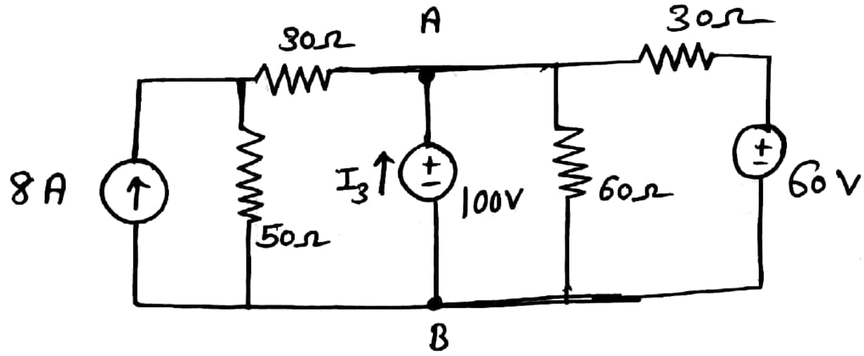
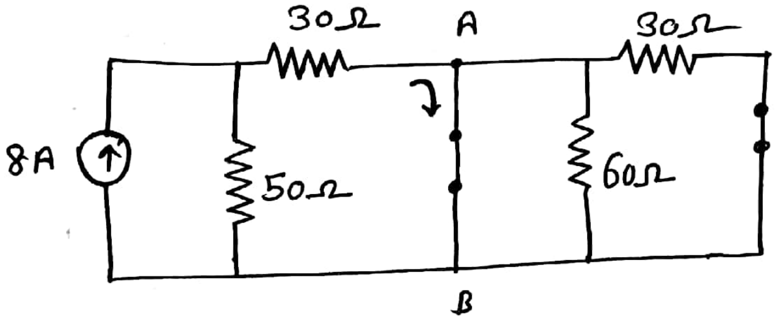
(7)

