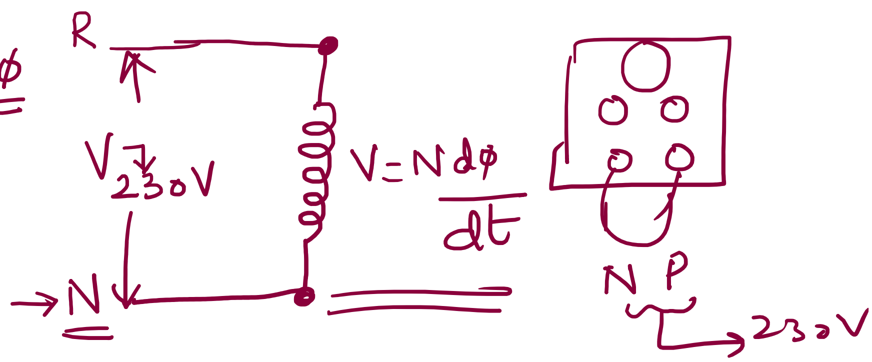
Topics

1. **Star-Delta transformation**
2. **Mesh Analysis**

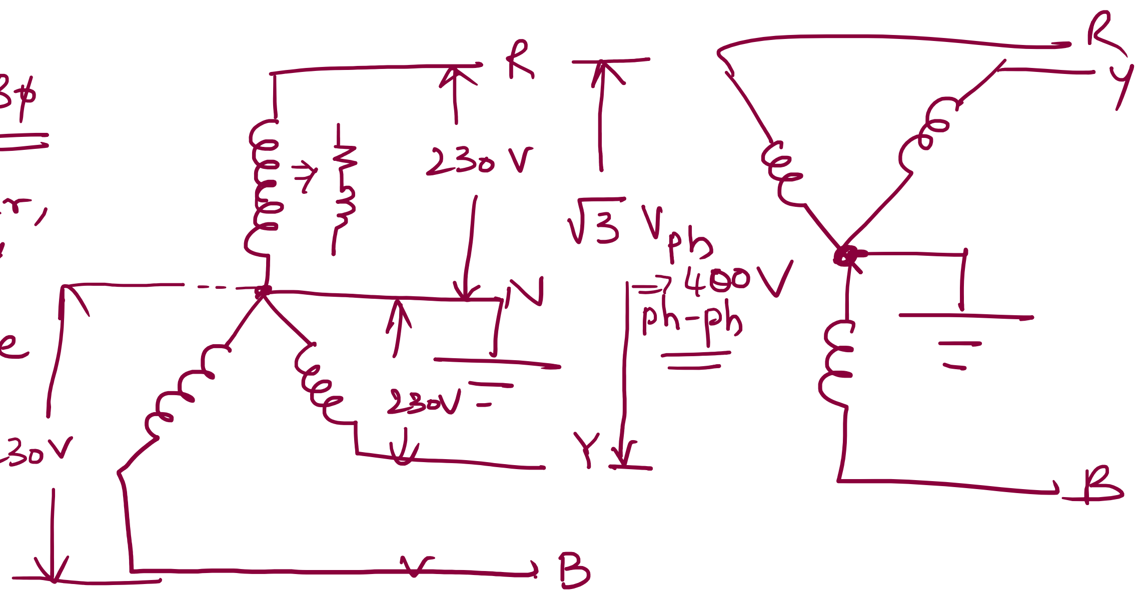
1ϕ ; 1-phase, 2ϕ, 3ϕ — A, R; B, Y; C, B; N

