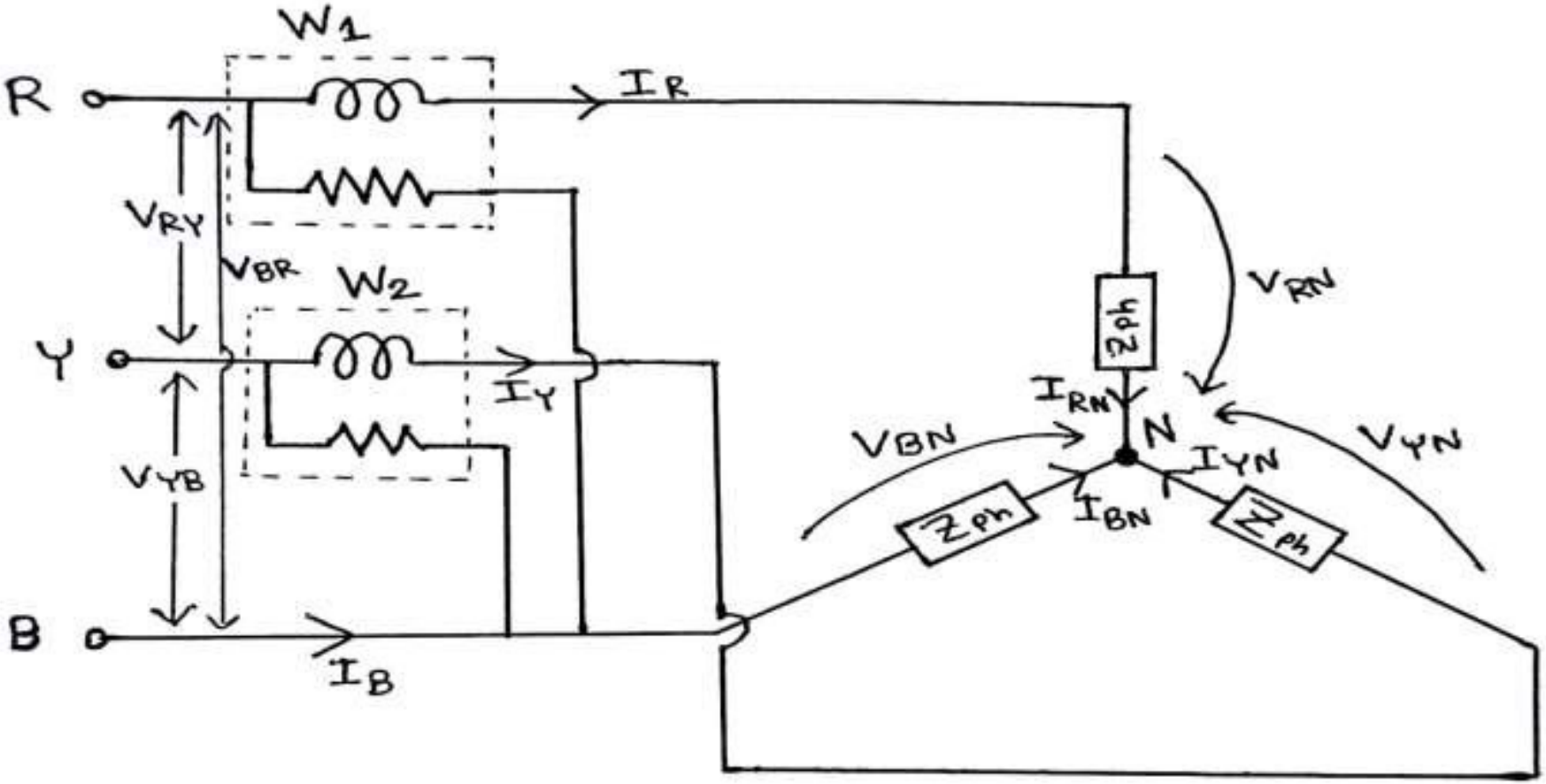
Three Phase Power Measurement


W1
R
IR
VRY
VBR
W2
Y
IY
VYB
B
IB
Zph
VRN
IRN
N
VBN
VYN
IYN
IBN
Zph
Zph

- Here,

$V_{RY,}\ V_{YB,}\ V_{BR} = V_L$ [Line Voltage]

$I_{R,}\ I_{Y,}\ I_B = I_L$ [Line Current]

$V_{RN,}\ V_{YN,}\ V_{BN} = V_{Ph}$ [Phase Voltage]

$I_{RN,}\ I_{YN,}\ I_{BN} = I_{Ph}$ [Phase Current]

- Wattmeter – 1

  Current(I): I_R

  Voltage(V): V_{RB}

Power:

