Experiment 8 :

- ***Aim*** : Three phase power measurement by two wattmeter method
- ***Objective*** : Three phase power measurement using two wattmeter method.

Theory :

The connection diagram for the measurement of power in three phase power measurement circuit using two wattmeter's method is shown in figure 1. This is irrespective of the circuit connection star or delta. The circuit may be taken as balanced or unbalanced one, balanced type being only a special case. Please not the connection of two wattmeter's. The current coil of the wattmeter's 1 and 2 in series with R and B phase with the pressure voltage coils being connected across R-Y and B-Y respectively. Y is the third phase in which no current coil is connected.

If star connected circuit is taken as an example the total instantaneous power consumed in the circuit is,

W=IRN·V(RN)+IYN·V(YN)+IBN·VBNW=IRN·V(RN)+IYN·V(YN)+IBN·VBN . . . (1)

Each of the terms in the above expression equation (1) is the instantaneous power consumed by the phases. From the connection diagram, the circuit in and the voltages across the respective (current, power or voltage) coils in the wattmeter, W1 are IRN and VRY = VRN – VYN.
So, the instantaneous power measured by the
wattmeter W1 is W1=IRN·VRYW1=IRN·VRY.

Similarly the instantaneous power measured by the wattmeter W2 is.
W2=IBN·VBY=IBN·(VBN−VYN)

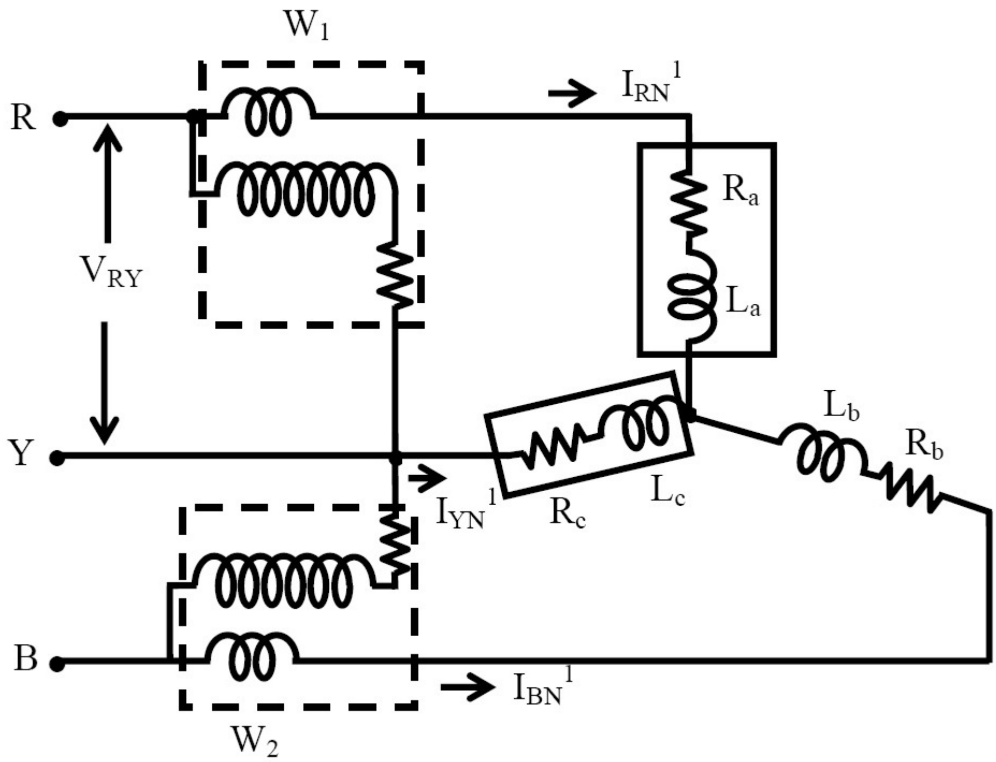
Some of the two readings as given above is,

$$
\begin{aligned}
W_1 + W_2 &= I_{RN}(V_{RN} - V_{YN}) + I_{BN}(V_{BN} - V_{YN}) \\
&= I_{RN}V_{RN} + I_{BN}V_{BN} - V_{YN}(I_{RN} + I_{BN}) \quad ------(2)
\end{aligned}
$$

