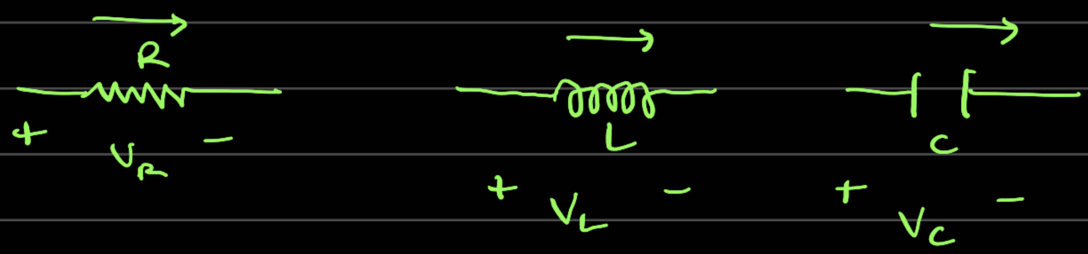
Day - 1

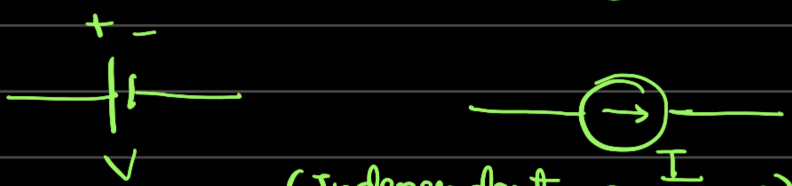
→ 3 basic elements : R, L, C

→ 2 sources : Voltage, Current

→ Discussion :

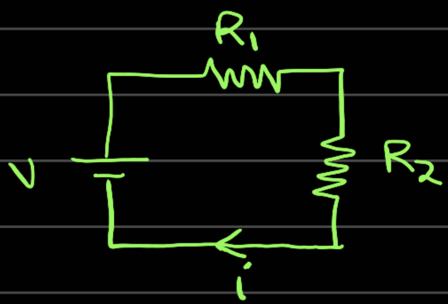


$V_R = i_R R$ $\qquad$ $V_L = L\dfrac{di_L}{dt}$ $\qquad$ $i_c = C\dfrac{dV_c}{dt}$



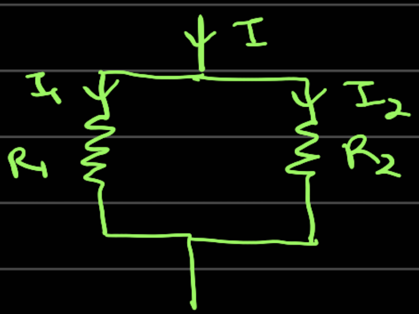
(Independent sources)

- Familiar stuff :



Series:

$$i = \frac{V}{R_1 + R_2}$$



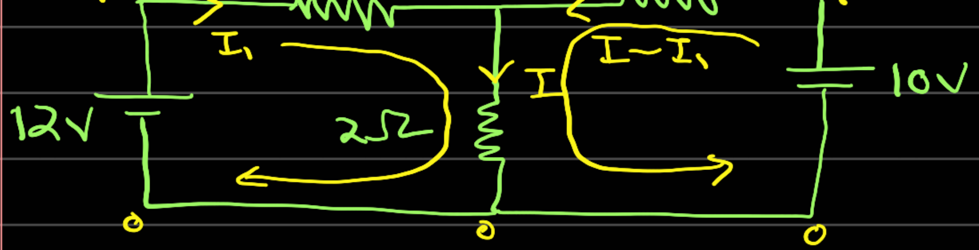
Parallel:

$$I_1 = \frac{R_2}{R_1 + R_2} I$$

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

1)

I.)



