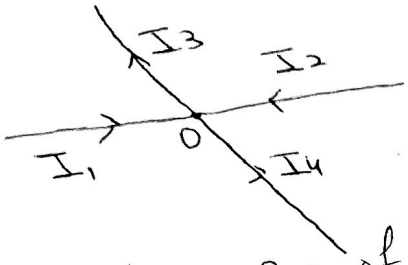
Kirchoff's Law:-

In 1847, a German Physicist, Kirchoff, formulated two fundamental laws of electricity. These laws are:-

i):- Kirchoff's current Law (KCL):-



The algebraic sum of all the current meeting at a junction point are ~~assumed~~ is always zero.

$$\sum I \text{ at junction point} = 0$$

or

"The total current flowing towards a junction point is equal to the total current flowing away from the junction point".

Sign convention:-

currents flowing towards a junction is assumed to be +ve while currents flowing away from a junction point is assumed to be negative.

Consider the above junction Point (O). At this junction point. Suppose $I_1 = 2A$, $I_2 = 4A$ and $I_3 = 1A$ and if we want to determine I_4 then applying KCL at O:-

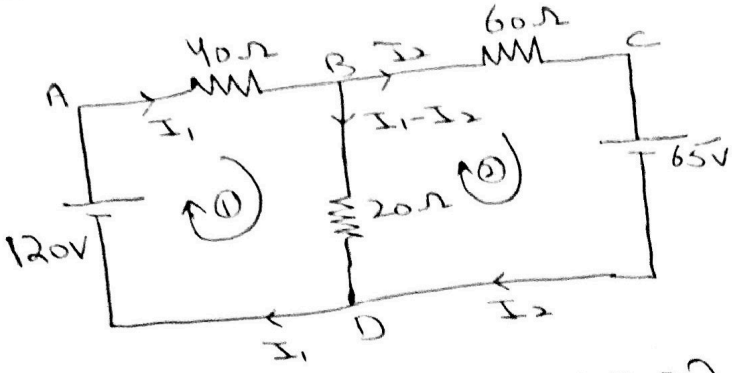
$$I_1 + I_2 - I_3 - I_4 = 0$$

$$I_4 = I_1 + I_2 - I_3$$

$$I_4 = 2 + 4 - 1 = \boxed{5A}$$

Example 1:-

In the network shown below, Find the magnitude of current by KVL & KCL (mesh current method).



Applying KVL on mesh ABDA,

$$120 - 40I_1 - 20(I_1 - I_2) = 0$$
$$120 - 40I_1 - 20I_1 + 20I_2 = 0$$
$$120 = 60I_1 - 20I_2 \quad \text{—— ①}$$

Applying KVL on mesh BCDB:-

$$-60I_2 - 65 + 20(I_1 - I_2) = 0$$
$$-60I_2 - 65 + 20I_1 - 20I_2 = 0$$
$$-80I_2 - 65 + 20I_1 = 0$$
$$-65 = -20I_1 + 80I_2 \quad \text{—— ②}$$

Solving eqn ① & ② by determinant method:-

$$\text{determinant} = \begin{vmatrix} 60 & -20 \\ -20 & 80 \end{vmatrix}$$
$$= 4800 - 400 = \boxed{4400}$$

$$I_1 = \frac{\begin{vmatrix} 120 & -20 \\ -65 & 80 \end{vmatrix}}{4400} = \frac{(120)(80) - (-65)(-20)}{4400}$$

