MEASUREMENT OF POWER

AIM:

Three phase power measurement by two wattmeter method.

APPARATUS REQUIRED:

- Virtual Lab

THEORY:

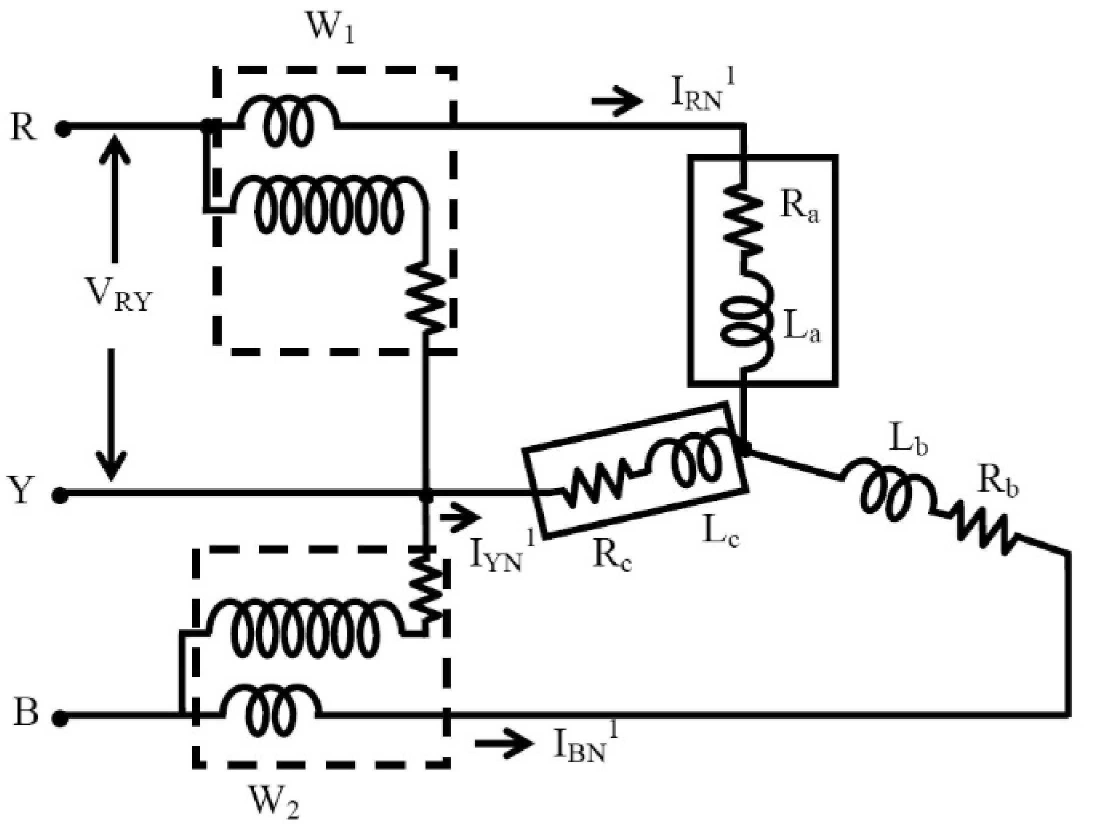


Fig 1: Connection diagram for three phase power measurement using two wattmeter method

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 note 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,

$$W = I_{RN} * V_{RN} + I_{YN} * V_{YN} + I_{BN} * V_{BN} \ldots (1)$$

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, pressure or voltage) coils in the wattmeter, W_1 are I_{RN} and

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

So, the instantaneous power measured by the wattmeter W_1 is

$$W_1 = I_{RN} * V_{RY}$$

Similarly the instantaneous power measured by the wattmeter W_2 is.

$$W_2 = I_{BN} * V_{BY} = I_{BN} * (V_{BN} - V_{YN})$$

Some of the two readings as given above is,

$$W_1 + W_2 = I_{RN}(V_{RN} - V_{YN}) + I_{BN}(V_{BN} - V_{YN})$$

$$= I_{RN}V_{RN} + I_{BN}V_{BN} - V_{YN}(I_{RN} + I_{BN}) \ldots . (2)$$

$$\text{and } I_{RN} + I_{BN} + I_{YN} = 0$$

applying in equation (2),

$$W_1 + W_2 = I_{RN}V_{RN} + I_{BN}V_{BN} + V_{YN}I_{YN} \ldots .. (3)$$

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.