SUPERPOSITION THEOREM

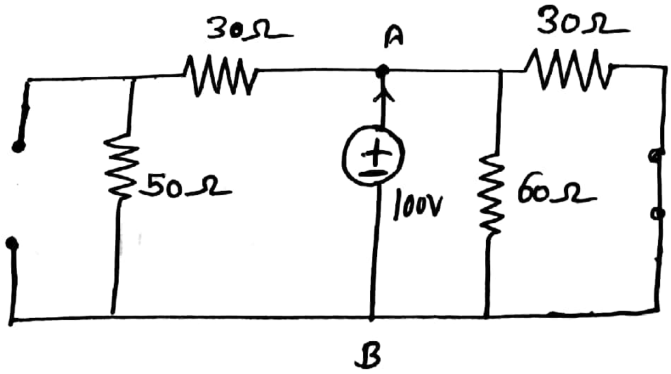


Considering 8A Source



$$I_{AB} = \frac{8 \times 50}{30+50} = 5A \ (A-B)$$

Considering 100 V Source



$$R_{eq} = (50+30) \,||\, (60 \,||\, 30)$$

$$= 80 \,||\, 20$$

$$R_{eq} = 16\,\Omega$$

$$\frac{60 \times 30}{60+30}$$

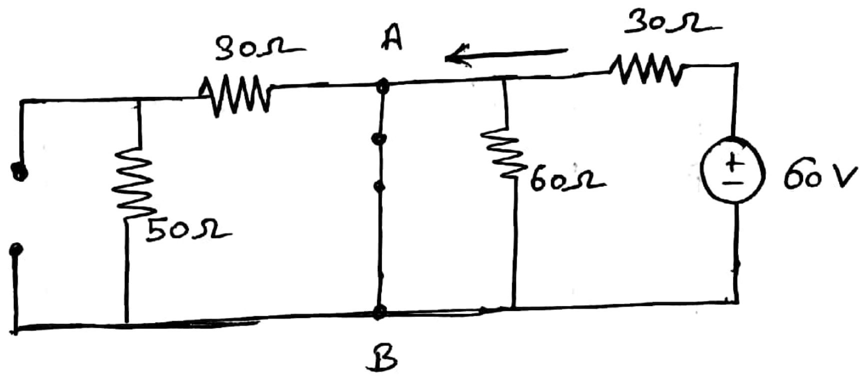
$$\frac{80 \times 20}{80+20}$$

$$I_{total} = \frac{100}{16}$$

$$\underline{I_{total} = 6.25\ A} \quad [B-A]$$

$$I_{B-A} = \underline{6.25\ A} \quad [B-A]$$

<u>Considering only 60 V Source</u>



$$I_{AB} = \frac{60}{30} = 2\ A$$

$$\{\ I_{AB} = 2A \quad [A-B]\ \}$$

Total current, $I = 5 - 6.25 + 2$

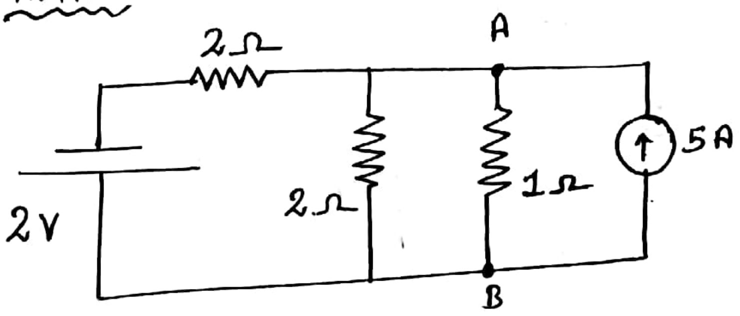
$$\boxed{I = 0.75\ A} \quad A-B$$

—x—

UNIV PROBLEM

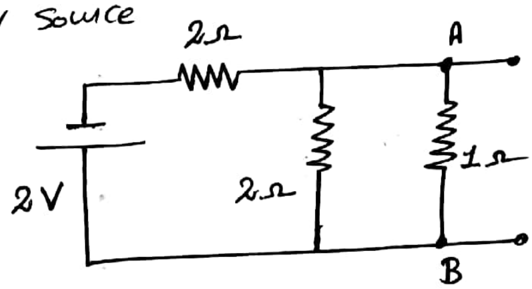
ALTERNATE METHOD

Eg 1)



