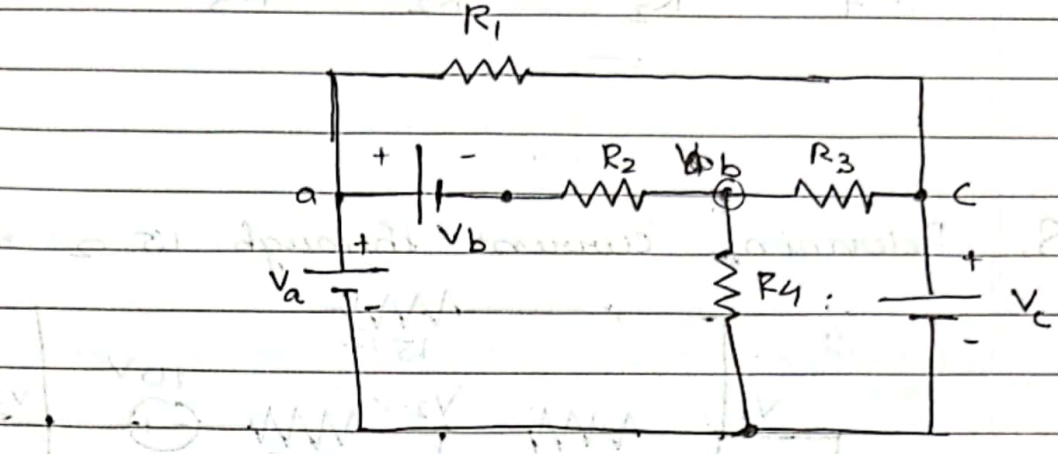
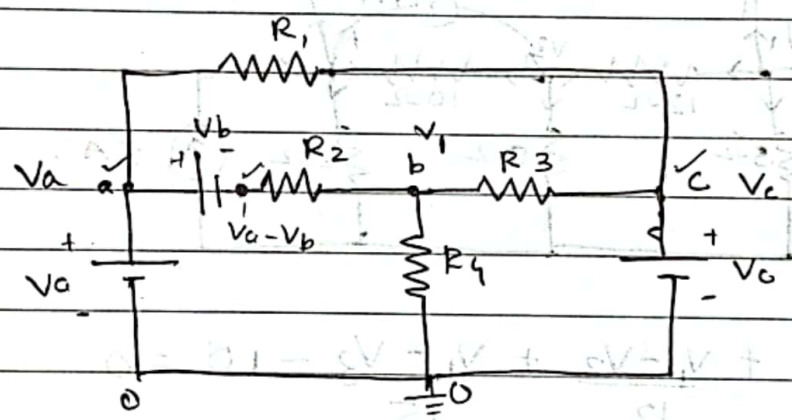
10/11 NODE VOLTAGE ANALYSIS



KCL

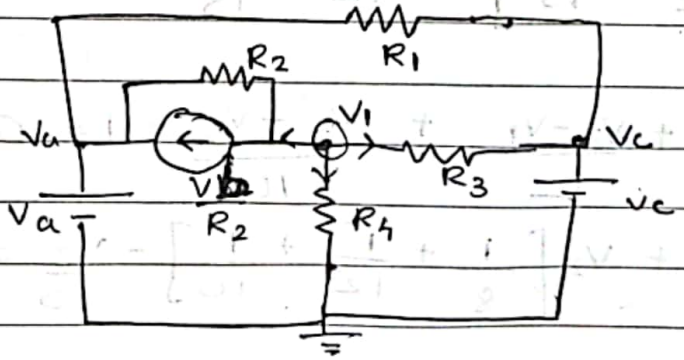
Algebraic sum of currents entering and leaving a node at any time must be zero.

NODE:- A point in an electric circuit where 2 or more elements are connected.



(Consider a node as reference)

Convert voltage sources into current sources and apply KCL (Other methods can be used too)



$$\frac{V_1 - 0}{R_4} + \frac{V_1 - V_a}{R_2} + \frac{V_b}{R_2} + \frac{V_1 - V_c}{R_3} = 0.$$