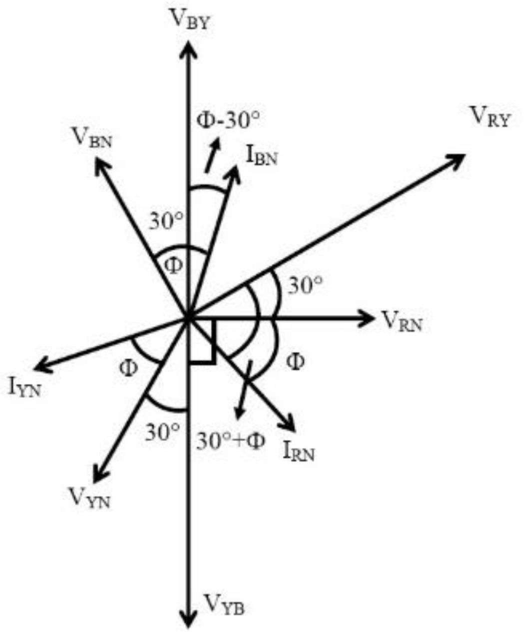


Fig 2: Phasor diagram of three phase balanced star connected circuit

PROCEDURE:

BALANCED LOAD :

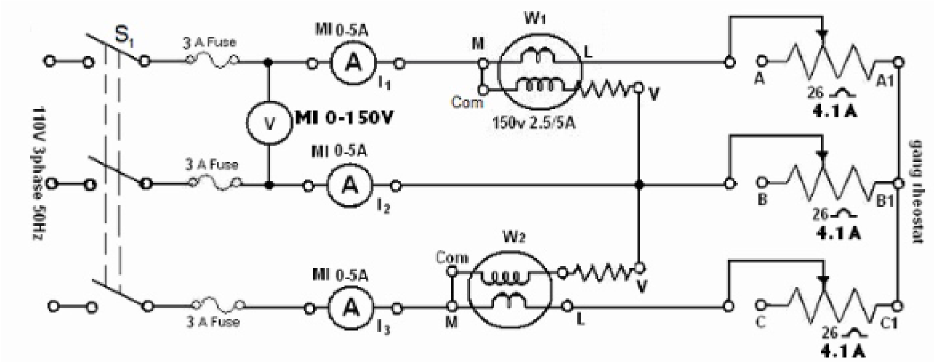


Fig. 1. Three phase power measurement circuit under balance condition

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 S_1.

5. Read the meters to obtain V_L, I_1, I_2 and I_3. Note the wattmeter reading W_1 and W_2`(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 LOAD :