$$12 - 2I_1 - 2I = 0 \quad \text{———} \quad (1)$$

$$10 - 2(I - I_1) - 2I = 0 \quad \text{———} \quad (2)$$

From (1) and (2),

$$12 - 2I_1 = 10 - 2(I - I_1)$$

$$\Rightarrow 2 = 2(2I_1 - I)$$

$$\Rightarrow I = 2I_1 - 1$$

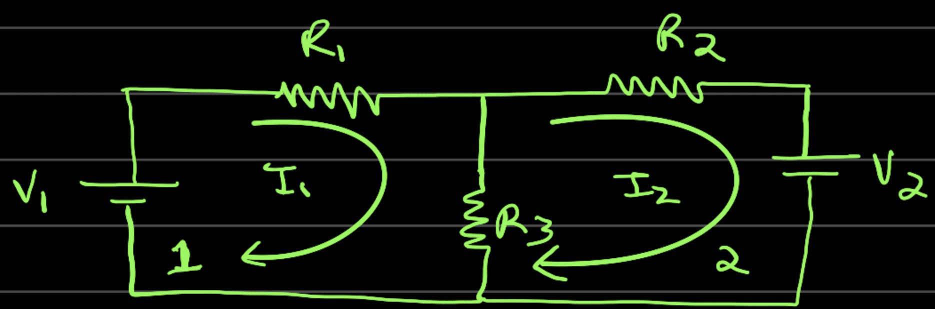
$$\therefore 12 = 2(I_1 + I)$$

$$\Rightarrow 6 = I_1 + 2I_1 - 1$$

$$\Rightarrow I_1 = 7/3$$

$$\therefore I = 2I_1 - 1 = \frac{14}{3} - 1 = \frac{11}{3}\,A$$

- make it general:



KVL at Loop I:

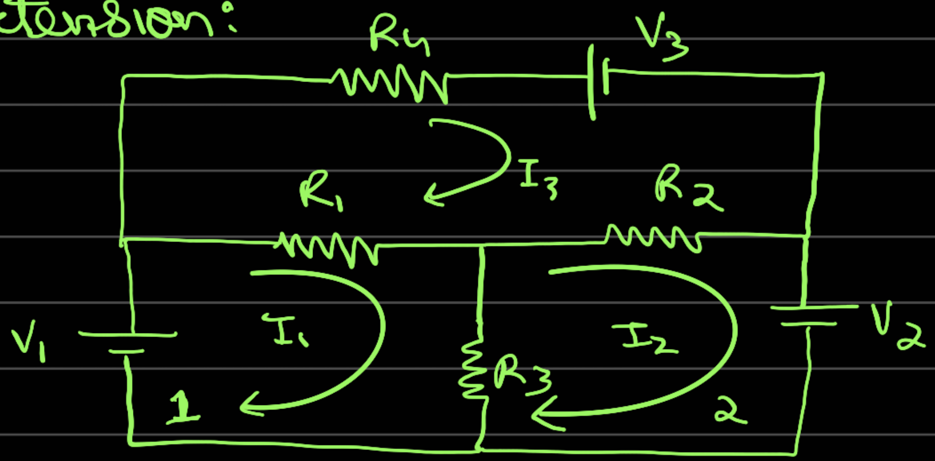
$$+V_1 - I_1 R_1 - (I_1 - I_2) R_3 = 0$$

KVL at Loop 2:

$$+V_2 + I_2R_2 - (I_1 - I_2)R_3 = 0$$

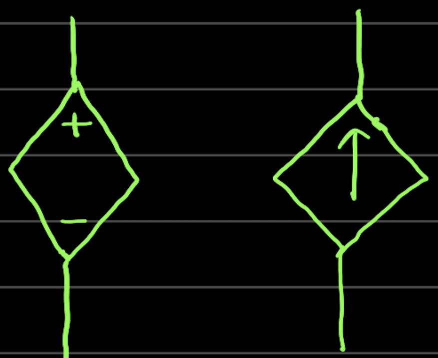
$$\begin{bmatrix} V_1 \\ -V_2 \end{bmatrix} = \begin{bmatrix} R_1 + R_3 & -R_3 \\ -R_3 & R_2 + R_3 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

→ Extension:



$$\begin{bmatrix} V_1 \\ -V_2 \\ -V_3 \end{bmatrix} = \begin{bmatrix} R_1+R_3 & -R_3 & -R_1 \\ -R_3 & R_2+R_3 & -R_2 \\ -R_1 & -R_2 & R_1+R_2+R_4 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

- Dependent sources:



V.S C.S.

