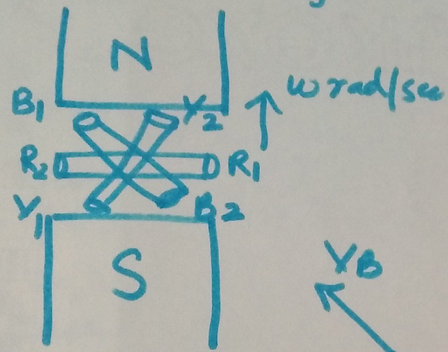
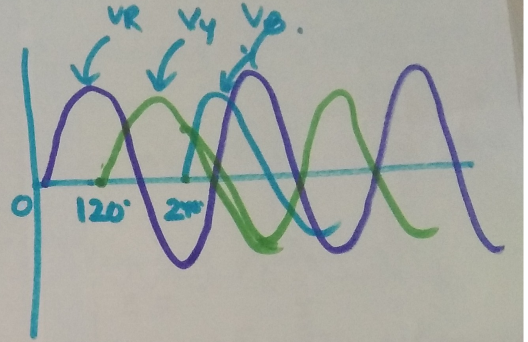
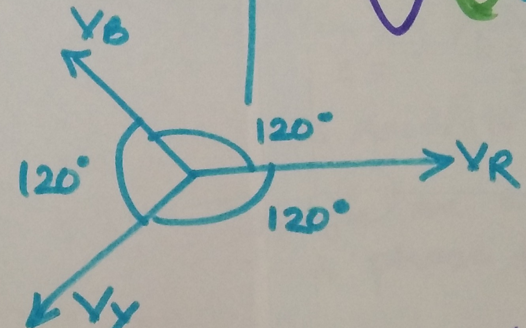
Three phase Circuits:-

Single phase Voltage can be generated by rotating a coil (winding) in a magnetic field (only one armature winding).

For 3ϕ generation :- 3 separate windings displaced from each other by equal electrical angles.







Three winding R, Y, & B. – Identical and have same angular Velocity. Voltage induced of same ma[gnitude] & freq.

$$V_R = V_m \sin \omega t$$

$$V_Y = V_m \sin(\omega t - 120^\circ)$$

$$V_B = V_m \sin(\omega t - 240^\circ)$$

Resultant $= V_R + V_Y + V_B =$

$$= V_m \sin\omega t + V_m \sin(\omega t - 120) + V_m \sin(\omega\ldots$$

$$= V_m[\sin\omega t + 2\sin(\omega t - 180)\cos 60]$$

$$= V_m[\sin\omega t - 2\sin\omega t \underbrace{\cos 60^\circ}_{1/2}]$$

$$= 0$$

Sum of the three Voltages at every instant is zero

Phase sequence :- The order in which the Voltages in three phases reaches their maxim +ve Value.

phase Voltage :- the Voltage induced in each winding

phase current :- The current flowing through each winding is called phase current.

Line Voltages :- The Voltage available b/w any pair of terminal or lines.

Line current :- The current flowing through each line.

Balanced S/m :- A 3ϕ S/m is said to be balanced if

a) Voltages in the three phases are equal in magnitude but differ in phase from each other by 120°

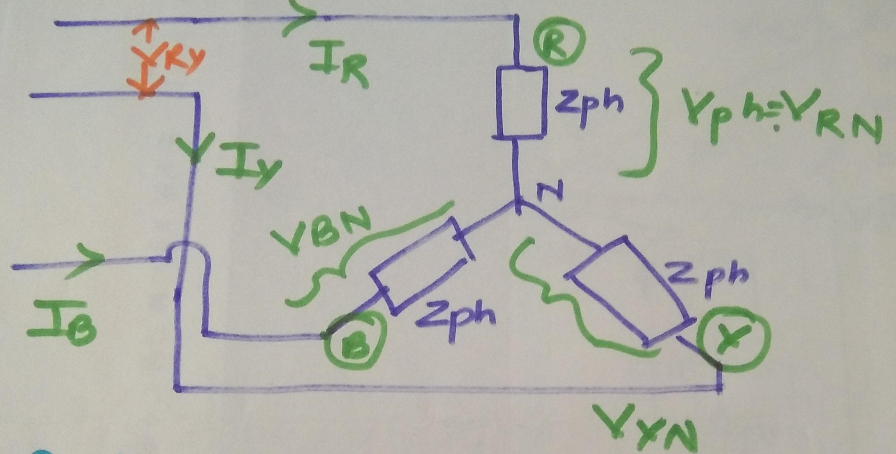
b) Currents in the three phases are equal in magnitude & differ in phase from each other by 120°

c) The loads connected across the three phases are identical ie all loads have same magnitude & pf.