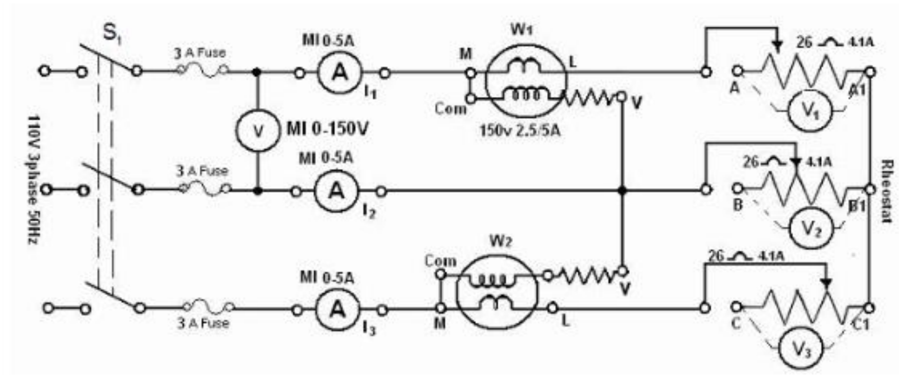


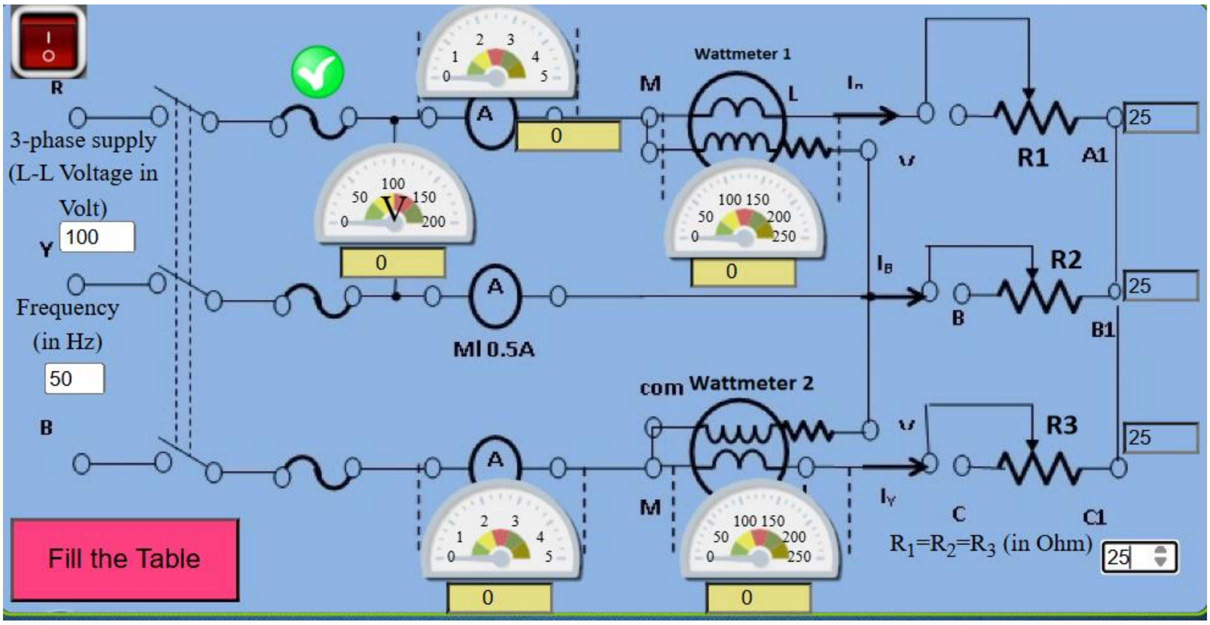
Fig. 2. Three phase power measurement circuit under unbalance condition

i. Connect the circuit as shown in Fig. 2.
ii. Replace the ganged rheostat by three separate rheostats of 26 Ω, 4.1 A and connect in a star.
iii. Adjust the three rheostats at the maximum values.
iv. Switch on the supply and set the autotransformer to 110 V.
v. Close switch S_1 and take five sets of observation for different rheostat settings such that the reading of I_1, I_2 and I_3 in each set is appreciably different to create unbalanced loading condition. The current should not exceed the limits in each arm.

