Ex. 1.1 : Using KCL, KVL find I_1, I_2 and r in the following circuit. (Fig. 1.9)

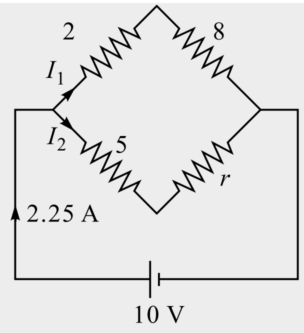


Fig. 1.9

Solution : From Fig. 1.9. Resistance 2   and 8   are in series with equivalent resistance 8 + 2 = 10   and 5   and r are in series with equivalent resistance of $(5 + r)$ ohms.

$$I_1 = \frac{10\text{ V}}{10}$$

$$\boxed{I_1 = 1\text{ A}}$$

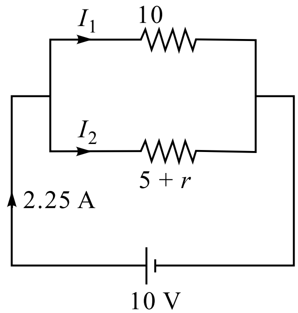


Fig. 1.9(a)

$$\text{But } I_1 + I_2 = 2.25 \quad \text{... (KCL)}$$

$$I_2 = 2.25 \quad 1$$

$$\boxed{I_2 = 1.25\text{ A}}$$

From the circuit

$$I_2 = \frac{10}{5 + r}$$

$$1.25 = \frac{10}{5 + r} \quad \text{or} \quad 5 + r = \frac{10}{1.25}$$

$$\boxed{r = 3}$$

Ex. 1.2 : Find I in Fig. 1.10.

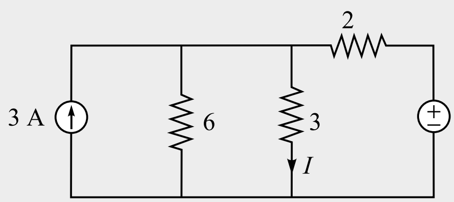


Fig. 1.10

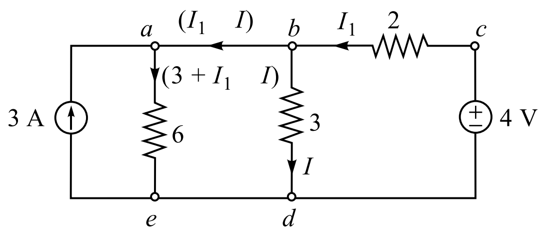


Fig. 1.10(a)

Solution : Assuming branch current and using KCL finding various other currents we will write KVL equations. As there are two variables I and I_1, we need two equations from the circuit in Fig. 1.10(a).

Apply KVL in *abdea*

$$3I \quad 6(3 + I_1 \quad I) = 0$$

$$9I \quad 6I_1 = 18 \qquad \text{.... (i)}$$

Apply KVL in *bdcb*

$$3I \quad 4 + 2I_1 = 0$$

$$3I + 2I_1 = 4 \qquad \text{.... (ii)}$$

Ex. 1.10 : Find I in Fig. 1.22.

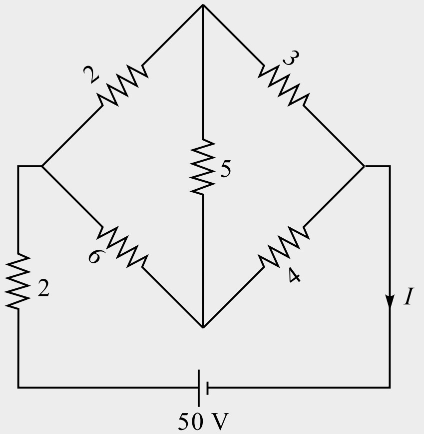


Fig. 1.22

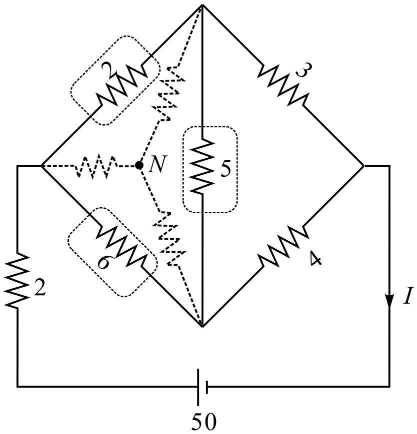


Fig. 1.22(a)

