FACULTY OF ENGINEERING & TECHNOLOGY

UNIVERSITY OF LUCKNOW

Lecture Notes
Subject Code: EE–302
Electrical Measurement & Measuring Instruments
(Measurement of Power in AC Circuit)

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POWER MEASUREMENT IN A THREE PHASE CIRCUIT

The active power in an AC circuit is measured using Wattmeter.

A wattmeter is a measuring instrument provided with two coils :

- ***a pressure coil (potential coil)***
- ***a current coil***

Deflection of the pointer α V I cos (Φ) i.e, Active power

Methods of measuring the power:

- One wattmeter method
- Two wattmeter method
- Three wattmeter method

Blondel's Theorem –

Number of meters required to measure total power in balanced three-phase system is given by

number meters = number wires -1

Example

2 elements

3 elements

3 phase 3-wire delta system
2-meters

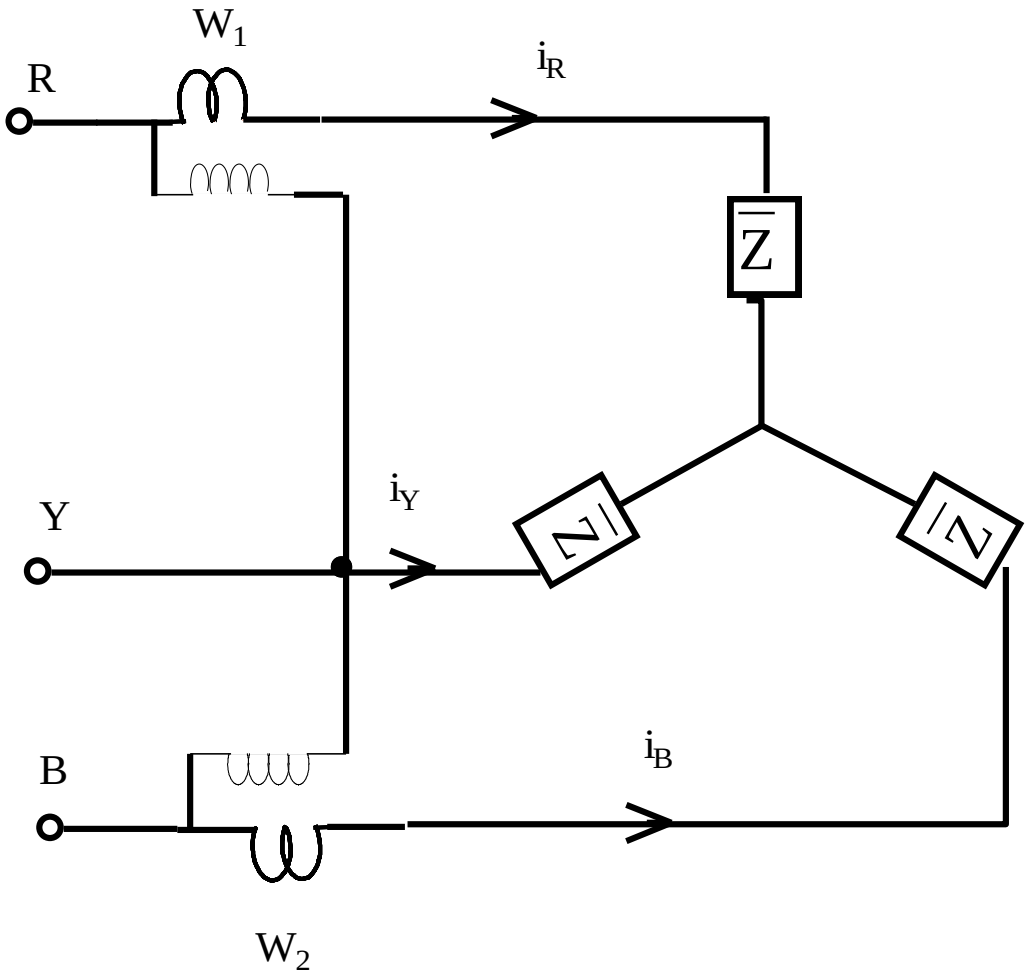
3 phase 4-wire wye system
3-meters

3 phase 3 wire wye system
2-meters

Meters can be integrated into single unit that displays total power. Each integral meter is called an **element**

Two wattmeter method

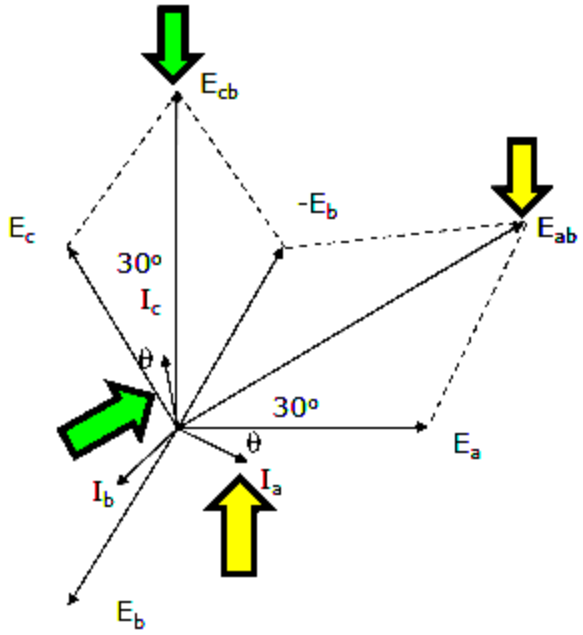
For balanced or unbalanced load (star or delta connected)

