Lecture 46

1. With a neat circuit diagram and phasor diagram, show that two wattmeters are sufficient to measure active power in a three phase system. Also derive an expression for the powerfactor of the system.

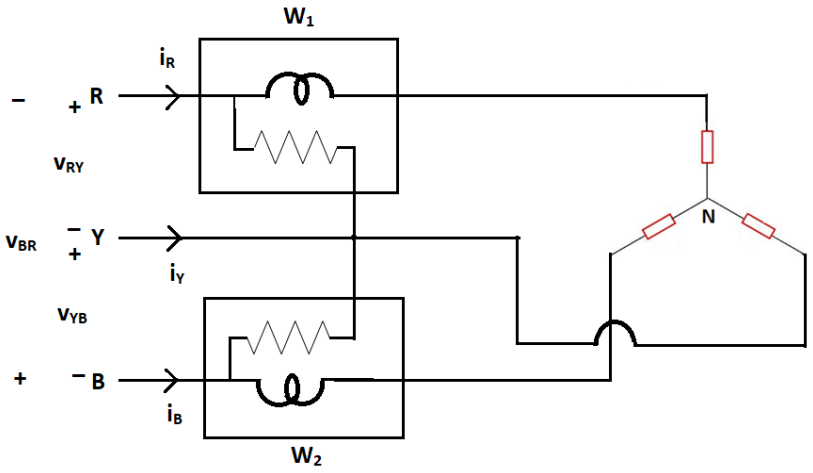
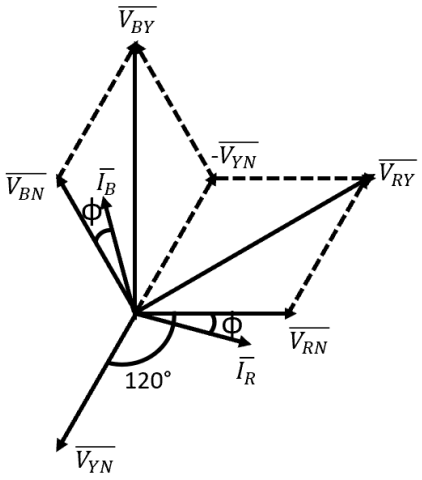


Fig: Two Wattmeter Method circuit diagram

$W_1 = V_{RY} * I_R * \cos(\angle(V_{RY}, I_R))$

$W_2 = V_{BY} * I_B * \cos(\angle(V_{BY}, I_B))$



$\overline{V_{RY}} = \overline{V_{RN}} - \overline{V_{YN}}$

$\overline{V_{BY}} = \overline{V_{BN}} - \overline{V_{YN}}$

Consider inductive load. Then, phase current lags phase voltage.

$W_1 = V_{RY} * I_R * \cos(30+\phi)$ & $W_2 = V_{BY} * I_B * \cos(30-\phi)$

$W_1 = V_{RY} * I_R * \cos(30+\phi)$ & $W_2 = V_{BY} * I_B * \cos(30-\phi)$

$W_1 = V_L * I_L * \cos(30+\phi)$ & $W_2 = V_L * I_L * \cos(30-\phi)$

Therefore, $W_1 + W_2 = \sqrt{3} * V_L * I_L * \cos\phi = P_{3-phase}$ --- (1)

Similarly, $\sqrt{3} * (W_2 - W_1) = \sqrt{3} * V_L * I_L * \sin\phi = Q_{3-phase}$ --- (2)

$$\frac{(2)}{(1)} \Rightarrow \frac{Q_{3-phase}}{P_{3-phase}} = \frac{\sqrt{3}*(W_2 - W_1)}{W_1 + W_2} = \text{Tan}\phi$$

Hence, power factor of the system is,

$$\cos\phi = \cos\left(Tan^{-1}\left(\frac{\sqrt{3}*(W_2 - W_1)}{W_1 + W_2}\right)\right)$$