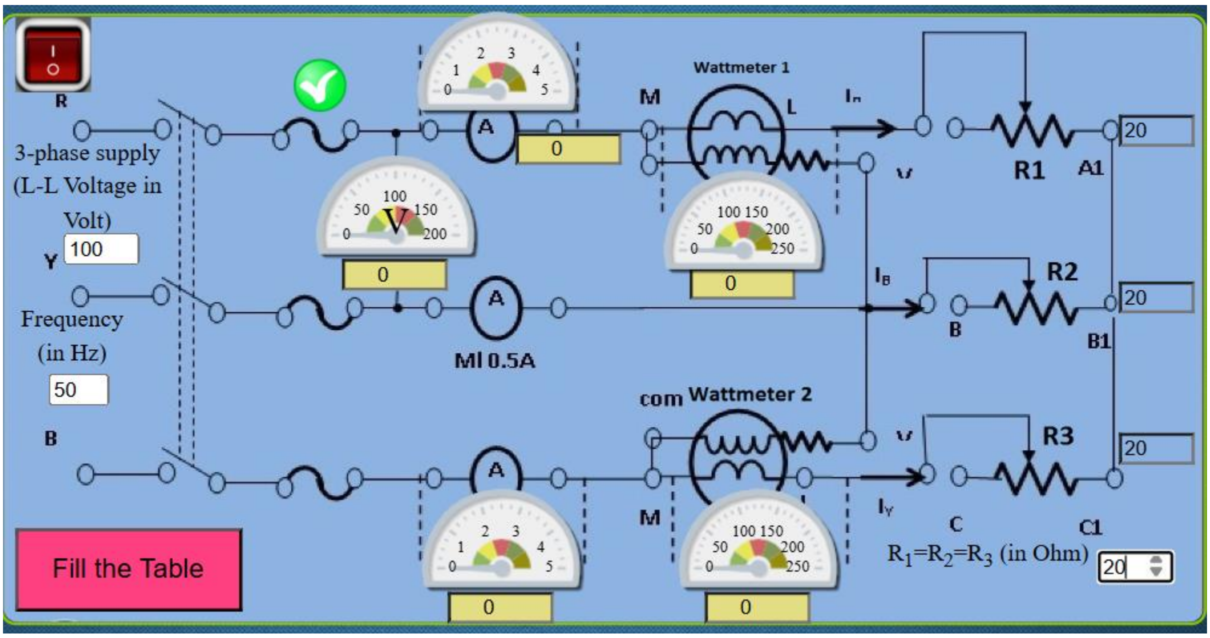
SIMULATION

BALANCED:

CASE 1:



CASE 2:

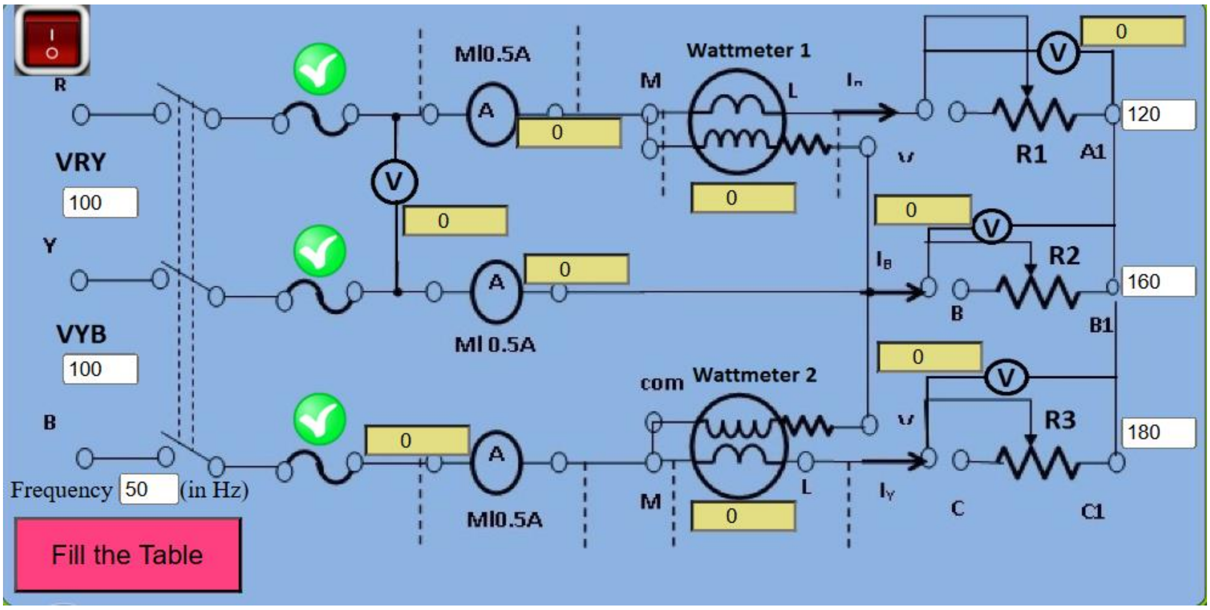


TABULATION:

