GARVIT SHAH
F-24

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- **Aim:** To study measurement of Power in three phase circuit using two Wattmeter method.

- **Apparatus:** Wattmeter (600V/5A), Voltmeter (0-600V) Ammeter (0-5A), Auto-Transfer, 3-Ø Induction motor, connecting wires.

- **Theory:** Power consumed by a 3-Ø balanced or unbalanced load (delta connected) can be measured by using 2-Wattmeters properly connected in the circuit. In Two-Wattmeter method, the current coils of the wattmeter are connected with any two lines, say R and Y as shown in Fig 1. While the pressure coil of each wattmeter is connected between these two lines & the third line i.e., B as shown above. Under running ~~cod~~ conditions, the power consumed by the 3Ø system is the sum of the two individual wattmeters —

$$P_{measured} = W_1 + W_2$$

W_1 by wattmeter 1, W_2 by wattmeter 2

Total power in circuit : $P_{calc} = \sqrt{3}\, V_L I_L \cos\theta$

V_L line voltage, I_L line current, $\cos\theta$ Power factor

Phase angle $\theta = \left[\tan^{-1}\left\{\sqrt{3}\left(\frac{W_2 - W_1}{W_2 + W_1}\right)\right\}\right]$

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- Error % = $\frac{P_{calc} - P_{measured}}{P_{measured}} \times 100$

- Multiplying factor = $\frac{\text{Voltage Rating} \times \text{Current Rating} \times \text{Power factor}}{\text{Full-scale reading}}$

- **Procedure -**

1. Connect the circuit as shown in the Fig 1
2. Start the 3Ø - AC supply & observe wattmeter readings. If one wattmeter reads -ve or gives reverse reading then switch OFF the supply & the reverse the current coil terminals.
3. Now, again start the AC supply & set the voltage to desired value using auto-transformer & then note down the current in ammeter i.e. line current I_L, Voltage in ammeter i.e. line voltage V_L & power rating in both the wattmeters ie. W_1 & W_2.
4. Repeat the procedure for 5 diff voltages

- **Questions -**

1. What are the advantages & disadvantages of two wattmeter method ?

A.1 **Advantages -**

- Applicable for balanced as well as unbalanced loads
- Only 2 wattmeters are required to measure 3Ø power

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- If load is balanced then even the power factor can be determined.

Disadvantages -

- Not suitable for 3-Ø & 4 wire system.
- Signs of W_1 & W_2 must be identified correctly to avoid wrong results.

- Conclusions :

The mean % error is 2.069 which shows the two Wattmeter method yields results that are in good agreement with the theoretical values.

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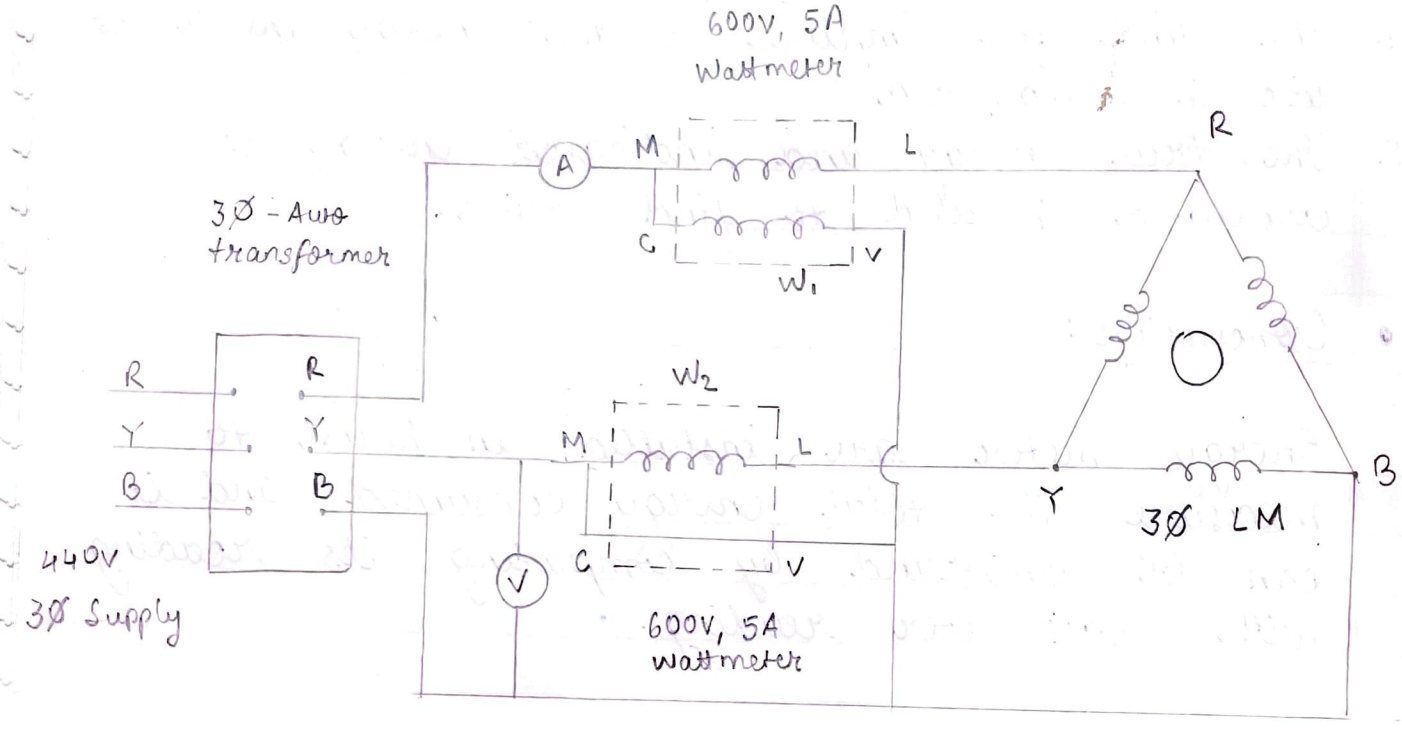
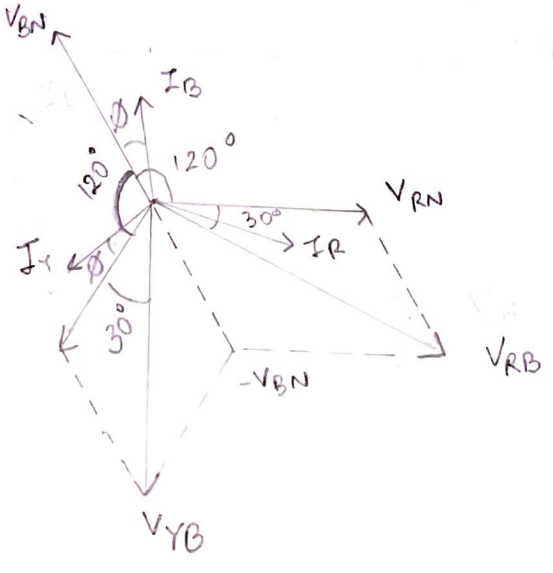