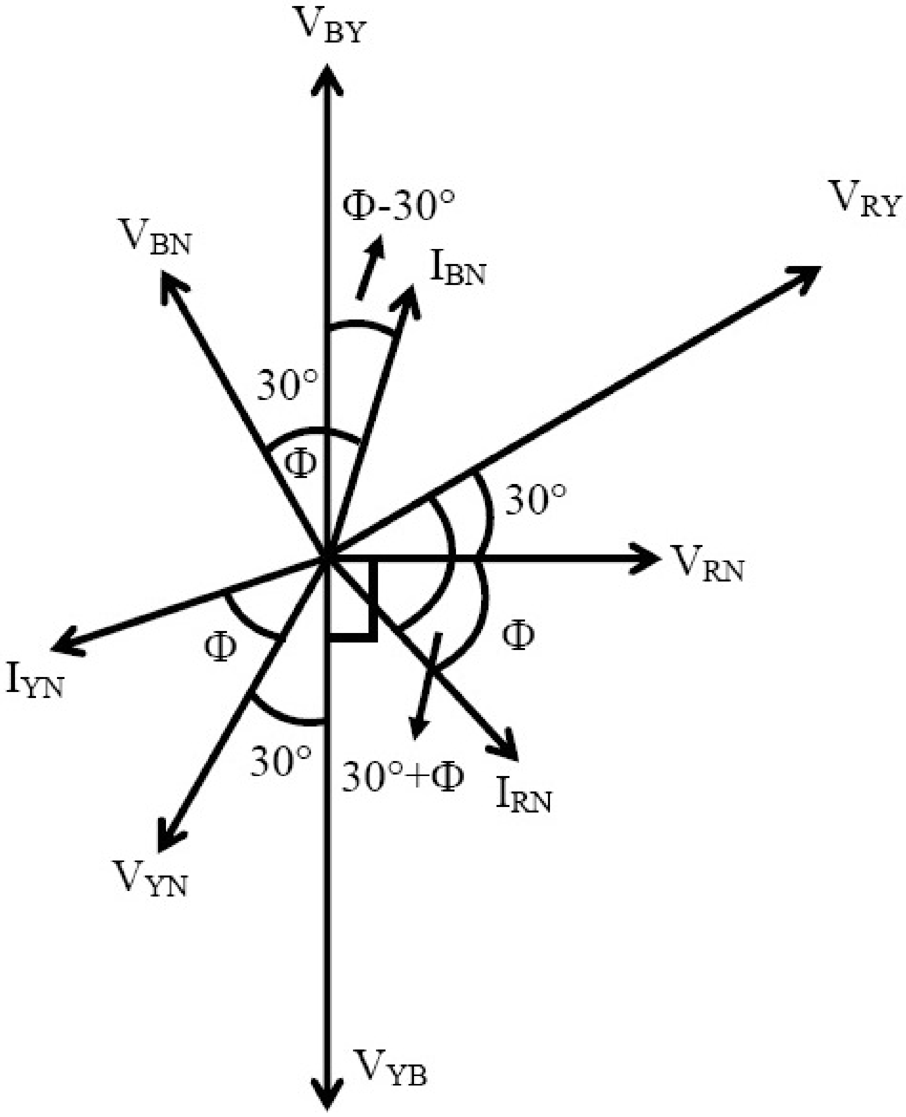
$$\text{and } I_{RN} + I_{BN} + I_{YN} = 0$$
$$\text{applying in equation (2)},$$

$$W_1 + W_2 = I_{RN}V_{RN} + I_{BN}V_{BN} + V_{YN}\, I_{YN} \quad --------(3)$$

Equation (1) is compared with equation (3) to give the total instantaneous power consumed in the circuit. They are found to be same. The phasor diagram of three phase balanced star connected circuit is shown in figure 2.



