E/21/345

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PRE LAB - EE256 : POWER AND ENERGY | THREE PHASE MEASUREMENTS.

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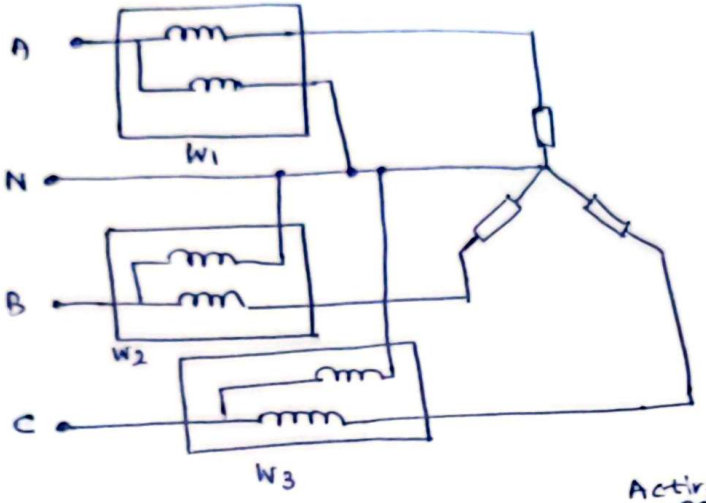
① Describe the different methods of three phase measurements for balanced three phase load & unbalanced three phase loads?

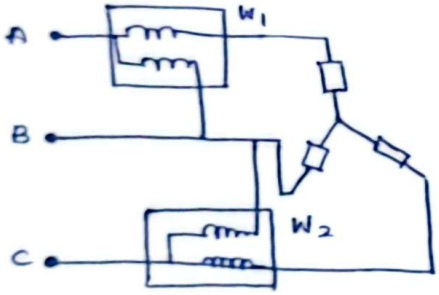
(i.) Three-wattmeter method



- configuration: each wattmeter is connected to a line (A, B, C) with common neutral
- Used for - balanced and unbalanced loads
- this configuration requires a neutral connection.

Active power → $P = W_1 + W_2 + W_3$

(ii.) Two-wattmeter method



- configuration : wattmeters are connected between two lines.
- Used for → balanced ~~system~~ loads : star or delta
- unbalanced ~~system~~ loads : only in 3-wire systems (no neutral)

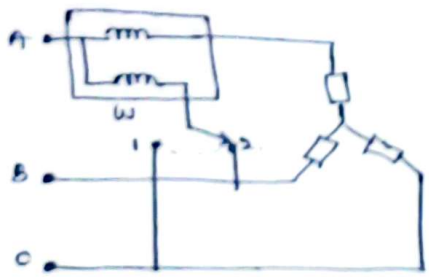
Active power = $W_1 + W_2$

Reactive power = $\sqrt{3}(W_2 - W_1)$

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

$\cos\phi$ → power factor

(iii.) One-wattmeter method.



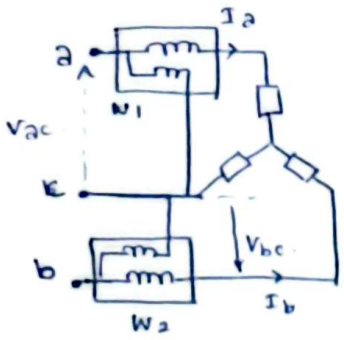
- configuration : one wattmeter connected and reading taken with switching connections.
- Used only for balanced loads.

Active power = $W_1 + W_2$

② Compare the pros & cons of the methods you described in q1?

Method	Pros	Cons.
Three-Wattmeter.	• Suitable for 4-wire systems with neutral • Accurate for both balanced & unbalanced systems.	• Requires 3 wattmeters. • Need access to the neutral point • Complex wiring.
Two-Wattmeter	• works for both balanced and unbalanced loads. (In 3-wire systems) • can be used to calculate power factor. • Does not require neutral • Only two wattmeters required.	• Accuracy reduce at lower power factors. • Not suitable for 4-wire systems.
One-Wattmeter	• Economical, only needed one wattmeter. • simple setup for balanced loads.	• only works for balanced loads. • Required switching for full measurement.

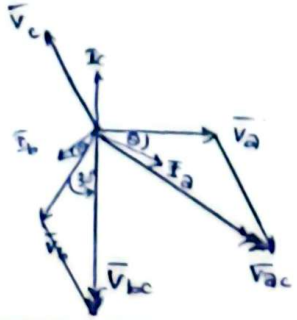
③ Derive the equation of total load power in a wye(Y) configuration for two-wattmeter method.



assume that reference is $\bar{V}_a$, and power factor is $\cos\theta$ (Lagging).

$$W_1 = |\bar{I}_a||\bar{V}_{ac}|\cos(30-\theta)$$
$$= I_L V_L \cos(30-\theta) \quad \text{—①}$$

$$W_2 = |\bar{I}_b||\bar{V}_{bc}|\cos(30+\theta)$$
$$W_2 = I_L V_L \cos(30+\theta) \quad \text{—②}$$



① + ② ⇒ $W_1 + W_2 = I_L V_L [\cos(30-\theta) + \cos(30+\theta)]$

$$= I_L V_L [2\cos 30 \cos\theta]$$

$$W_1 + W_2 = \sqrt{3} I_L V_L \cos\theta$$

Active power $= \sqrt{3} V_L I_L \cos\theta$

∴ Active power $= W_1 + W_2$

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