$V_\alpha = f(i_x) \longrightarrow$ C.C.V.S

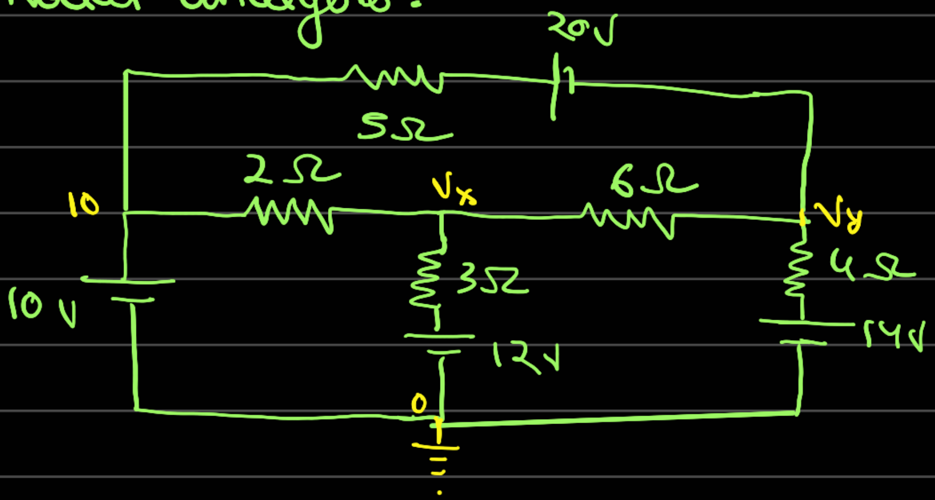
$f(V_x) \longrightarrow$ V.C.V.S

$i_\alpha = f(i_x) \longrightarrow$ C.C.C.S

$f(V_x) \longrightarrow$ V.C.C.S

All we did till now was mesh analysis.

→ Nodal analysis:



$$\frac{V_x - 10}{2} + \frac{V_x - V_y}{6} + \frac{V_x - 12}{3} = 0$$

(KCL @ V_x)

$$\Rightarrow V_x - \frac{V_y}{6} = 9$$

KCL @ V_y

$$\frac{20 + V_y - 10}{5} + \frac{V_x - V_y}{6} + \frac{V_y - 14}{4} = 0$$

$$\Rightarrow \frac{V_x}{6} + \frac{17V_y}{60} = \frac{1}{2}$$

51+5

$$\Rightarrow V_x + \frac{17V_y}{10} = 3$$

$$\therefore \frac{(51+5)}{30} V_y = -6$$

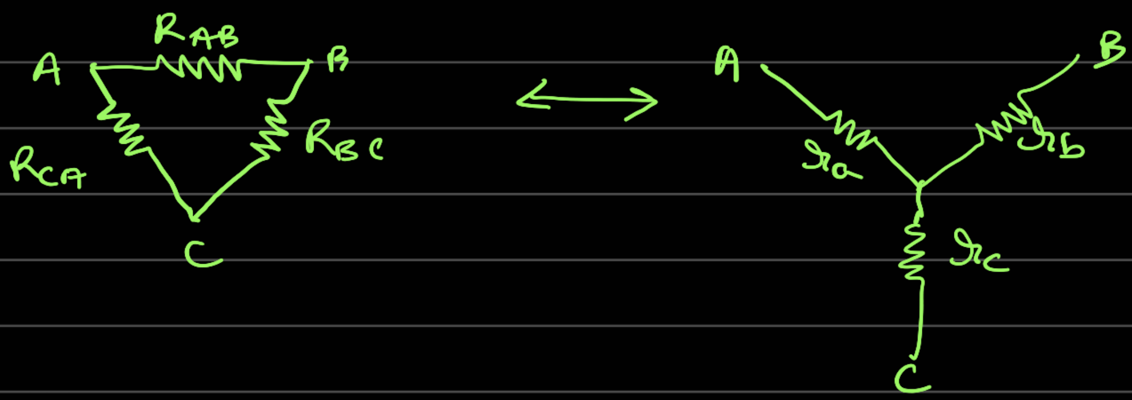
$$\Rightarrow V_y = -\frac{30 \times 6}{56} = \frac{-45}{14}$$

$$V_x = 9 - \frac{45}{6 \times 14}$$

$$= 9 - \frac{15}{28}$$

$$= 237/28$$

→ $\star - \delta$ conversion :



$$r_a = \frac{R_{AB} R_{CA}}{\Sigma R}$$

$$r_B = \frac{R_{AB} R_{BC}}{\Sigma R}$$

$$r_c = \frac{R_{CA} R_{BC}}{\Sigma R}$$

→ Thevenin and norton's Theorem :-