SOLUTION

Eliminate 5A source by open circuit it and keep only 2V source



Calculate the total resistance

$$R_{eq} = (2 \| 1) + 2$$

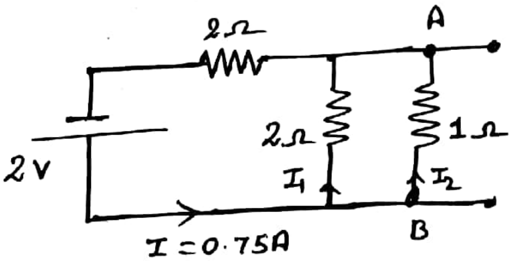
$$R_{eq} = \frac{2 \times 1}{2+1} + 2$$

$$\boxed{R_{eq} = 2.67\,\Omega}$$

Calculate the total current

$$I = \frac{V}{R_{eq}} = \frac{2}{2.67}$$

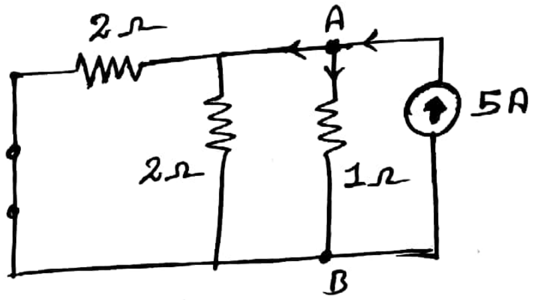
$$\boxed{I = 0.75\text{ A.}}$$



$$I_2 = \frac{0.75(2)}{2+1}$$

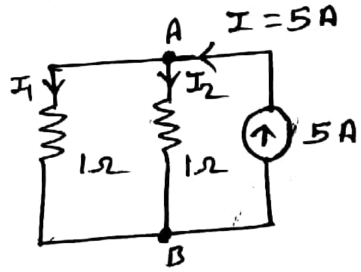
$$\boxed{I_2 = 0.5\text{ A}}$$ B – A

Eliminate 2V source by short circuit it and keep only 5A source



⇓

$$2 \| 2 = 1\,\Omega$$



$$I_2 = \frac{5(1)}{1+1}$$

$$\boxed{I_2 = 2.5\text{ A}}$$ A – B

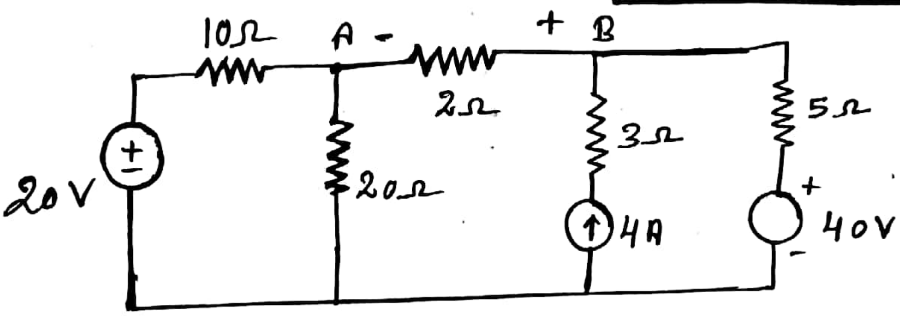
Total current when both the sources are present is given by

$$I_{1\Omega} = 2.5 - 0.5$$

$$\boxed{I_{1\Omega} = 2\text{ A}}$$ A – B

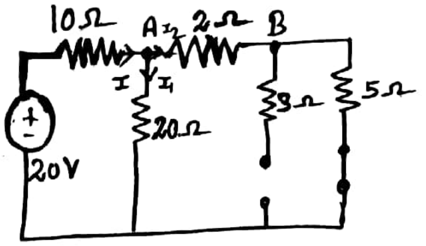
UNIV PROBLEM

Eg : 2



Keeping only 20 V source	Keeping only 4A source	Keeping only 40V source

Keeping only 20 V source



Find R_{eq}

$$R_{eq} = 10 + [20 \| (2+5)]$$

$$= 10 + [20 \| 7]$$

$$= 10 + \frac{20 \times 7}{20+7}$$

$$= 10 + 5.185$$

$$R_{eq} = \underline{15.185\ \Omega}$$

Total current

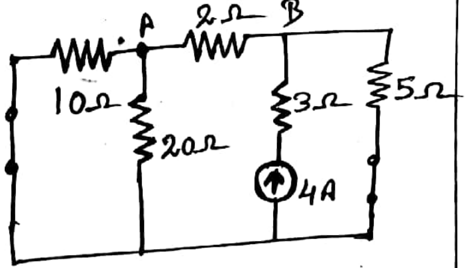
$$I = \frac{20}{15.185} = \underline{1.317\ A}$$

Current flowing through 2Ω resistor

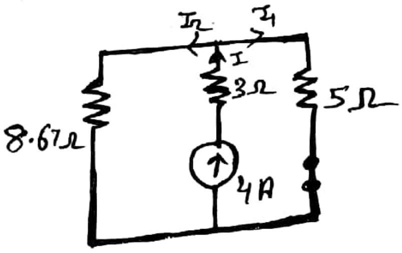
$$I_2 = \frac{1.317\ (20)}{20+2+5}$$

$$\boxed{I_2 = 0.98\ A}$$ A-B

Keeping only 4A source



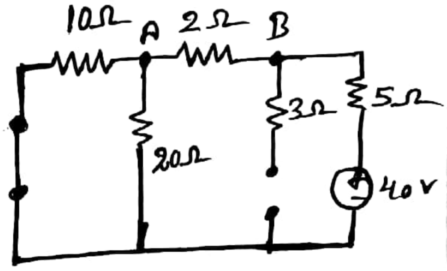
$$(10 \| 20) + 2 = 8.67\ \Omega$$



$$I_2 = \frac{4\ (5.0)}{5 + 8.67}$$

$$\boxed{I_2 = 1.463\ A}$$ B-A

Keeping only 40V source



$$R_{eq} = [(10 \| 20) + 2] + 5$$

$$= \left[\frac{10 \times 20}{10+20}\right] + 2 + 5$$

$$R_{eq} = 13.67\ \Omega$$

$$I = \frac{40}{13.67} = \underline{2.93\ A}$$

Current flowing through 2Ω resistor is

$$\boxed{I = 2.93\ A}$$ B-A

Total current

$$I_{2\Omega} = 0.98 - 1.463 - 2.93$$

$$I_{2\Omega} = -3.413\ A$$

$$\boxed{I_{2\Omega} = 3.413 A}$$ B-A

$$V_{2\Omega} = 3.413\ (2)$$

$$\boxed{V_{2\Omega} = 6.826\ V}$$

MAXIMUM POWER TRANSFER THEOREM

The maximum power transfer theorem states that in a linear, bilateral DC network, maximum power is delivered to the load when the load resistance is equal to the internal resistance of a source.