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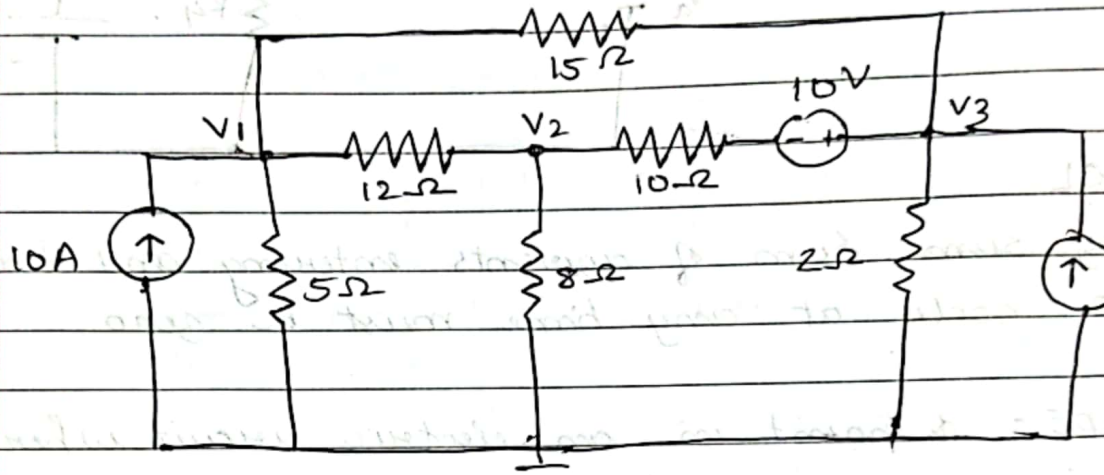
Q. Determine current through 15 Ω resistor.



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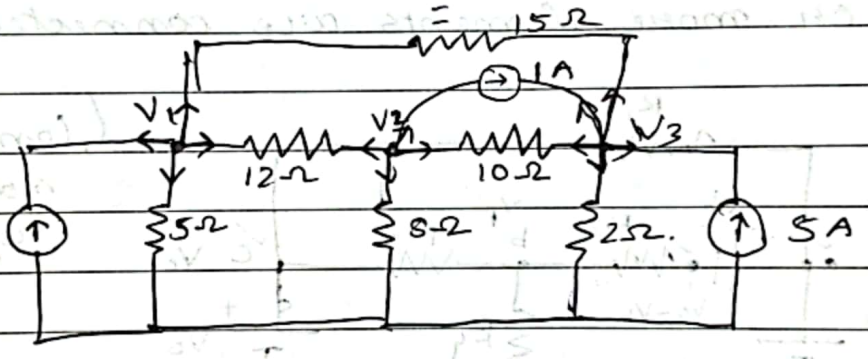
Ans.



$$\frac{V_1 - 0}{5} + \frac{V_1 - V_2}{12} + \frac{V_1 - V_3}{15} - 10 = 0.$$

$$V_1\left[\frac{1}{5} + \frac{1}{12} + \frac{1}{15}\right] - \frac{V_2}{12} - \frac{V_3}{15} = 0 \quad \text{— (1)}$$

$$\frac{V_2 - 0}{8} + \frac{V_2 - V_1}{12} + \frac{V_2 - V_3}{10} + 1 = 0.$$

$$\frac{-V_1}{12} + V_2\left[\frac{1}{8} + \frac{1}{12} + \frac{1}{10}\right] - \frac{V_3}{10} = -1 \quad \text{— (2)}$$

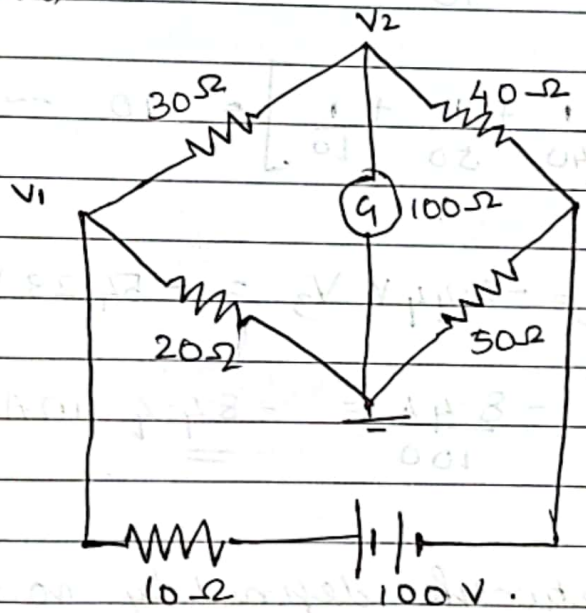
$$\frac{V_3 - 0}{2} + \frac{V_3 - V_2}{10} - 1 - 5 + \frac{V_3 - V_1}{15} = 0$$

$$-\frac{V_1}{15} - \frac{V_2}{10} + V_3\left[\frac{1}{2} + \frac{1}{10} + \frac{1}{15}\right] = 6 \quad \text{— (3)}$$