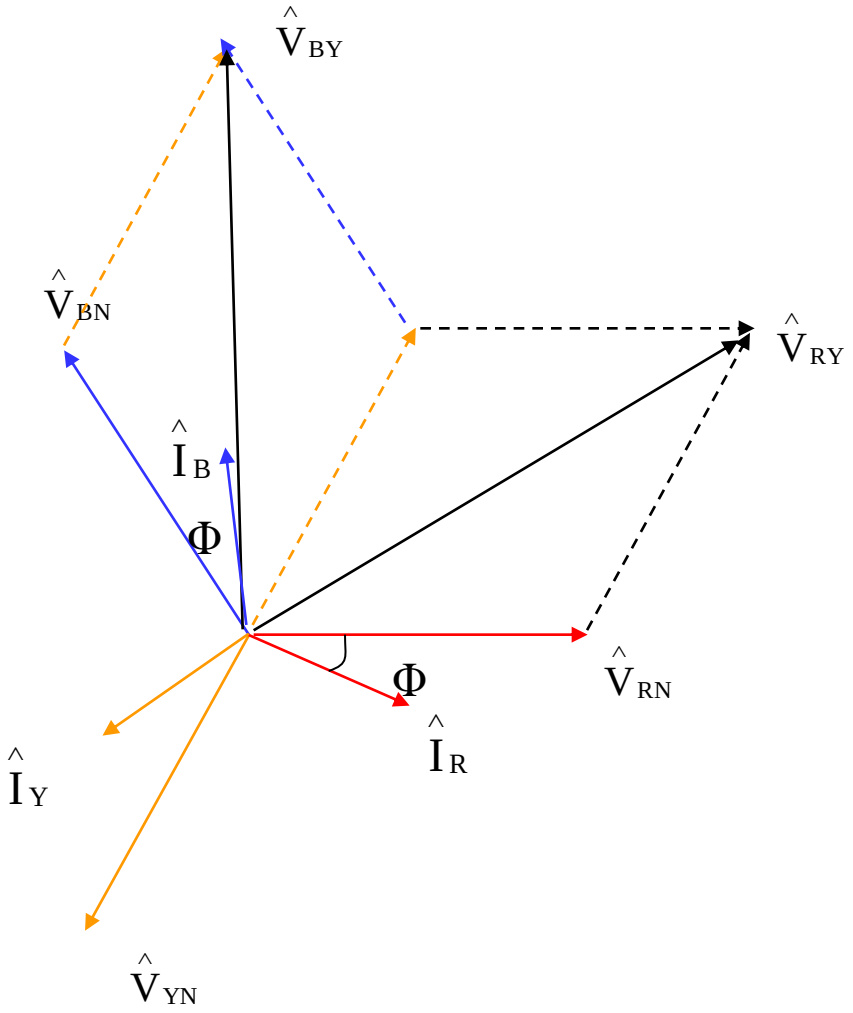


TWO Wattmeter Method

Using RMS values: (balanced load only)

For Phase sequence RYB





TWO Wattmeter Method

- Supply voltage - symmetrical and balanced

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

For lagging power factor

- Power measured by $W_1 = V_{RY}\, I_R \cos$ (angle between V_{RY} & I_R)

$$= V_L I_L \cos (30^\circ+\Phi)$$

- Power measured by $W_2 = V_{BY}\, I_B \cos$ (angle between V_{BY} & I_B)

$$= V_L\, I_L \cos (30^\circ-\Phi)$$

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

$$= \sqrt{3}\ V_L I_L \cos \Phi = \text{Total active power}$$

TWO Wattmeter Method

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

$= -V_L I_L \text{Sin}\,\Phi$

$$\sqrt{3}\,\frac{W_2 - W_1}{W_2 + W_1} = \tan\phi$$

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

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

TWO Wattmeter Method

Variation of Wattmeter readings with load power factor

Φ in degrees	PF	W_1	W_2	Remarks
0	1	0.866 $V_L I_L$	0.866 $V_L I_L$	Equal Readings
30	0.866	0.5 $V_L I_L$	$V_L I_L$	One wattmeter shows the double of the other
60	0.5	0	0.866 $V_L I_L$	One wattmeter shows ZERO
90	0	-0.5 $V_L I_L$	0.5 $V_L I_L$	One wattmeter shows the equal but opposite reading of the other

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References:

Text Books:

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3. M.B. Stout, “Basic Electrical Measurement” Prentice hall of India, India.
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