$$I_L = \frac{V_{th}}{R_{th} + R_L}$$

$$P_L = I_L^2 R_L$$

Maximum power transfers when $R_{th} = R_L$

$$\therefore \quad I_L = \frac{V_{th}}{2R_L}$$

$$P_L = \frac{V_{th}^2}{4R_L^{\cancel{2}}} \cancel{R_L}$$

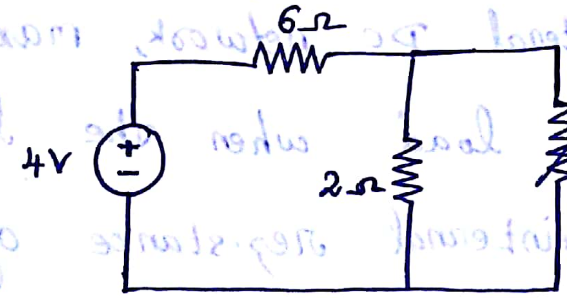
$$\left[P_L = \frac{V_{th}^2}{4R_L} \right] \qquad \left[R_L = R_{th} \right]$$

EXAMPLE: Audio amplifier & Speaker

When impedance of the audio amplifier equals the speaker impedance, the speaker will delivers maximum power output.

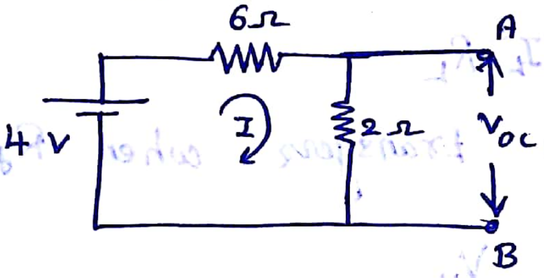
EXAMPLE : 1

Determine the Value of R_L when it is dissipating Maximum power. Also find the value of maximum power dissipated.



Solution

To find V_{th}

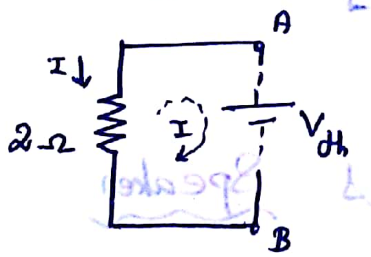


$$4 = 6I + 2I$$

$$4 = 8I$$

$$I = \frac{4}{8} = 0.5\ A$$

Finding $V_{oc} = V_{th}$

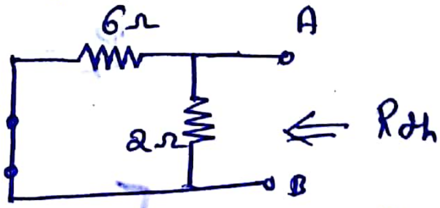


$$-V_{th} = -2I$$

$$-V_{th} = -2(0.5)$$

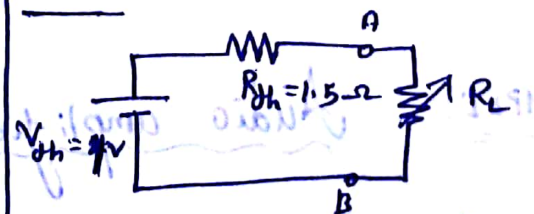
$$\boxed{V_{th} = 1\ V}$$

To find R_{th}



$$R_{th} = \frac{6 \times 2}{6+2} = \frac{12}{8} = 1.5\ \Omega$$

$$R_{th} = 1.5\ \Omega$$



$$I = \frac{V_{th}}{R_{th} + R_L}$$

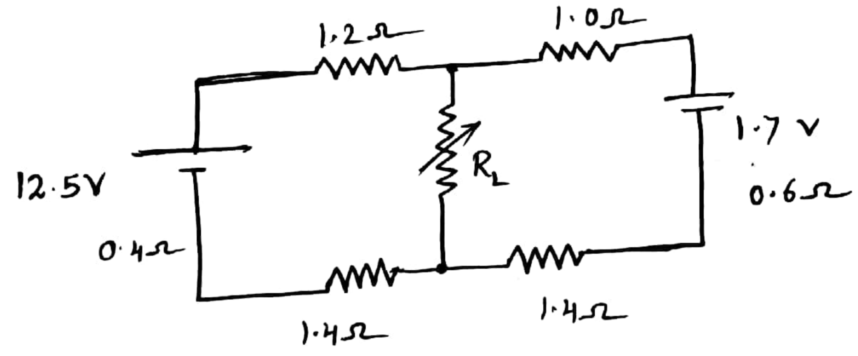
$$I = \frac{1}{1.5 + 1.5} = 0.$$

$$R_L = R_{th}$$

$R_L = 1.5\ \Omega$ for delivering Maximum power.

