EXPERIMENT-2

Three Phase Power Measurement

Aim of the experiment

Three phase power measurement by two wattmeter method.

Theory

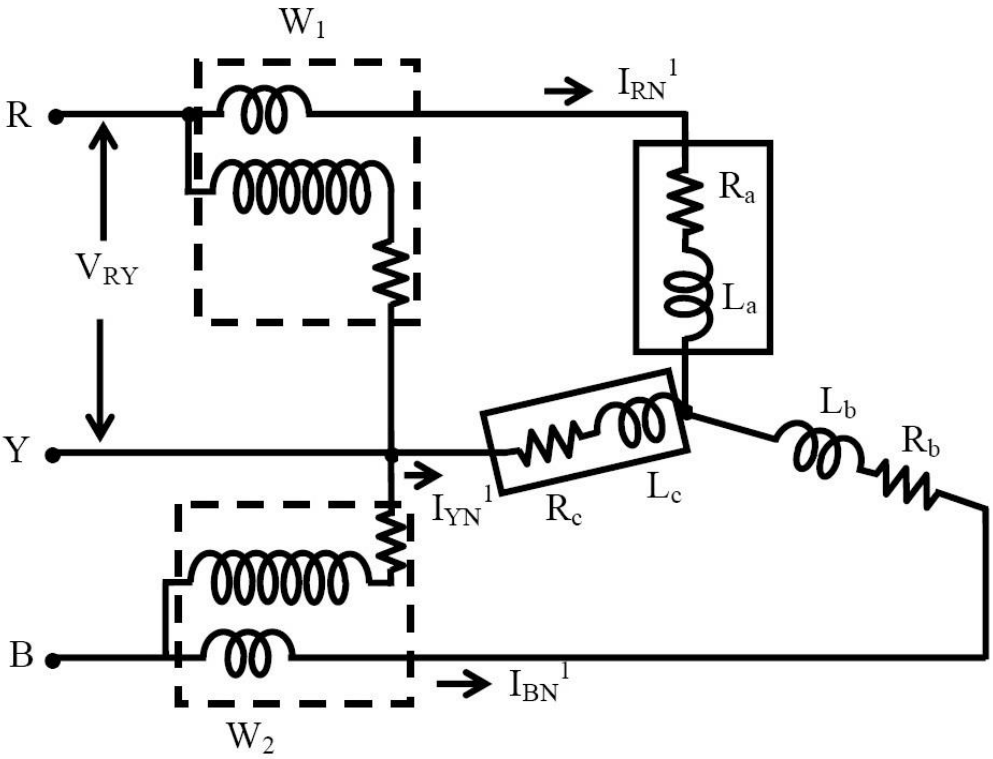


Fig 1: Connection diagram for three phase power measurement using two wattmeter method

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

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

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,

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

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

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

$$applying\ in\ equation\ (2),$$

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

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.