1ϕ



3ϕ

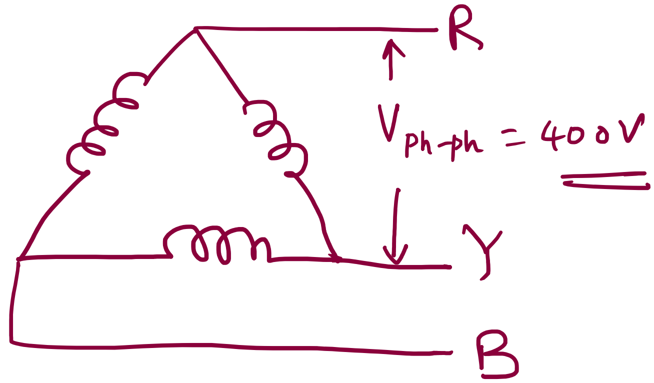
Star, Y, Wye



3ϕ

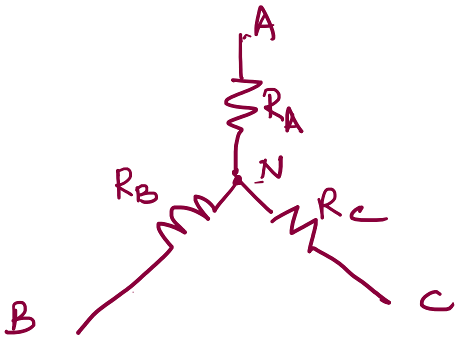
Delta

Δ



Star - Delta transformation

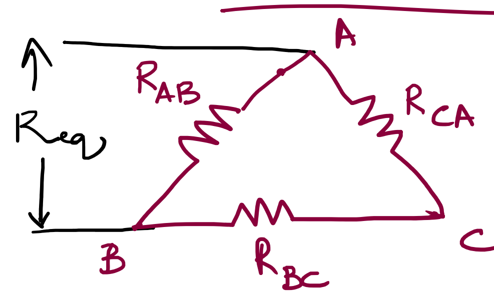
Y - connection



Megger

Ω

Delta connection



$R_{AB} = R_A + R_B$

$R_{BC} = R_B + R_C$

$R_{CA} = R_A + R_C$

Resistance b/w A & B $= R_{AB} \parallel^{el} (R_{BC} + R_{CA})$

$$= \frac{R_{AB}(R_{BC}+R_{CA})}{R_{AB}+R_{BC}+R_{CA}}$$

Resistance b/w B & C $= \dfrac{R_{BC}(R_{AB}+R_{CA})}{R_{AB}+R_{BC}+R_{CA}}$

Resistance b/w CA $= \dfrac{R_{CA}(R_{AB}+R_{BC})}{R_{AB}+R_{BC}+R_{CA}}$

$$R_A + R_B = \frac{R_{AB}(R_{CA}+R_{BC})}{R_{AB}+R_{BC}+R_{CA}} \quad \text{—— (1)}$$

$$R_B + R_C = \frac{R_{BC}(R_{AB}+R_{CA})}{R_{AB}+R_{BC}+R_{CA}} \quad \text{—— (2)}$$

$$R_C + R_A = \frac{R_{CA}(R_{AB}+R_{BC})}{R_{AB}+R_{BC}+R_{CA}} \quad \text{—— (3)}$$

✓

Delta to Star transformation

$R_A \rightarrow (1) + (3) - (2)$; $R_B \rightarrow (1) + (2) - (3)$; $R_C \rightarrow (2) + (3) - (1)$

$R_A \rightarrow (1) + (3) - (2)\ ,\ R_B$

$$R_A + \cancel{R_B} = \frac{R_{AB}\,(R_{CA} + \cancel{R_{BC}})}{R_{AB} + R_{BC} + R_{CA}} \quad \text{— } (1)$$

$$R_A + \cancel{R_C} = \frac{R_{AC}\,(R_{AB} + \cancel{R_{BC}})}{R_{AB} + R_{CA} + R_{BC}} \quad \text{— } (3)$$

$$-\cancel{R_B} - \cancel{R_C} = \frac{-\cancel{R_{BC}}\,(\cancel{R_{AB}} + \cancel{R_{CA}})}{R_{AB} + R_{BC} + R_{CA}} \quad \text{— } (2)$$

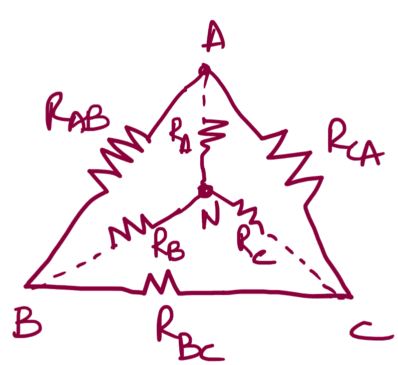
$$\cancel{2}\, R_A = \frac{\cancel{2}\, R_{AB} R_{CA}}{(R_{AB} + R_{BC} + R_{CA})}$$