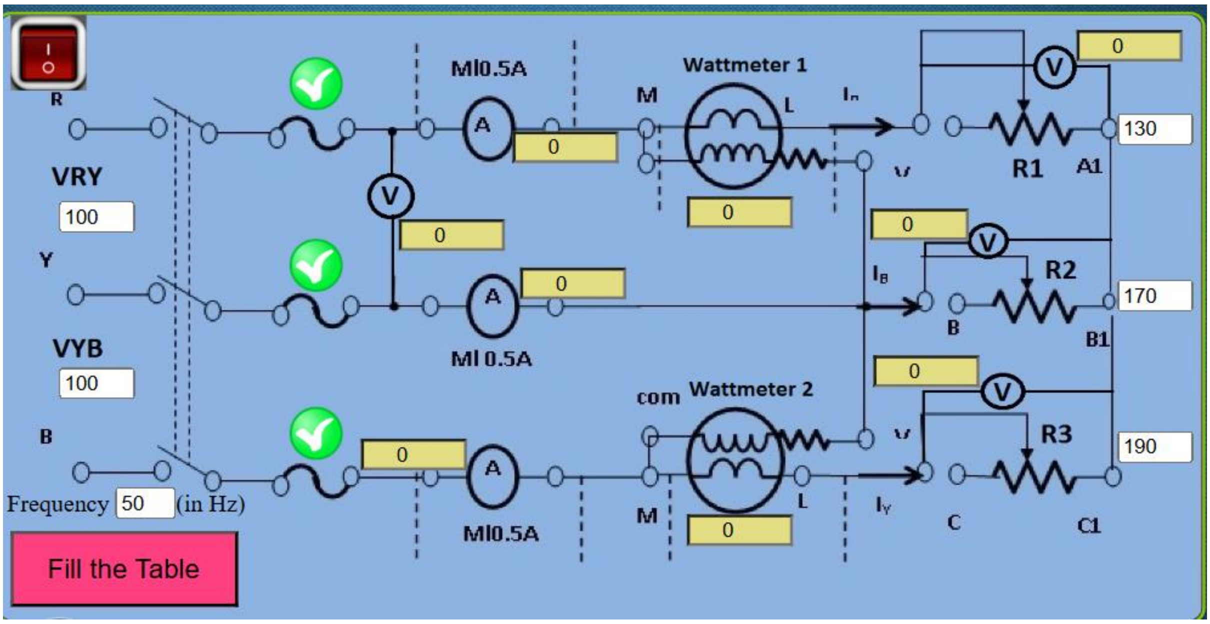
Serial no. of Observation	V_{RY}	I_R (Amp)	Cos(V_{RY}, I_R)	V_{BY}	I_B (Amp)	Cos(V_{BY}, I_B)	I_3(Amp)	W_1	W_2	W_C (Calculated power)	W_M(Measured Power=W_1+W_2)
1st	100	2.3093977	0.8652280	100	2.3093977	0.8669190	2.3093977	199.81557	200.20609	399.99885	400.02166
2nd	100	2.8867472	0.8652280	100	2.8867472	0.8669190	2.8867472	249.76946	250.25761	499.99856	500.02708

UNBALANCED:

CASE 1:



CASE 2:



TABULATION:

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	97.802081	91.417450	125.98662	0.8150173	0.5713590	0.6999256	220.12385	112.06192	109.76192	221.82385
2nd	101.36629	89.766017	122.79396	0.7797407	0.5280353	0.6462840	205.79884	104.89942	102.59942	207.49884

RESULT:

Thus the measurement of power is simulated and validated in virtual lab.