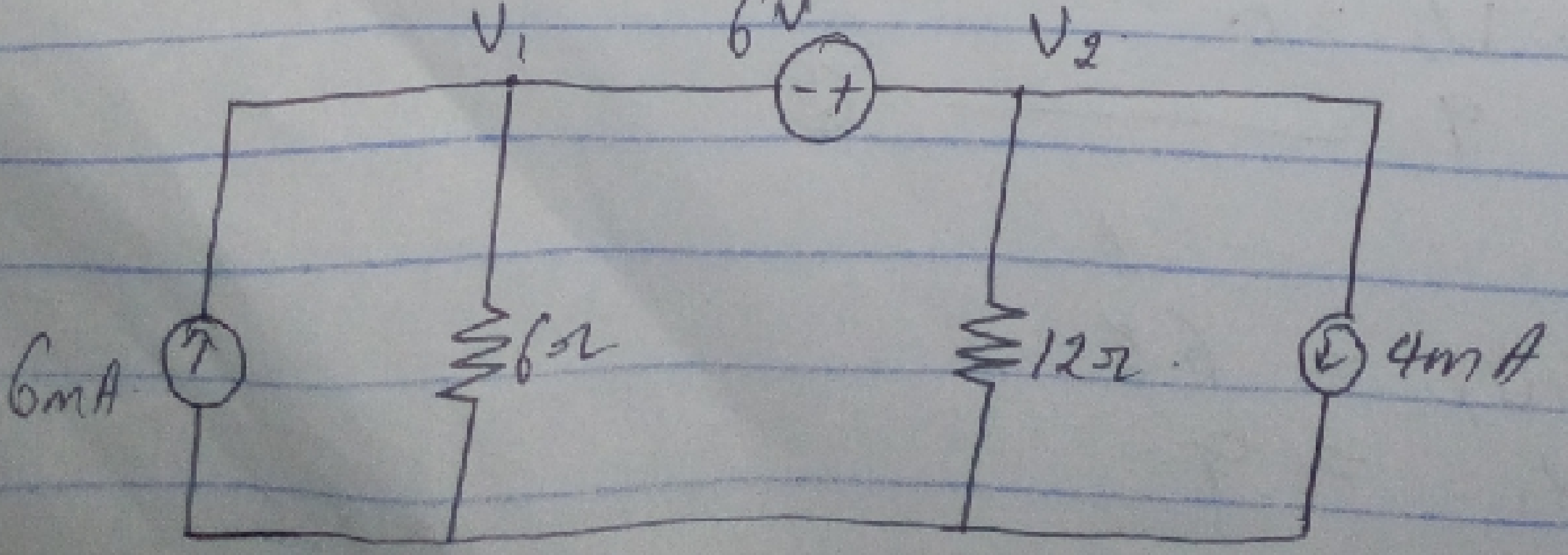
& the Current through the 2Ω resistor;

$$I_{2\Omega} = \frac{V_1 - 0}{2}$$

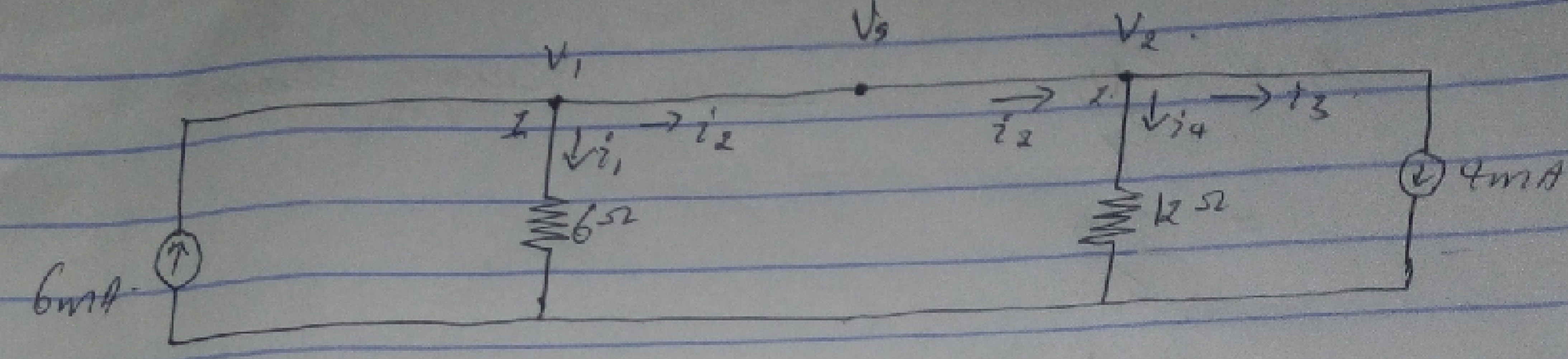
$$= \frac{8.4 - 0}{2} = \frac{8.4}{2}$$

$$I_{2\Omega} = 4.2 A$$ ans 2

No (4)



find the voltages & Currents through 6Ω & 12Ω.



$\rightarrow \quad V_1 - V_2 = 6V$

Let's say $V_1 - V_2 \equiv i_2$.

@ node 1; using KCL.

$6mA = i_1 + i_2$

$6mA = \frac{V_1}{6} + (V_1 - V_2)$

$6mA = \frac{V_1 + 6(V_1 - V_2)}{6}$

$6mA = \frac{V_1 + 6V_1 - 6V_2}{6}$

$36 = 7V_1 - 6V_2$ ——— (1).

@ node 2; using KCL

$i_2 = i_4 + i_3$ $\qquad$ * $i_3 = 4mA$

$\rightarrow i_2 = i_4 + 4mA$ $\quad \therefore \quad 4mA = i_2 - i_4$

$4mA = (V_1 - V_2) - \frac{V_2}{12}$

$4mA = \frac{12(V_1 - V_2) - V_2}{12}$

$48 = 12V_1 - 12V_2 - V_2$

$48 = 12V_1 - 13V_2$ ——— (2).

Solving V_1 & V_2 simultaneously, we have.

$V_1 = 9.5V$, $V_2 = 5.1V$.

(13)

Current through the 6Ω ——

$\therefore i_1 = \frac{V_1}{6}$

$= \frac{9.5}{6}$

$= 1.58\ A$

$i_2 = V_1 - V_2$

$= 9.5 - 5.1$

$= 4.4\ A$

Current through the 12Ω ——

$i_3 = \frac{V_2}{12}$

$= \frac{5.1}{12}$

= ~~6.9 A~~ $= 0.43\ A$

$\therefore V_1 = 9.5\ V$, $V_2 = 5.1\ V$.

& $i_{6\Omega} = 1.58$ & $i_{12\Omega} = 0.43\ A$