Solution : Follow the steps Fig. 1.22 (a) to (d)

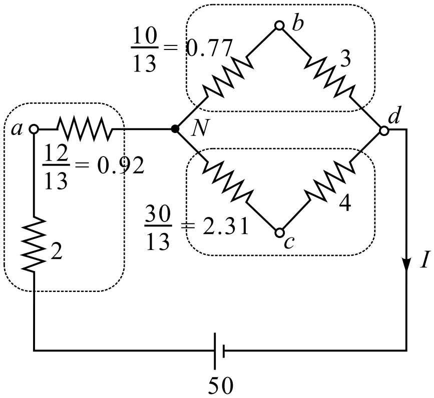


Fig. 1.22(b)

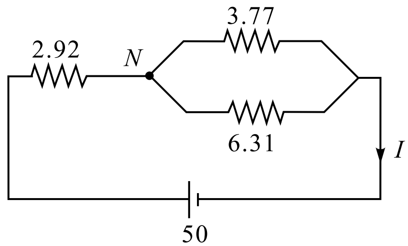


Fig. 1.22(c)

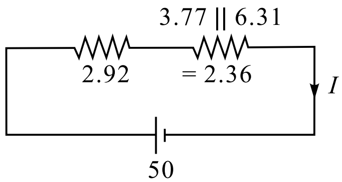


Fig. 1.22(d)

From Fig. 1.22(d), we get

$$I = \frac{50}{2.92 + 2.36} = \boxed{9.47\text{ A}}$$

Ex. 1.11 : Find R_{ab} in Fig. 1.23.

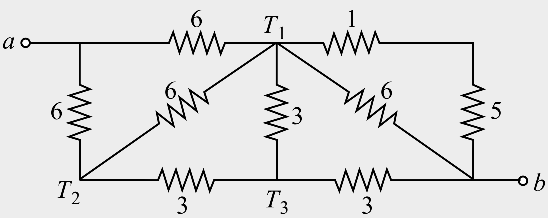


Fig. 1.23

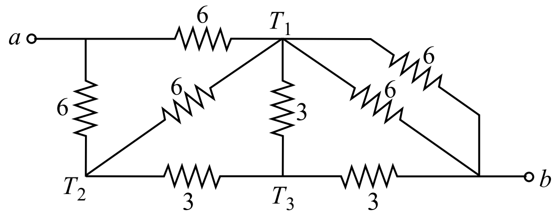
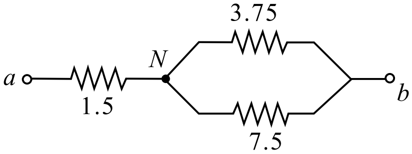
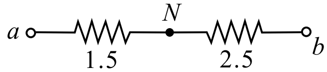


Fig. 1.23(a)





From Fig. 1.28(a) to (f)

$$R_{ab} = 1.5 + 2.5$$

$$\text{or } \boxed{R_{ab} = 4}$$

Ex. 1.17 : Find R_{ab} in Fig. 1.29.

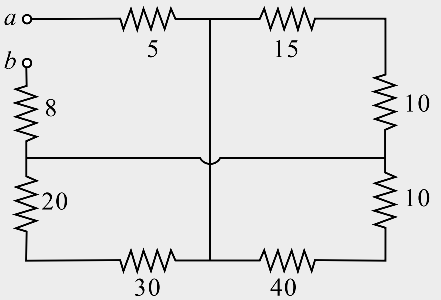


Fig. 1.29

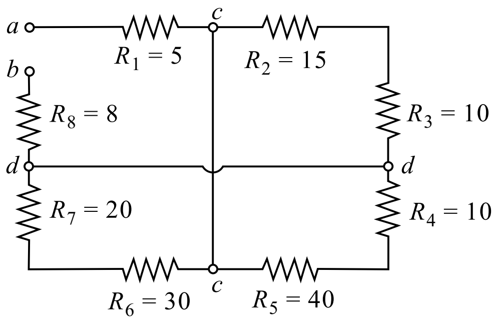


Fig. 1.29(a)

Solution : First label the junctions (remember junctions without any element between them are equipotential) as shown in Fig 1.29(a). Redraw as in Fig 1.29(b).