[Fig 1: Connection diagram for three phase power measurement using two wattmeter method]



Circuit Diagram –

- ***Balanced -***

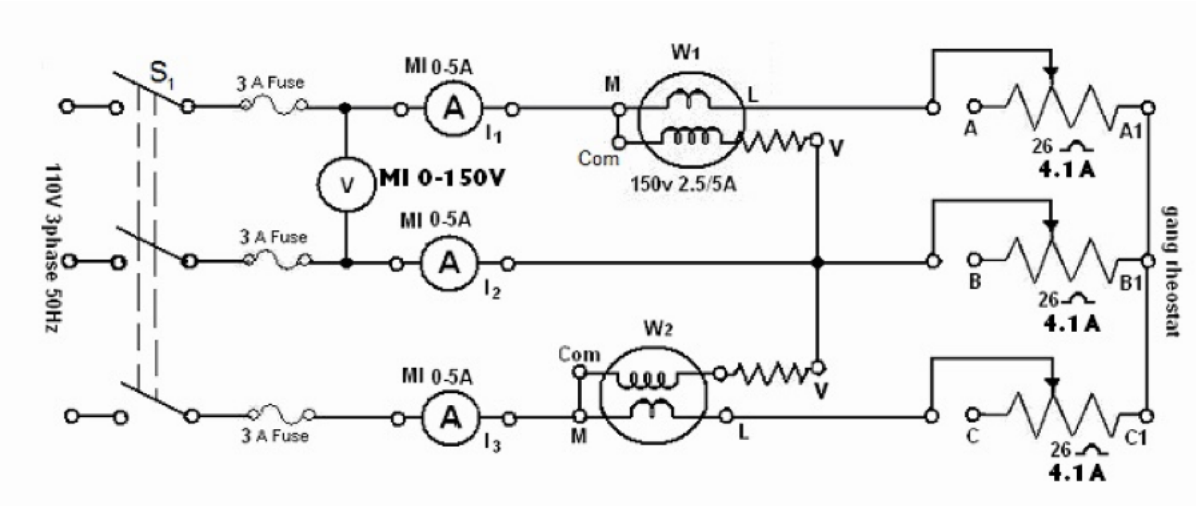


Fig. 1. Three phase power measurement circuit under balance condition

- ***Unbalanced –***

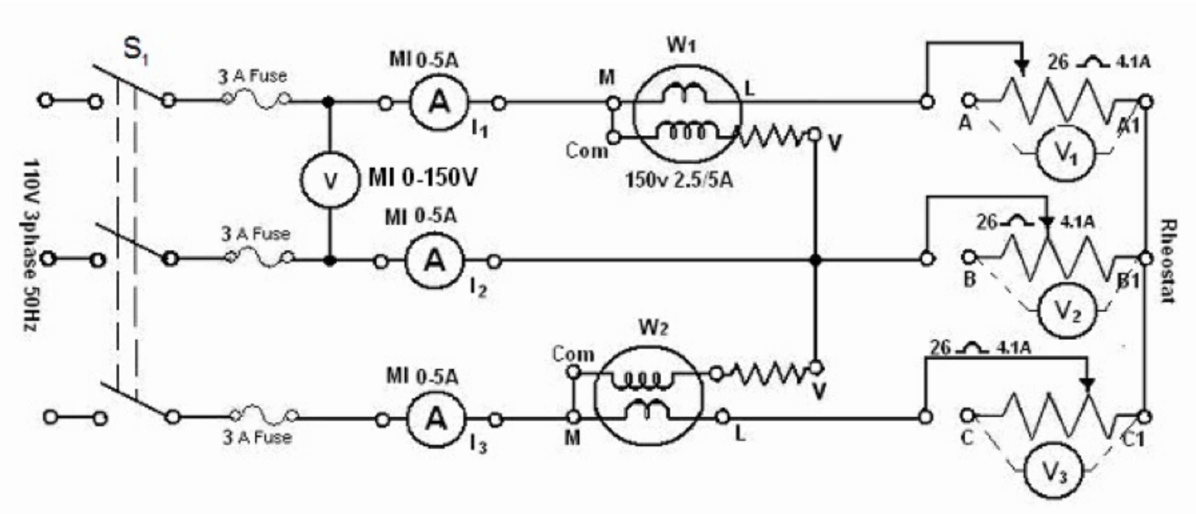


Fig. 2. Three phase power measurement circuit under unbalance condition

Procedure –

Balanced –

1. Connect the circuit as shown in Fig. 1.
2. Adjust the ganged rheostat for the maximum resistance.
3. Switch on the supply.
4. Close switch S1S1.
5. Read the meters to obtain VL, I1, I2, and I3. Note the wattmeter reading W1 and W2 (Note the multiplying factor on the wattmeter).

6. Vary the load resistance and obtain at least five sets of observations, the current should not exceed the limit (4.1 A).

Unbalanced –

1. Connect the circuit as shown in Fig. 2.
2. Replace the ganged rheostat by three separate rheostats of 26 Ω, 4.1 A and connect in a star.
3. Adjust the three rheostats at the maximum values.
4. Switch on the supply and set the autotransformer to 110 V.
5. Close switch S and take five sets of observation for different rheostat settings such that the reading of I1, I2 and I3 in each set is appreciably different to create unbalanced loading condition. The current should not exceed the limits in each arm.

Observations –

Balanced –

Serial no. of Observation	V_{RY}	I_R (Amp)	Cos(V_{RY}, I_R)	V_{BY}	I_B (Amp)	Cos(V_{BY}, I_B)	I_3(Amp)	W_1	W_2	W_C (Calculated power)	W_M(Measured Power=W_1+W_2)
1st	100	2.3093977	0.8652280	100	2.3093977	0.8669190	2.3093977	199.81557	200.20609	399.99885	400.02166