Delta

↓

Star

$$\boxed{\begin{aligned} R_A &= \frac{R_{AB}\,R_{CA}}{(R_{AB} + R_{BC} + R_{CA})} \rightarrow (4) \\[2ex] R_B &= \frac{R_{BC}\,R_{AB}}{(R_{AB} + R_{BC} + R_{CA})} \rightarrow (5) \\[2ex] R_C &= \frac{R_{CA}\,R_{BC}}{(R_{AB} + R_{BC} + R_{CA})} \rightarrow (6) \end{aligned}}$$



STAR TO DELTA

$4 \times 5 + 5 \times 6 + 4 \times 6$

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_{AB}^2 \cdot R_{CA} R_{BC} + R_{AB} R_{BC}^2 \cdot R_{CA} + R_{AB} R_{BC} R_{CA}^{2}}{(R_{AB} + R_{BC} + R_{CA})^2}$$

$$= \frac{R_{AB} R_{BC} R_{CA} \left[R_{AB} + \cancel{R_{BC}} + R_{CA} \right]}{(R_{AB} + R_{BC} + \cancel{R_{CA}})^{\cancel{2}}}$$

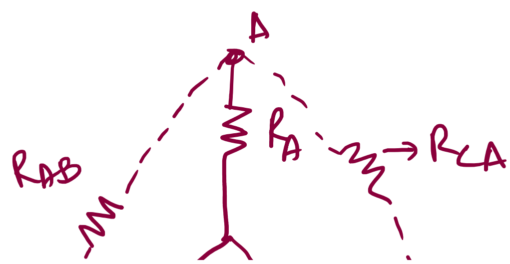
$$R_A R_B + R_B R_C + R_C R_A = \frac{R_{AB} R_{BC} R_{CA}}{(R_{AB} + R_{BC} + R_{CA})} \rightarrow (7)$$

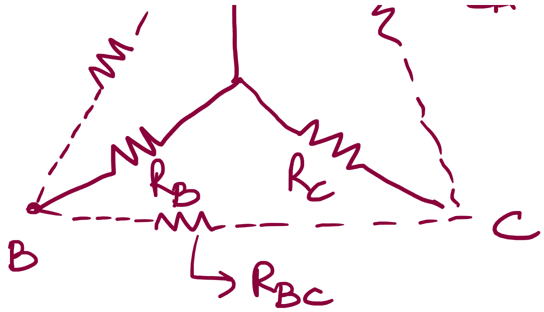
$$\frac{(7)}{R_A} \quad (\text{i.e; eq } (4)) \; ; \quad \frac{R_A R_B + R_B R_C + R_C R_A}{R_A} = \frac{\dfrac{\cancel{R_{AB}} R_{BC} \cancel{R_{CA}}}{(R_{AB} \cancel{+ R_{BC}} + R_{CA})}}{\dfrac{\cancel{R_{AB}} \cancel{R_{CA}}}{(R_{AB} \cancel{+ R_{BC}} + R_{CA})}}$$

$$R_{BC} = \frac{(R_A R_B + R_B R_C + R_C R_A)}{R_A}$$

$$R_{AB} = \frac{(R_A R_B + R_B R_C + R_A R_C)}{R_C}$$

$$R_{CA} = \frac{(R_A R_B + R_B R_C + R_A R_C)}{R_B}$$

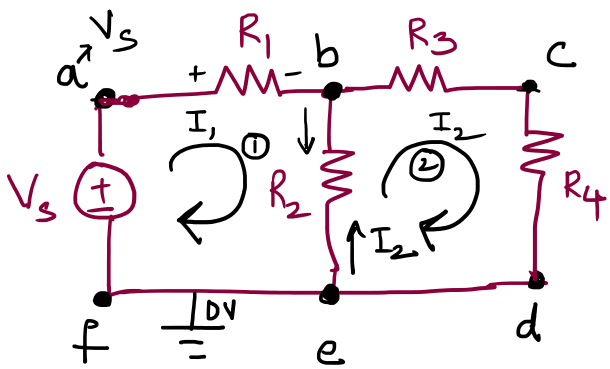




(II) MESH ANALYSIS OF DC CIRCUITS

NODE "