$W_1 = V_{RB} I_R \text{Cos}(V_{RB} \hat{} I_R)$

- Wattmeter – 2

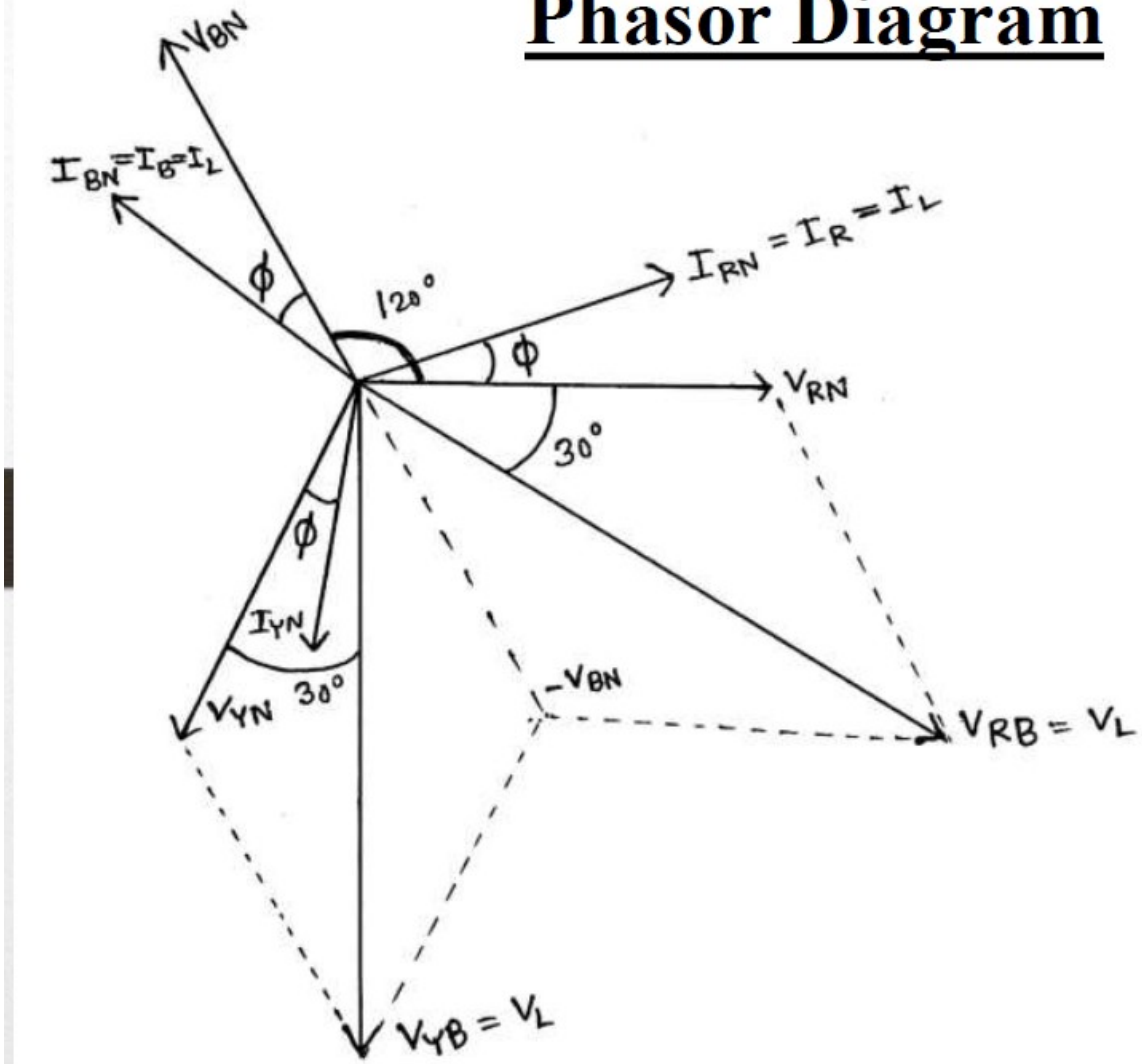
  Current(I): I_Y

  Voltage(V): V_{YB}

Power:

$W_2 = V_{YB} I_Y \text{Cos}(V_{YB} \hat{} I_Y)$

Phasor Diagram



$$V_{RB} = V_{RN} - V_{BN}$$
$$V_{YB} = V_{YN} - V_{BN}$$

From Phasor Diagram we can Write,

$$W_1 = V_{RB} I_R \text{Cos}(V_{RB} \hat{} I_R)$$

$$= V_L I_L \text{Cos}(30^0 + \Phi)$$

$$W_2 = V_{YB} I_Y \text{Cos}(V_{YB} \hat{} I_Y)$$

$$= V_L I_L \text{Cos}(30^0 - \Phi)$$

$W_1 + W_2$

- $W_1 + W_2 = V_L I_L [Cos(30° + \Phi) + Cos(30° - \Phi)]$

$$= V_L I_L \left[2Cos \frac{30°+\Phi+30°-\Phi}{2} . Cos \frac{30°+\Phi-30°+\Phi}{2}\right]$$

$$= 2\, V_L I_L Cos30° Cos\Phi$$

$$= 2\, V_L I_L \frac{\sqrt{3}}{2} Cos\Phi$$

$$= V_L I_L \sqrt{3} Cos\Phi \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$W_1 - W_2$

$$W_1 - W_2 = V_L I_L [cos(30° + \Phi) - cos(30° - \Phi)]$$

$$= V_L I_L [2sin \frac{30° + \Phi + 30° - \Phi}{2} . sin \frac{30° - \Phi - 30° - \Phi}{2}]$$

$$= 2\, V_L I_L sin30° \sin(-\Phi)$$

$$= -2\, V_L I_L \frac{1}{2} sin\Phi$$

$$= -\, V_L I_L sin\Phi \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$\frac{W_1 - W_2}{W_1 + W_2}$$

- Deviding Eqn (2) By Eqn (1) We Get,

$$\frac{W_1 - W_2}{W_1 + W_2} = \frac{-V_L I_L sin\Phi}{V_L I_L \sqrt{3} Cos\Phi}$$

$$\frac{W_1 - W_2}{W_1 + W_2} = -\frac{1}{\sqrt{3}} tan\Phi$$

$$tan\Phi = -\sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)$$

$$\Phi = tan^{-1}\left\{-\sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)\right\}$$

- Power Factor of Load = cosΦ