2nd	100	1.1546988	0.8652280	100	1.1546988	0.8669190	1.1546988	99.907785	100.10304	199.99942	200.01083
3rd	100	0.7697992	0.8652280	100	0.7697992	0.8669190	0.7697992	66.605190	66.735364	133.33295	133.34055
4th	100	0.5773494	0.8652280	100	0.5773494	0.8669190	0.5773494	49.953892	50.051523	99.999713	100.00541
5th	100	0.4618795	0.8652280	100	0.4618795	0.8669190	0.4618795	39.963114	40.041218	79.999771	80.004333

Unbalanced –

Serial no. of Observation	V_R	V_y	V_b	I_R (Amp)	I_Y (Amp)	I_B (Amp)	W_C (Calculated power)	W_1	W_2	W_M(Measured Power=W_1+W_2)
1st	87.052381	119.29800	134.21025	0.7254354	0.7456114	0.7456114	252.16955	128.08477	125.78477	253.86955
2nd	85.421906	117.33947	135.86676	0.6101556	0.6175753	0.6175753	208.49458	106.24729	103.94729	210.19458
3rd	83.249652	121.28806	137.82734	0.5549968	0.5513086	0.5513086	189.05585	96.527927	94.227927	190.75585
4th	80.241199	121.33075	140.74367	0.5015067	0.4853223	0.4853223	167.43207	85.716036	83.416036	169.13207
5th	77.785138	121.43559	143.12052	0.4575589	0.4336979	0.4336979	150.32873	77.164368	74.864368	152.02873

Result –

Three Phase Power has been calculated successfully using Wattmeter method.

Precautions –

1. Connection should be tight.
2. Note down the reading carefully.
3. Ammeter reading should not exceed the limit.
4. Switch of the circuit when not in use.
5. With negative deflection in wattmeter connection should be reversed.

Conclusion –

1. Sum of two wattmeter readings is the sum of total power consumed in three phase cut.
2. Power factor cos = cos(tan((W2-W1)/(W2+W1))).
3. These networks are used in power industry due to reasons of economy and performance.