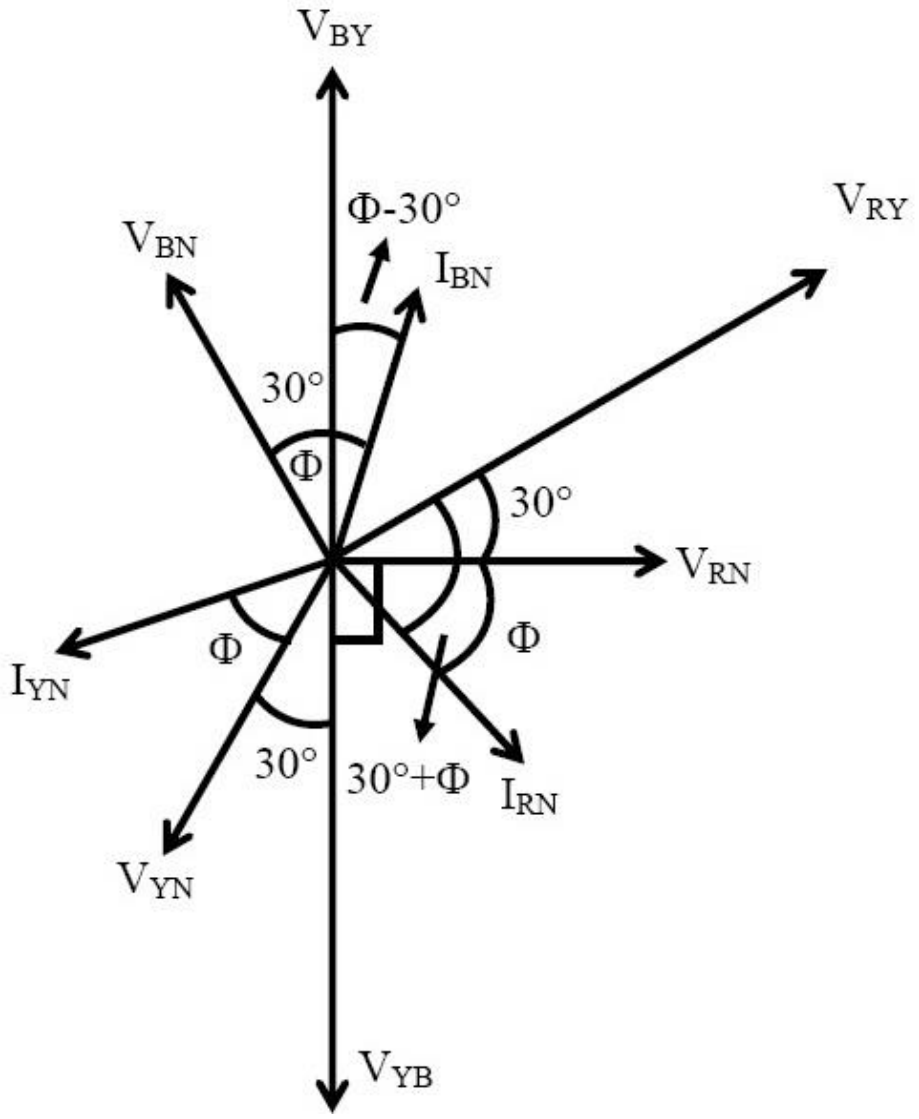


Fig 2: Phasor diagram of three phase balanced star connected circuit

Procedure

BALANCED LOAD :

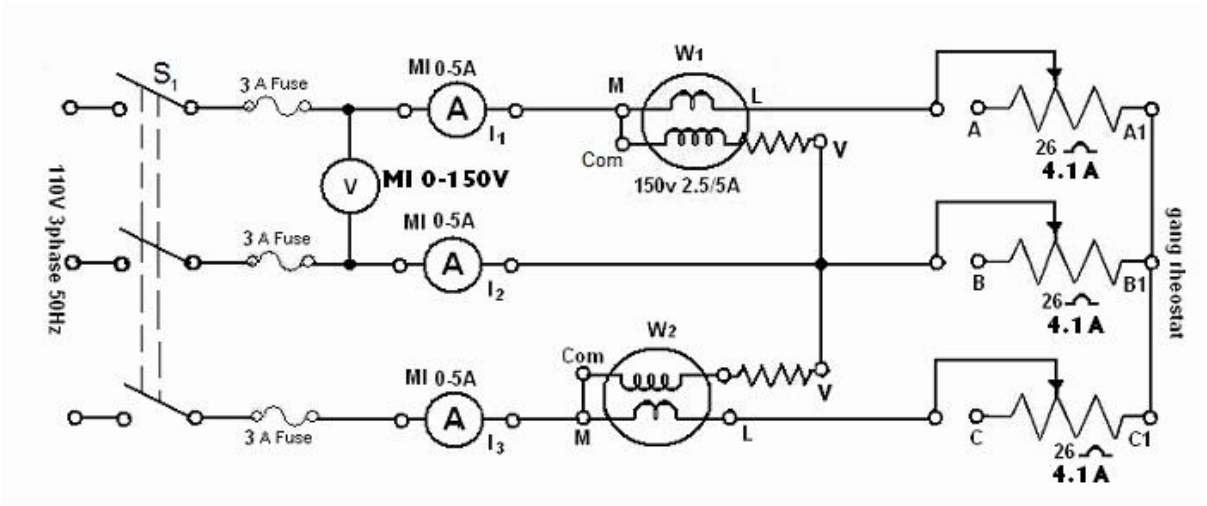


Fig. 1. Three phase power measurement circuit under balance condition

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).