$$P_{max} = I^2 R_L = 0.33^2 (1.5) = \underline{0.16\ W}$$

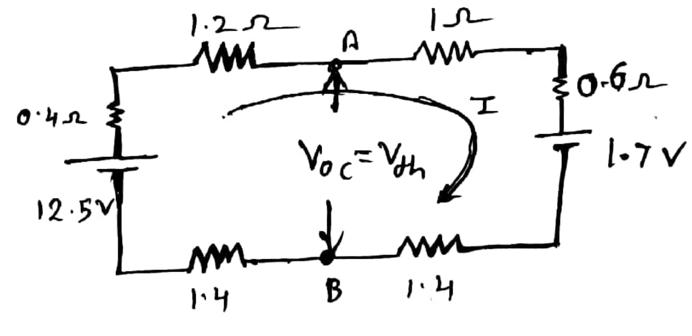
EXAMPLE : 2



For the given circuit find the value of R_L for the maximum power to be delivered

SOLUTION

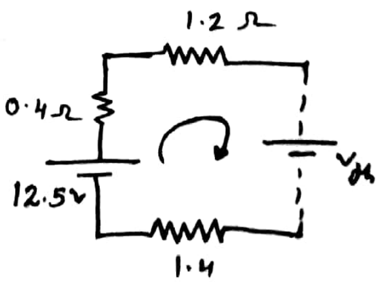
STEP 1 Remove the load resistor R_L and open circuit it and find V_{th} across the terminal A & B



$$12.5 - 1.7 = (0.4 + 1.2 + 1 + 0.6 + 1.4 + 1.4)\,I$$

$$\boxed{I = 1.8\ A}$$

To find V_{th}



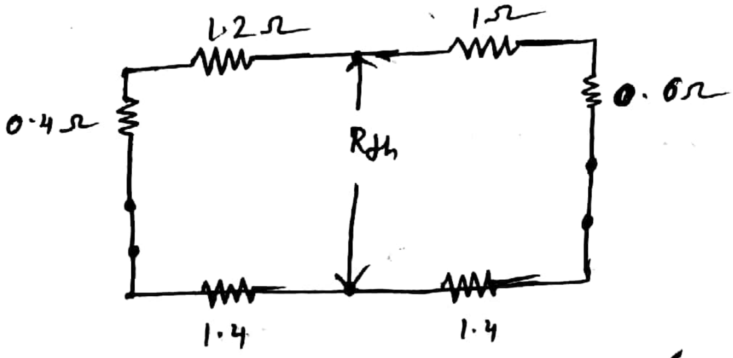
$$12.5 - V_{th} = (0.4 + 1.2 + 1.4)\,I$$

$$12.5 - V_{th} = 3I$$

$$12.5 - V_{th} = 3\,(1.8)$$

$$\boxed{V_{th} = 7.1\ V}$$

To find R_{th}

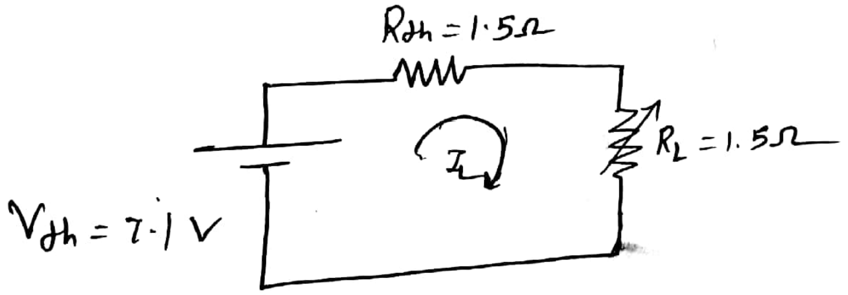


$$R_{th} = (1.2 + 0.4 + 1.4) \parallel (1 + 0.6 + 1.4)$$

$$R_{th} = 3 \parallel 3$$

$$\boxed{R_{th} = 1.5\,\Omega}$$

To find Thevenin's Equivalent circuit



To get maximum power from source

$$\boxed{R_{th} = R_L = 1.5\,\Omega}$$

$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{7.1}{3} = \underline{2.37\,A}$$