Interconnection of 3ϕ :-

1) Star or Wye Y

2) Delta or Mesh



3 phase Voltages : V_{ph}

V_{RN}, V_{YN}, V_{BN} are equal in magnitude

120° apart

V_{YN} lags behind V_{RN} by 120° & V_{BN} lags behind V_{RN} by 240°.

$V_{ph} = V_{RN} = V_{YN} = V_{BN}$

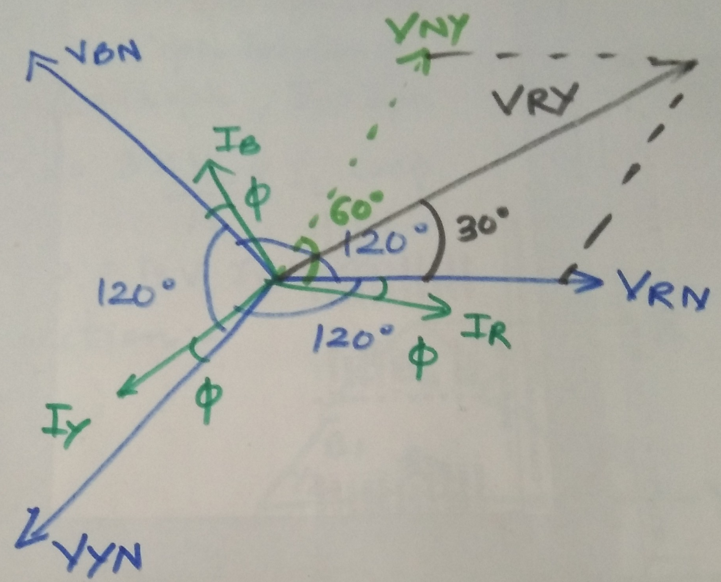
V_L - line Voltages = $V_{RY} = V_{YB} = V_{B}$

$\bar{V}_{RY} = V_R - V_Y = \bar{V}_{RN} + \bar{V}_{NY}$

$\bar{V}_{YB} = \bar{V}_{YN} + \bar{V}_{NB}$

$V_{BR} = \bar{V}_{BN} + V_{NR}$

phasor diagram:-



angle b/w V_{RN} & $V_{YN} = 120°$

V_{NY} is antiphase V_{YN}

angle b/w V_{RN} & $V_{NY} = 60°$

$V_{RY}^2 = V_{RN}^2 + V_{NY}^2 + 2 V_{RN} \times V_{NY} \cos(V_{RN} \wedge V_{NY}$