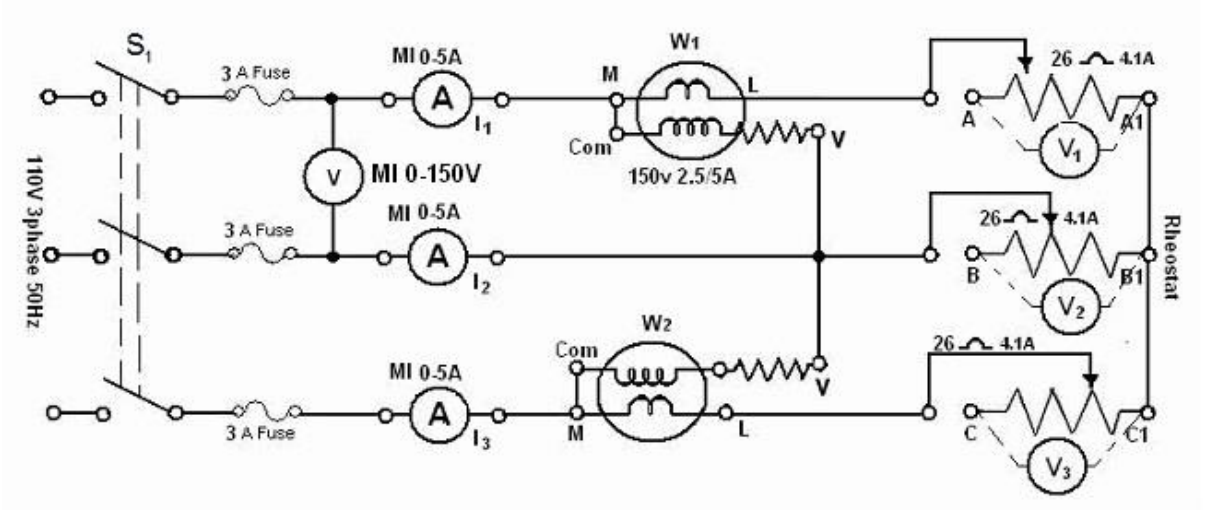
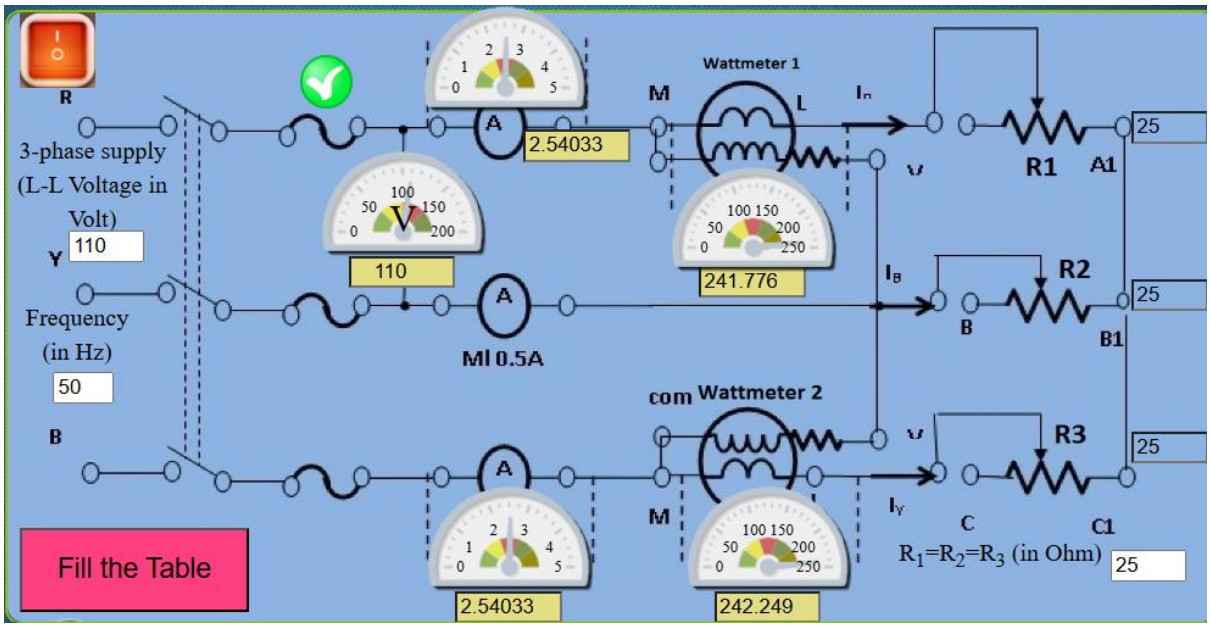


