Ch 4:-

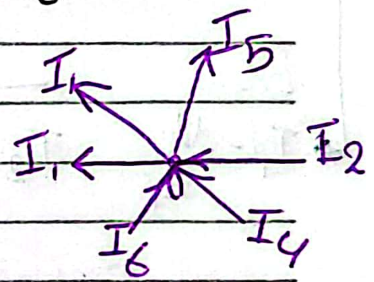
Dc circuit Analysis

1] Kirchhoff's current law:-

→ The algebraic sum of the currents leaving a closed surface is zero $I_1 + I_3 + I_5 = 0$

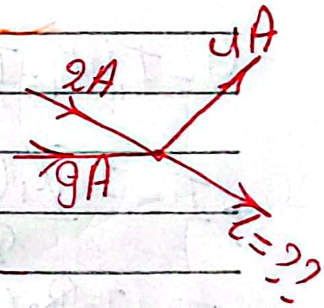
→ The algebraic sum of the currents entering a closed surface is zero $I_2 + I_4 + I_6 = 0$

→ The algebraic sum of the currents entering a closed surface equals the algebraic sum of those leaving $I_1 + I_3 + I_5 = I_2 + I_4 + I_6$



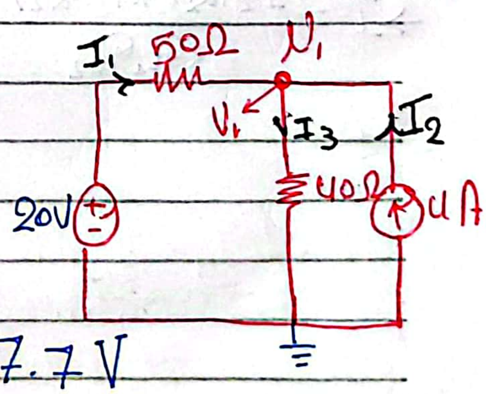
EX:-

$2 + 9 = 4 + i$ $\therefore i = 7A$



Ex2:-

$I_1 = \frac{(20 - V_1)}{50}$, $I_2 = 4A$, $I_3 = \frac{V_1 - 0}{40}$

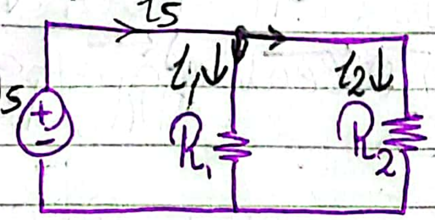


$N_1 \Rightarrow I_1 + I_2 = I_3$

$\frac{20 - V_1}{50} + 4 = \frac{V_1}{40}$ $\therefore V_1 = 97.7V$

$\therefore I_1 = -1.54A$, $I_3 = 2.42A$

2 Current Division (التوازي)



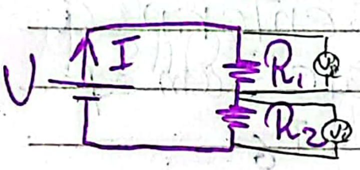
$$I_1 = I_S \frac{R_2}{R_1+R_2}$$ → المقاومة البعيدة

R_1+R_2 → مجموع المقاومتين

$$I_2 = I_S \frac{R_1}{R_1+R_2}$$

I_S → التيار الكلى

→ Voltage divider law :- *التوالى*



$$V_1 = V * \frac{R_1}{R_1+R_2}$$

$$V_2 = V * \frac{R_2}{R_1+R_2}$$

$$V_x = V \frac{R_x}{R_t}$$

→ $I_1 = \frac{V}{R_1}$, $I_2 = \frac{V}{R_2}$

$$R_t = \frac{R_1 * R_2}{R_1+R_2}$$

$$\therefore I = \frac{V(R_1+R_2)}{R_1 * R_2}$$

$V = I_1 R_1 = I_2 R_2$

$$\cancel{I = \frac{VR_1 + VR_2}{R_1 * R_2}}$$

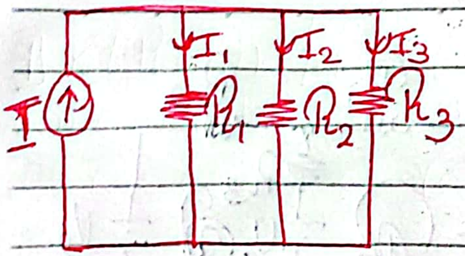
$$\rightarrow I = \frac{I_1 \cancel{R_1}(R_1+R_2)}{\cancel{R_1} R_2} = \frac{I_1(R_1+R_2)}{R_2}$$ #

$$\rightarrow I = \frac{I_2 R_2 (R_1+R_2)}{R_1 R_2}$$

$$\therefore I_1 = \frac{I R_2}{(R_1+R_2)}$$

$$\therefore I_2 = \frac{I R_1}{(R_1+R_2)}$$

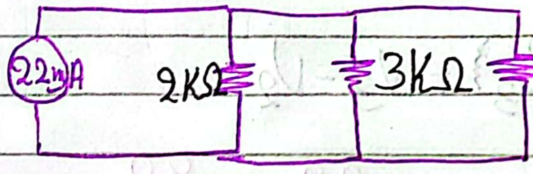
#



$$I_1 = I\,\frac{R_2//R_3}{(R_2//R_3)+R_1}$$

$$I_2 = I\,\frac{R_3//R_1}{(R_3//R_1)+R_2}$$

$$I_3 = I\,\frac{R_2//R_1}{(R_2//R_1)+R_3}$$



~~$I_1 \neq I$~~

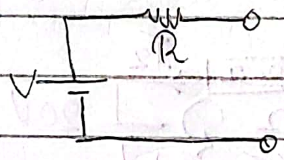
$(R_1//R_2) = \frac{2*3}{2+3} = 1.2$, $R_2//R_3 = \frac{6*3}{6+3} = 2$, $R_3//R_1 = \frac{6*2}{2+6} = 3/2$