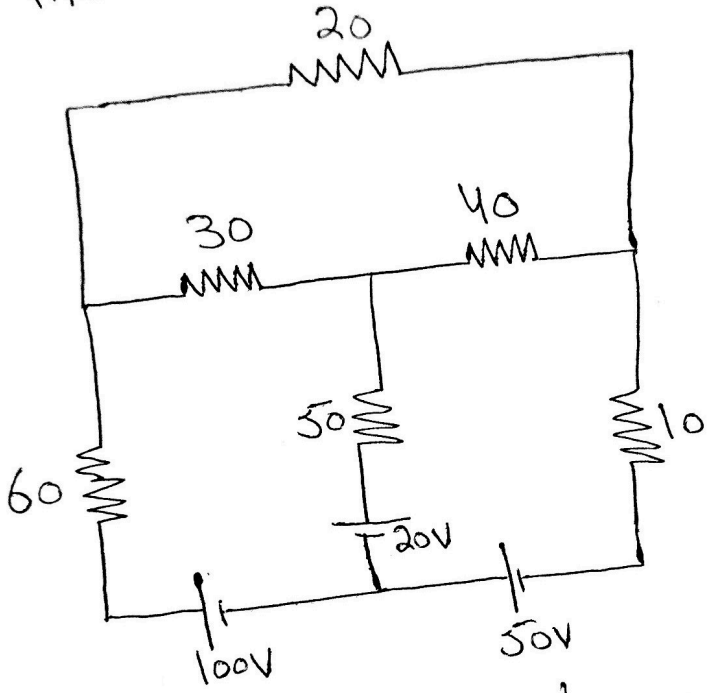
$$\boxed{I_1 = 1.886A}$$

$$I_2 = \frac{\begin{vmatrix} 60 & 120 \\ -20 & -65 \end{vmatrix}}{4400} = \frac{(60)(-65) - (-20)(120)}{4400}$$

$$I_2 = \frac{-1500}{4400} = \boxed{-0.341A}$$

Example 2:-

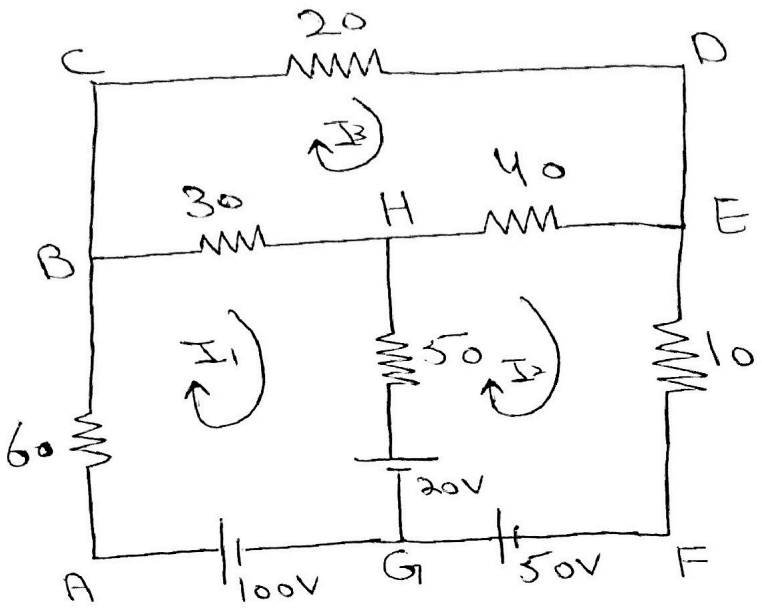
calculate the currents in each branch of the ckt shown below:-



(Solved on next page).

