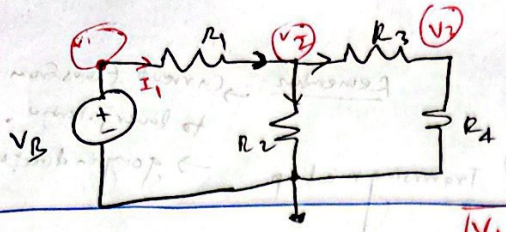
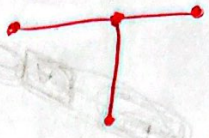
Q1





(N-1) = 3

$V_1 = V_B$ — (1)

(A)

$$\frac{V_1 - V_2}{R_1} = \frac{V_2}{R_2} + \frac{V_2 - V_3}{R_3} + \frac{V_3}{R_4}$$

$$\frac{V_1}{R_1} + V_2\left(\frac{1}{R_2} + \frac{1}{R_1}\right) + \left(\frac{V_3}{R_4}\right) \Rightarrow 0$$

$$\frac{V_1 - V_2}{R_1} = \frac{V_2}{R_2} + \frac{V_2 - V_3}{R_3}$$

$$\frac{V_1}{R_1} + V_2\left(-\frac{1}{R_1} - \frac{1}{R_2} - \frac{1}{R_3}\right) + \frac{V_3}{R_3} = 0 \quad — (2)$$

$$\frac{V_2 - V_3}{R_3} = \frac{V_3}{R_4}$$

$$\frac{V_2}{R_3} + V_3\left(-\frac{1}{R_3} - \frac{1}{R_4}\right) \Rightarrow 0 \quad — (3)$$

$AX = B$

$X = A^{-1}B$

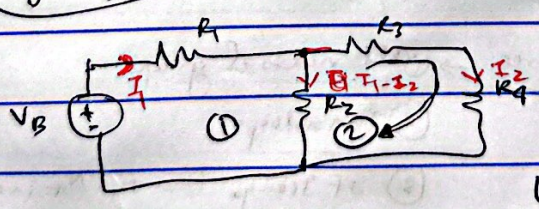
Voltage →

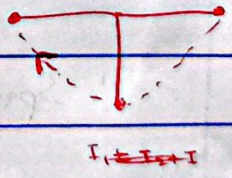
$$\begin{bmatrix} 1 & 0 & 0 \\ \frac{1}{R_1} & -\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) & \frac{1}{R_3} \\ 0 & \frac{1}{R_3} & -\left(\frac{1}{R_3}+\frac{1}{R_4}\right) \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} V_B \\ 0 \\ 0 \end{bmatrix}$$

Matlab / Octave

(B)

→ No grounding here





b-(n-1)

s-(4-1) → 3

Loop (1)

$$V_B - I_1R_1 - (I_1 - I_2)R_2 = 0$$

$$V_B = I_1(R_1 + R_2) - I_2R_2 \quad — (1)$$

#(2)

~~$-(I_1 - I_2)R_3$~~ Loop (1)

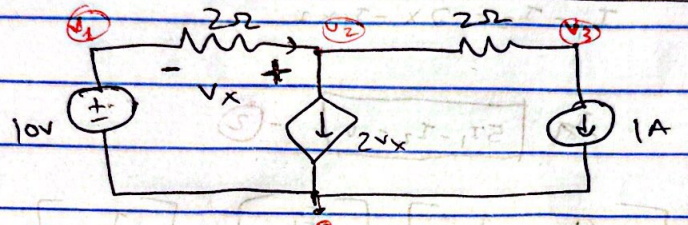
$$-I_2R_3 - I_2R_4 + (I_1 - I_2)R_2 = 0$$

$$I_1 R_2 + I_2(-R_2 - R_4 - R_3) = 0 \quad -(2)$$

Cramers ⇒

$$\begin{bmatrix} (R_1+R_2) & -R_2 \\ R_2 & -(R_2+R_3+R_4) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_B \\ 0 \end{bmatrix}$$

Q2.



Voltage ⇒

$$V_1 = 10V \quad -(1)$$

$V_x \Rightarrow (V_2 - 10)$

Node (2) :-

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

$$\frac{10 - V_2}{2} = 2(V_2 - 10) + \frac{V_2 - V_3}{2}$$

$$5 - \frac{V_2}{2} = 2V_2 - 20 + \frac{V_2}{2} - \frac{V_3}{2}$$

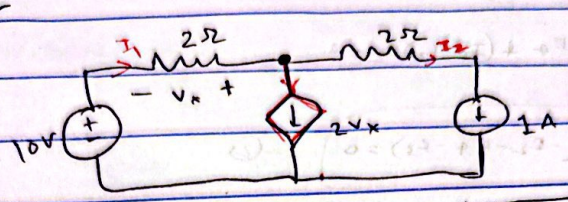
$$25 \Rightarrow 3V_2 - \frac{V_3}{2} \quad -(2)$$

Node (3) :- $\frac{V_2 - V_3}{2} = 1A$

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 3 & -\frac{1}{2} \\ 0 & \frac{1}{2} & -\frac{1}{2} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 25 \\ 1 \end{bmatrix}$$

$V_1 \Rightarrow 10$
$V_2 = 48/5$ $V_3 = 38/5$

Current :-



$I_2 = 1A$ — (1)

Using components laws wherever current sources are there.

$I_1 - I_2 = 2V_x$ — (2)

$V_x = -I_1 \times 2$

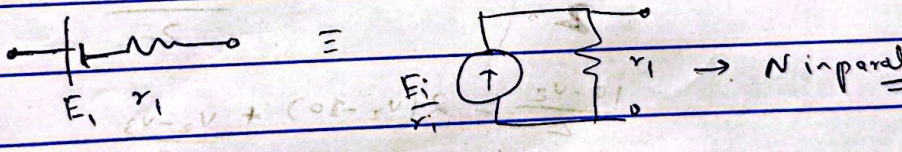
$I_1 - I_2 = 2x - I_1 \times 2$

$5I_1 - I_2 = 0$ — (2)

$$\begin{bmatrix} 0 & 1 \\ 5 & -1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$I_1 \Rightarrow \frac{1}{5} A$

Ans3.



effective current ⇒ $\sum_{i=1}^{N} \left(\frac{E_i}{r_i}\right)$ → eq^n resistance ⇒ $\frac{1}{\sum_{i=1}^{N} \frac{1}{r_i}}$

$V_{effective} \Rightarrow \sum_{i=1}^{N} \left(\frac{E_i}{r_i}\right) \times \frac{1}{\sum_{i=1}^{N} \frac{1}{r_i}}$