$= V_{RN}^2 + V_{NY}^2 + 2 V_{RN} \times V_{NY} \cos 60°$

$V_{RN} = V_{ph}$, $V_{RY} = V_L$

$=$

$V_L = V_{ph}^2 + V_{ph}^2 + \cancel{2} V_{ph}^2 \times \frac{1}{\cancel{2}}$

$V_L = 3 V_{ph}^2$. V_L

$I_L = I_{ph}$ $P = 3 \times$ power in each phase

Power

$P = 3 \times V_{ph} I_{ph} \cos\phi$

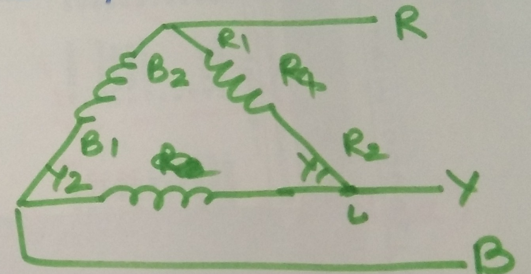
$= 3 V_{ph} I_{ph} \cos\phi$

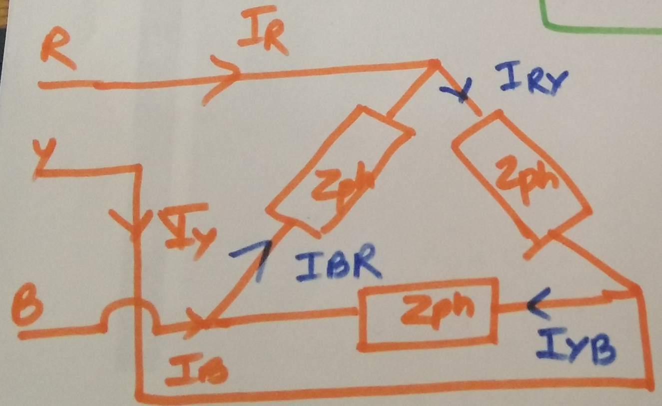
$V_L = \sqrt{3} V_{ph}$, $I_L = I_{ph}$

$P = 3 \times \frac{V_L}{\sqrt{3}} \times I_L \cos\phi$

$P = \sqrt{3} V_L I_L \cos\phi$

Delta Connection:-





$I_{ph} = I_{RY} = I_{YB} = I_{BR}$

$I_L = I_R = I_Y = I_B$

$\bar{I}_R + \bar{I}_{BR} = \bar{I}_{RY}$

$I_R = \bar{I}_{RY} + (-\bar{I}_{BR})$

$\bar{I}_Y + \bar{I}_{RY} = \bar{I}_{YB}$

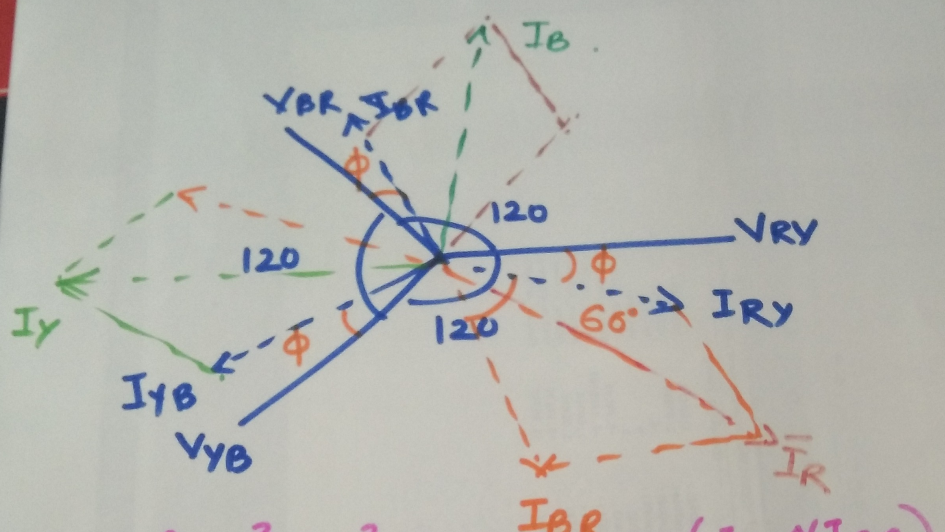
$\bar{I}_Y = \bar{I}_{YB} + (-\bar{I}_{RY})$

$\bar{I}_B + \bar{I}_{YB} = \bar{I}_B$

$I_B = \bar{I}_{BR} + ($

Phasor diagram:-

6



$$I_R^2 = I_{RY}^2 + I_{BR}^2 + 2 I_{RY} I_{BR} \cos(I_{RY} \wedge -I_{BR})$$

$$I_L^2 = I_{ph}^2 + I_{ph}^2 + 2 I_{ph} I_{ph} \cos 60°$$

$$I_L = 3 I_{ph}^2$$

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

P = 3x power in each phase

$$= 3 \times I_{ph} \times V_{ph} \cos\phi$$

$$= 3 V_{ph} I_{ph} \cos\phi$$

$$= 3 \times V_L \times \frac{I_L}{\sqrt{3}} \cos\phi$$