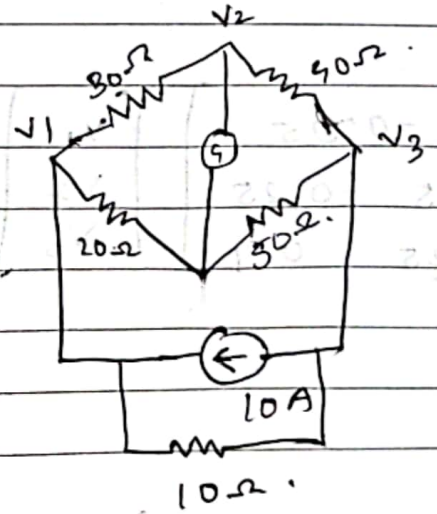
$V_1 = 33.69\ V \qquad V_2 = 10.38\ V \qquad V_3 = 13.93\ V$

$$I_{15} = \frac{V_1 - V_3}{15} = \frac{33.69 - 13.93}{15} = 1.32\ A$$

9. Determine the current through the galvanometer "G". Also write network equations using inspection method.



Ans.



$$\frac{V_1 - 0}{20} + \frac{V_1 - V_2}{30} + \frac{V_1 - V_3}{10} - 10 = 0.$$

$$V_1\left[\frac{1}{20} + \frac{1}{30} + \frac{1}{10}\right] - \frac{V_2}{30} - \frac{V_3}{10} = 10 \quad \text{---(1)}$$

$$\frac{V_2 - V_1}{30} + \frac{V_2 - 0}{100} + \frac{V_2 - V_3}{40} = 0$$

$$-\frac{V_1}{30} + V_2\left[\frac{1}{30} + \frac{1}{100} + \frac{1}{40}\right] - \frac{V_3}{40} = 0 \quad \text{---(2)}$$

$$\frac{V_3 - V_2}{40} + \frac{V_3 - 0}{50} + \frac{V_3 - V_1}{10} + 10 = 0$$

$$-\frac{V_1}{10} - \frac{V_2}{40} + V_3\left[\frac{1}{40} + \frac{1}{50} + \frac{1}{10}\right] = -10 \quad \text{---(3)}$$

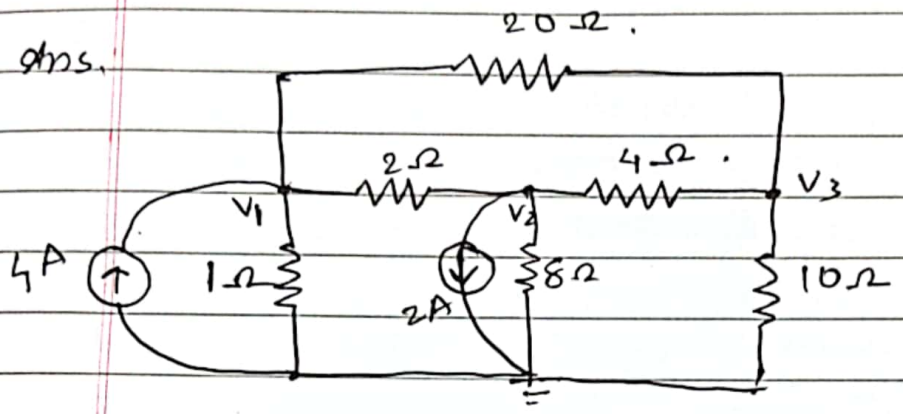
$V_1 = 23.4\,V \qquad V_2 = -8.44\,V \qquad V_3 = -54.28\,V$

$$I_{100} = \frac{V_2}{100} = \frac{-8.44}{100} = -84.4\ mA \text{ (upwards)}$$

Q. Realize the network defined by node voltage equation.

$$\begin{bmatrix} 1.55 & -0.5 & -0.05 \\ -0.5 & 0.875 & -0.25 \\ -0.05 & -0.25 & 0.4 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 4 \\ -2 \\ 0 \end{bmatrix}$$

Ans.



- $R_{12} = \frac{1}{0.5} = 2\Omega$.
- $R_{13} = \frac{1}{0.05} = 20$.
- $1.55 - 0.5 - 0.05 = G_1$

  $G_1 = 1$

  $\therefore R_1 = \frac{1}{G_1} = 1$
- $G_2 = 0.875 - 0.25 - 0.5 = 0.125$.

  $R_2 = \frac{1}{G_2} = \frac{1}{0.125} = 8\Omega$.
- $R_{23} = \frac{1}{0.25} = 4$
- $G_3 = 0.4 - 0.35 - 0.05 = 0.1$.

  $R_3 = \frac{1}{G_3} = \frac{1}{0.1} = 10\Omega$