$$P_L = I_L^2 R_L$$

$$P_L = 2.37^2 (1.5)$$

$$\boxed{P_L = 8.4\,W}$$

(or)

$$P_L = \frac{V_{th}^2}{4R_L}$$

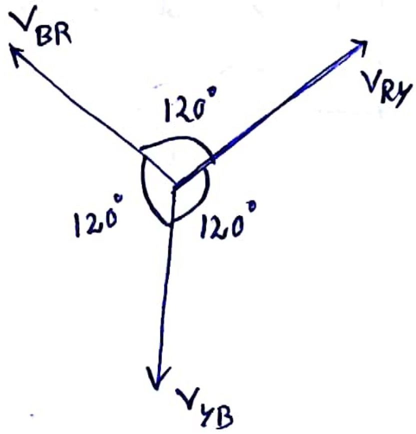
$$P_L = \frac{7.1^2}{4(1.5)} = \underline{8.4\,W}$$

3- PHASE CONNECTION

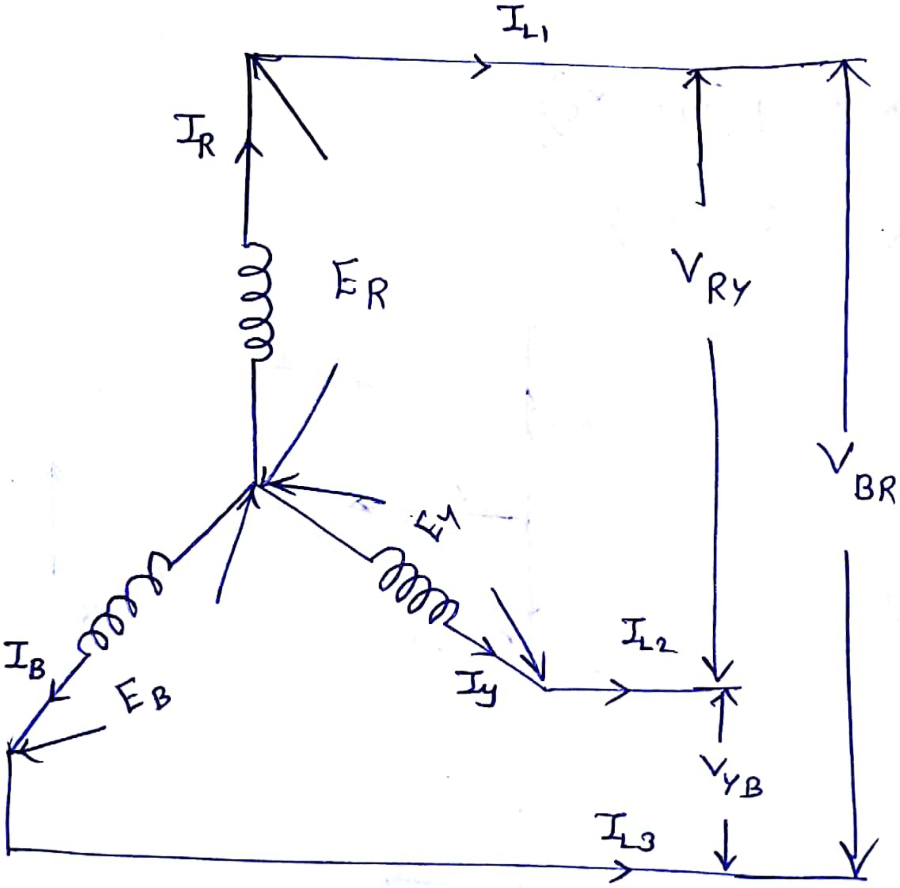
There are two types of three phase connections.

(i) Star (Y) Connection

(ii) Delta (∇) Connection.



STAR CONNECTION



$E_R = E_y = E_B = E_{Ph}$

E_{Ph} = phase voltage

$V_{RY} = V_{YB} = V_{BR} = V_L$

V_L = Line Voltage.