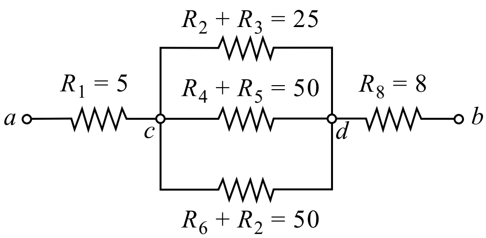


Fig. 1.29(b)

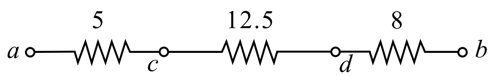


Fig. 1.29(c)

From Fig. 1.29(a), (b) and (c)

$$R_{ab} = 5 + 12.5 + 8$$

$$\text{or } \boxed{R_{ab} = 25.5}$$

Ex. 1.18 : Find R_{ab} by converting the outer delta to star in Fig. 1.30.

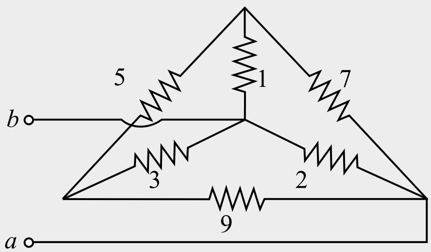


Fig. 1.30

Ex. 1.26 : Using mesh analysis find voltage across 3   resistance in Fig. 1.39.

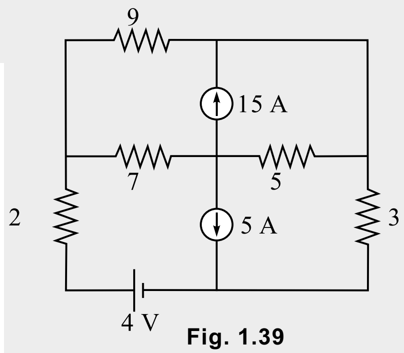


Fig. 1.39

Solution : KVL in super mesh I_1, I_2

$$9I_1 + 5(I_2 \quad I_4) + 7(I_1 \quad I_3) = 0$$

$$16I_1 + 5I_2 \quad 7I_3 \quad 5I_4 = 0 \quad .... \text{(i)}$$

$$\text{and } I_2 \quad I_1 = 15 \quad .... \text{(ii)}$$

KVL in super mesh I_3, I_4

$$7(I_3 \quad I_1) + 5(I_4 \quad I_2) + 3I_4 \quad 4 + 2I_3 = 0$$

$$7I_1 \quad 5I_2 + 9\,I_3 + 8I_4 = 4 \quad .... \text{(iii)}$$

$$\text{and } I_3 \quad I_4 = 5 \quad .... \text{(iv)}$$

$$V_3 = 3I_4 \text{ from Fig. 1.39(a)} \quad .... \text{(v)}$$

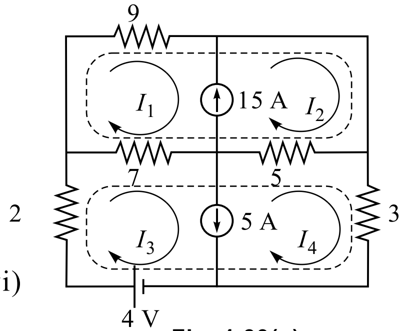


Fig. 1.39(a)

From equation (ii) $I_2 = I_1 + 15$

Substituting I_2 in equations (i) and (iii) we get

$$16I_1 + 5(I_1 + 15) \quad 7I_3 \quad 5I_4 = 0$$

$$21I_1 \quad 7I_3 \quad 5I_4 = \quad 75 \quad .... \text{(vi)}$$

$$\text{and} \quad 7I_1 \quad 5(I_1 + 15) + 9I_3 + 8I_4 = 4$$

$$12I_1 + 9I_3 + 8I_4 = 79 \quad .... \text{(vii)}$$

From equation (iv), (vi) and (vii)

$$\begin{bmatrix} 0 & 1 & 1 \\ 21 & 7 & 5 \\ 12 & 9 & 8 \end{bmatrix} \begin{bmatrix} I_1 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} 5 \\ 75 \\ 79 \end{bmatrix}$$

$$I_4 = 1.098$$

From equation (v)

$$V_3 = 3I_4$$

$$V_3 = \boxed{3.294 \text{ volts}}$$

1.8 Nodal Analysis

The nodal analysis is based on Kirchhoff's Current Law (KCL) unlike the mesh analysis which was based on KVL.

For application of this method follow the following steps:

Step 1: Identify junctions or nodes (here terminal where more than 2 elements are connected together is called a *node*). Be careful that "nodes which do not have any element connected between them are considered as one node."

Step 2: Consider any one node (normally the lowest where all the elements or branches are connected) as the reference or datum node.