Mesh	Node
→ More Voltage sources	→ More Current sources
→ KVL	→ KCL



Node → 04 nodes → 4 Voltages appear

Branches → 5

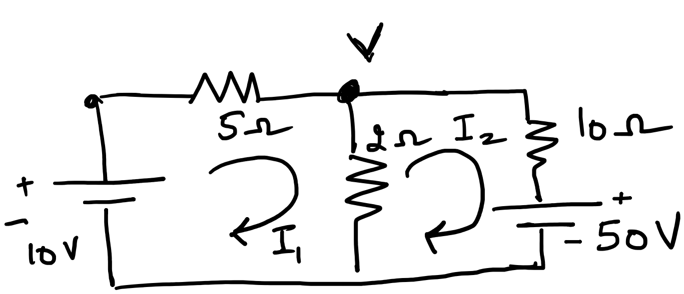
Loops/Meshes →

3 unknowns → 3eq.

$$V_s - I_1R_1 - R_2(I_1 - I_2) = 0 \Rightarrow V_s = I_1(R_1+R_2) - I_2R_2 \quad —①$$

$$-R_2(I_2 - I_1) - R_3I_2 - R_4I_2 = 0 \Rightarrow I_1(R_2) - I_2(R_2+R_3+R_4) = 0 \quad ②$$

1)



$I_1, I_2 = ??$

$$10 - 5I_1 - 2(I_1 - I_2) = 0 \Rightarrow 7I_1 - 2I_2 = 10 \quad — ①$$

$$-10I_2 - 50 - 2(I_2 - I_1) = 0 \Rightarrow 2I_1 - 12I_2 = 50 \quad — ②$$

→ Elimination / Back substitution

$$\rightarrow A\,X = B$$

$$\rightarrow \begin{bmatrix} 7 & -2 \\ 2 & -12 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 50 \end{bmatrix}$$

$$X = A^{-1}B \; ; \quad A^{-1} = \frac{\text{Adj}\,A}{|A|} \qquad \begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{ad - bc}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$

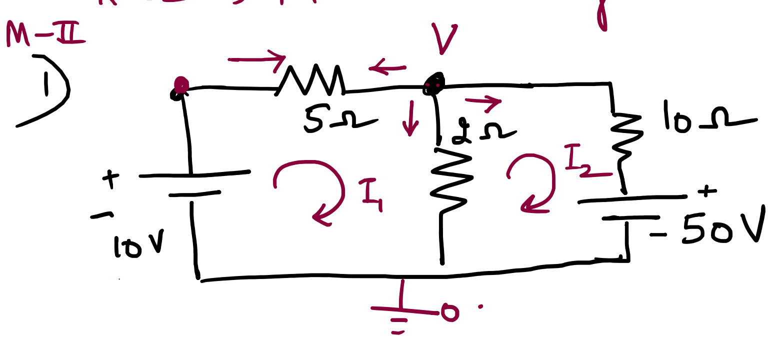
$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \frac{1}{(-84 + 4)} \begin{bmatrix} -12 & 2 \\ -2 & 7 \end{bmatrix} \begin{bmatrix} 10 \\ 50 \end{bmatrix}$$

$$= \begin{bmatrix} 0.25 \\ -4.125 \end{bmatrix} ; \quad I_1 = 0.25 ;$$

KCL → Nodal Analysis

M–II

1)



$I_1 , I_2 = ??$

$$\left(\frac{V - 10}{5}\right) + \frac{V}{2} + \frac{(V - 50)}{10} = 0 \qquad \text{KCL}$$

$$\frac{2 \cdot V}{2 \cdot 5} - 2 + \frac{V \cdot 5}{2 \cdot 5} + \frac{V}{10} - 5 = 0$$

$$\frac{2\cdot V}{2\cdot 5} - 2 + \frac{V\cdot 5}{2\cdot 5} + \frac{V}{10} - 5 = 0$$

$$\frac{8V}{10} = 7 \Rightarrow V = \frac{70}{8} = 8.75 = \frac{35}{4}$$

$$I_1 = \frac{10 - V}{5} = \frac{10 - 8.75}{5} = \underline{\underline{0.25}}\ A$$

$$I_2 = \frac{V - 50}{10} = \frac{8.75 - 50}{10} = \underline{\underline{-4.125}}\ A$$