Example 2:-

Calculate the current in each mesh of the ckt shown below:-



Soln:- mesh ABHGA:-

Applying KVL, we have:-

$$-60I_1 - 30(I_1 - I_3) - 50(I_1 - I_2) - 20 + 100 = 0$$

$$140I_1 - 50I_2 - 30I_3 = 80$$

dividing by 10:-

$$14I_1 - 5I_2 - 3I_3 = 8 \quad \text{— (1)}$$

mesh GHEFG:-

Applying KVL, we have,

$$20 - 50(I_2 - I_1) - 40(I_2 - I_3) - 10I_2 + 50 = 0$$

$$-50I_1 + 100I_2 - 40I_3 = 70 \quad \text{— (2)}$$

$$-5I_1 + 10I_2 - 4I_3 = 7$$

Mesh BCDEHB:-

Applying KVL, we have:-

$$-20I_3 - 40(I_3 - I_2) - 30(I_3 - I_1) = 0$$

$$30I_1 + 40I_2 - 90I_3 = 0$$

$$3I_1 + 4I_2 - 9I_3 = 0$$

By determinant method:-

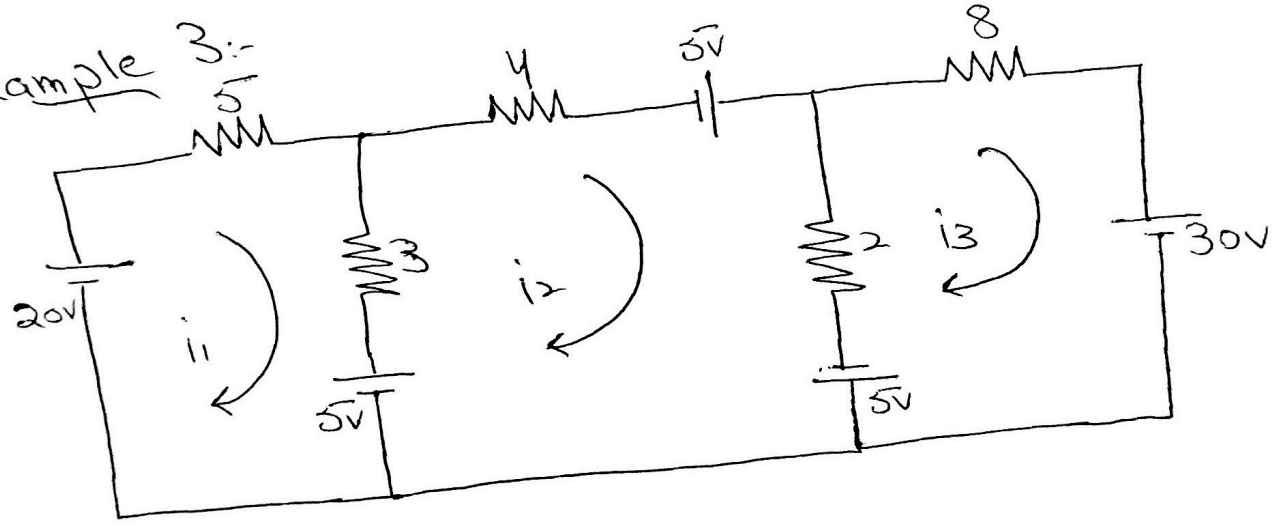
$$14I_1 - 5I_2 - 3I_3 = 8$$

$$-5I_1 + 10I_2 - 4I_3 = 7$$

$$3I_1 + 4I_2 - 9I_3 = 0$$

$$\Rightarrow \quad I_1 = 1.65\text{A}, \quad I_2 = 2.12\text{A}, \quad I_3 = 1.5\text{A}.$$

Example 3:-



$$20 - 5I_1 - 3(I_1 - I_2) - 5 = 0$$

$$20 - 5I_1 - 3I_1 + 3I_2 - 5 = 0$$

$$-8I_1 + 3I_2 + 15 = 0 \quad \text{— (1)}$$

on 2nd mesh:-

$$-4I_2 + 5 - 2(I_2 - I_3) + 5 + 5 - 3(I_2 - I_1) = 0$$

$$-4I_2 + 15 - 2I_2 + 2I_3 - 3I_2 + 3I_1 = 0$$

$$3I_1 - 9I_2 + 2I_3 + 15 = 0$$

(P.T.O)

KVL on 3rd mesh:-

$$-5-2(I_3-I_2)-8I_3-30=0$$

$$-5-2I_3+2I_2-8I_3-30=0$$

$$+2I_2-10I_3-35=0$$

$$\Rightarrow \quad -8I_1+3I_2+0I_3=-15 \quad \text{—— (1)}$$

$$3I_1-9I_2+2I_3=-15 \quad \text{— (2)}$$

$$0I_1+2I_2-10I_3=35 \quad \text{— (3)}$$

$$\boxed{I_1=2.56A}$$

$$\boxed{I_2=1.82A}$$

$$\boxed{I_3=-3.13A}$$