FIG 1

Power measurement using Two Wattmeter Method



Observation Table :

Sr no.	Line Voltage V_L	Line Current I_L	W_1 (x 4)	W_2 (x4)	$P_{measured} = W_1 + W_2$	θ	P_{calc} $\sqrt{3} V_L I_L \cos\theta$	% Error
1	400 V	3.6A	220	-135	340	-82.12°	341.94	0.57
2	360 V	3.0A	165	-97	272	-81.47°	277.46	2
3	300 V	2.4A	120	-60	240	-79.10°	235.81	1.74
4	280 V	2.2A	100	-50	200	-79.10°	201.75	0.875
5	240 V	2.0A	80	-45	140	-80.81°	132.77	5.16

Calculations :

1] • $P_{measured} = (220 - 135)4 = 340W$

• $\theta = \tan^{-1}\left[\sqrt{3}\left(\frac{-355}{85}\right)\right] = -82.12°$

• $P_{calculated} = \sqrt{3} \times 400 \times 3.6 \times \cos(-82.12°) = 341.94\ W$

$\%\ Error = \frac{341.94 - 340}{340} \times 100 = 0.57\ \%$

2] • $P_{measured} = (165 - 97)4 = 272\ W$

• $\theta = \tan^{-1}\left[\sqrt{3}\left(\frac{-262}{68}\right)\right] = -81.47°$

• $P_{calculated} = \sqrt{3} \times 360 \times 3.0 \times \cos(-81.47°) = 277.46\ W$

$\%\ Error = \frac{277.46 - 272}{272} \times 100 = 2\%$

3] • $P_{measured} = (120-60)4 = 240\ W$

• $\theta = \tan^{-1}\left[\sqrt{3}\left(\frac{-180}{60}\right)\right] = -79.10°$

• $P_{calculated} = \sqrt{3} \times 300 \times 2.4 \times \cos(-79.10°) = 235.81\ W$

$\%\ Error = \frac{235.81 - 240}{240} \times 100 = 1.74\ \%$

4] • $P_{measured} = (100-50)4 = 200\ W$

• $\theta = \tan^{-1}\left(\sqrt{3}\left(\frac{-150}{50}\right)\right) = -79.10°$

• $P_{calculated} = \sqrt{3} \times 280 \times 2.2 \times \cos(-79.10°) = 201.75\ W$

$\%\ Error = \frac{201.75 - 200}{200} \times 100 = 0.875\ \%$

5] • $P_{measured} = (80-45)4 = 140\ W$

• $\theta = \tan^{-1}\left[\sqrt{3}\left(\frac{-125}{35}\right)\right] = -80.81°$

• $P_{calculated} = \sqrt{3} \times 240 \times 20 \times \cos(-80.81°) = 132.77\ W$

$\%\ Error = \frac{132.77 - 140}{140} \times 100 = 5.16\ \%$