From phasor diagram.

$$V_{RY} = E_R - E_y$$

$$V_{RY} = \sqrt{E_R^2 + E_y^2 + 2E_R E_y \cos 60^\circ}$$

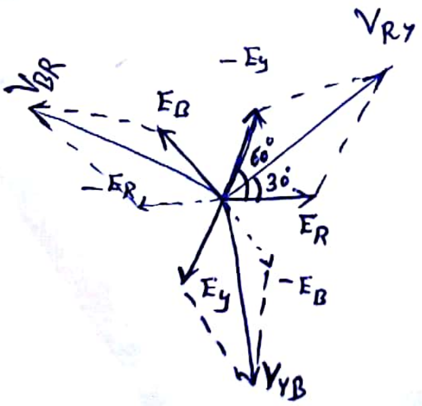
$$V_{RY} = \sqrt{E_{Ph}^2 + E_{Ph}^2 + 2E_{Ph}E_{Ph}(1/2)}$$

$$V_{RY} = \sqrt{3E_{Ph}^2}$$

$$V_L = \sqrt{3E_{Ph}^2}$$

$$\boxed{V_L = \sqrt{3}\,E_{Ph}}$$

PHASOR DIAGRAM



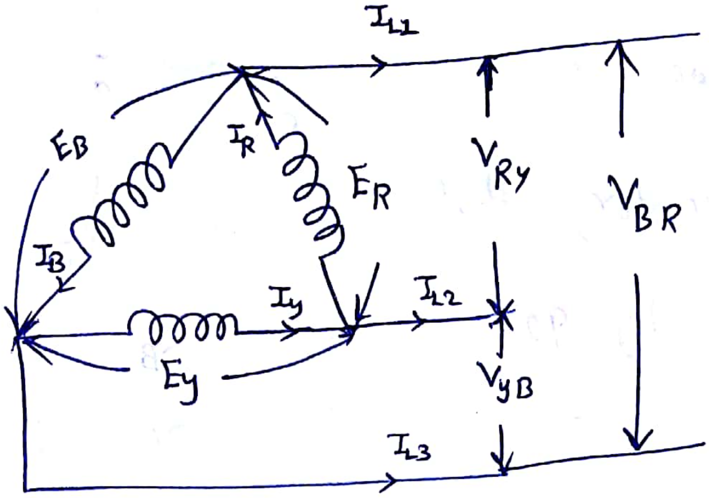
$I_{L1} = I_R$

$I_{L2} = I_y$

$I_{L3} = I_B$

$$\boxed{I_L = I_{Ph}}$$

DELTA CONNECTION



Here

$E_R = V_{RY}$

$E_y = V_{yB}$

$E_B = V_{BR}$

$\boxed{E_L = V_{ph}}$

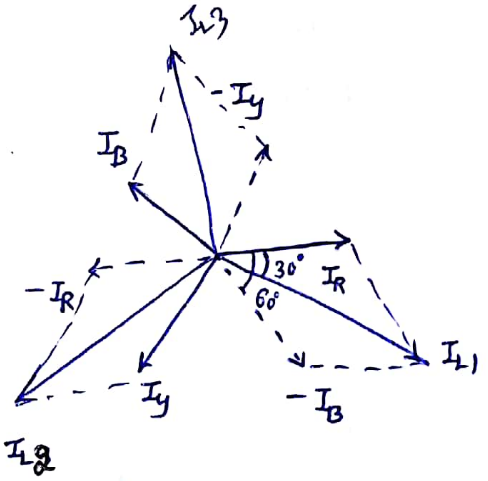
$I_{L1} = I_R - I_B$

$I_{L2} = I_y - I_R$

$I_{L3} = I_B - I_y$

$I_R = I_y = I_B = I_{ph}$

PHASOR DIAGRAM



$I_{L1} = I_R - I_B$

According to parallelogram law of Vector

$$I_{L1} = \sqrt{I_R^2 + I_B^2 + 2 I_R I_B \cos 60°}$$

$$I_{L1} = \sqrt{I_{ph}^2 + I_{ph}^2 + 2 I_{ph} I_{ph} \, 1/2}$$

$$I_{L1} = \sqrt{3 I_{ph}^2}$$

$$\boxed{I_{L1} = \sqrt{3}\, I_{ph}}$$

$$\boxed{I_L = \sqrt{3}\, I_{ph}}$$