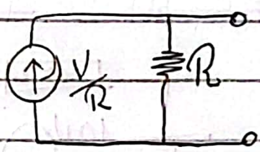
$I_1 = I\,\frac{(3//6)}{(3//6)+R_2} = 22*\frac{2}{2+2} = 11mA$ $I_2 = 22*\frac{3/2}{3/2+3} = 7.3\,mA$

$I_3 = \frac{1.2}{1.2+6}*22 = 3.67\,mA$

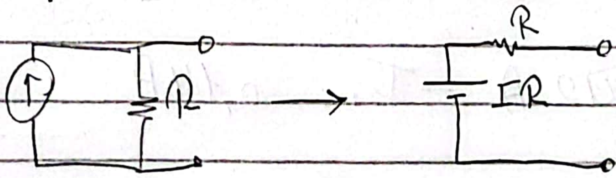
3] SOURCE TRANSformations.

shows the Transformation from a voltage source To an equivalent current source

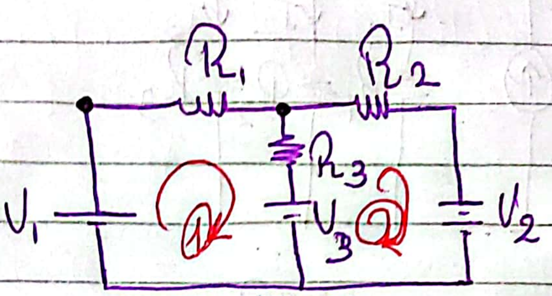




8 the Transformation from a current source To an equivalent ~~current~~ voltage source.



4) Mesh analysis.



Mesh(1):-

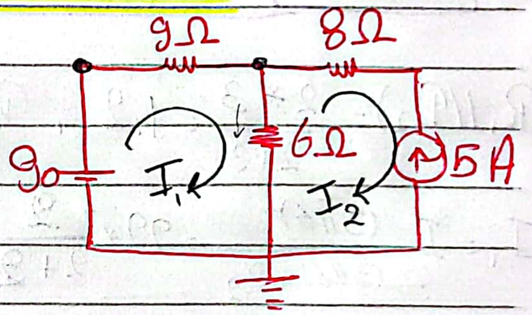
$\sum IR = \sum V$

$R_1 I_1 + (I_1 - I_2) R_2 = V_1 - V_3$

Mesh(2):-

$R_2 I_2 + (I_2 - I_1) R_3 = V_3 - V_2$

Ex:-



Mesh(1)

$9I_1 + 6(I_1 - I_2) = 90$

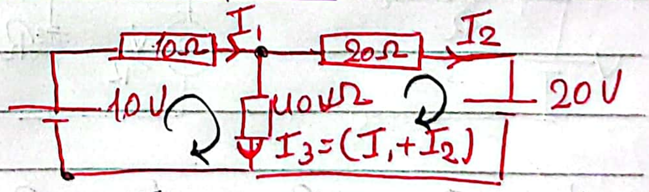
$90 - 9I_1 - 6(I_1 - I_2) = 0$

$90 - 9I_1 - 6I_1 + 6I_2 = 0$

$-15I_1 + 6I_2 = -90 \quad \therefore I_1 = 4A$

$5 \leftarrow$

EX



$\rightarrow 10 - 10I_1 - I_3\,40 = 0$

$10 - 10I_1 - I_1\,40 - 40I_2 \Rightarrow 10 = 50I_1 - 40I_2$

$\rightarrow -20I_2 - 20 - 40I_3 = 0 \quad -20 = -40I_1 + 60I_2$

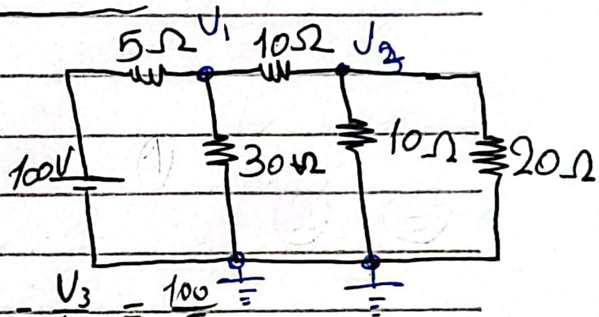
$\therefore I_2 = -0{,}42\ A \quad \therefore I_1 = -0{,}14\ A$

5] Nodal analysis:-

This method is also known as the node voltage method since the node voltage are with respect to the ground the following are the three laws that define the equation related to the voltage that is measured between each circuit node:-

- ohm's law
- kirchhoff's Voltage
- kirchhoff's current

Ex:- $\frac{V_1}{5} - \frac{100}{5}$



loop(1)

$$\frac{V_1-100}{5}+\frac{V_1}{30}+\frac{V_1-V_3}{10}=0$$

$$\rightarrow \left(\frac{1}{5}+\frac{1}{30}+\frac{1}{10}\right)V_1 - \frac{V_3}{10} = \frac{100}{5}$$

loop(2)

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

$$\frac{V_3}{10}-\frac{V_1}{10}+\frac{V_3}{10}+\frac{V_3}{20} = \left(\frac{1}{10}+\frac{1}{10}+\frac{1}{20}\right)V_3 - \frac{V_1}{10} = 0$$

$$\rightarrow \frac{1}{3}V_1 - \frac{1}{10}V_3 = 20$$

$$\rightarrow -\frac{1}{10}V_1 + \frac{1}{4}V_3 = 0$$

$$\therefore V_1 = 68.18\ V$$

$$V_3 = 27.2\ V$$