Fig. 2. Three phase power measurement circuit under unbalance condition

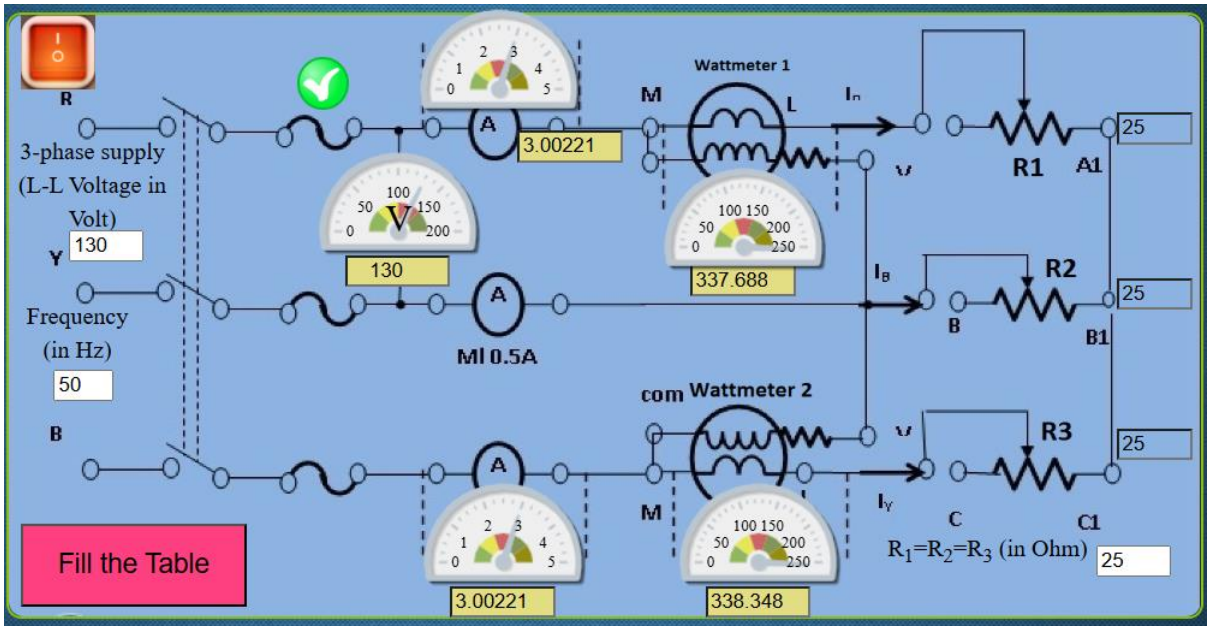
a. Connect the circuit as shown in Fig. 2.
b. Replace the ganged rheostat by three separate rheostats of 26 Ω, 4.1 A and connect in a star.
c. Adjust the three rheostats at the maximum values.
d. Switch on the supply and set the autotransformer to 110 V.
e. Close switch S_1 and take five sets of observation 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.

Balanced Load :

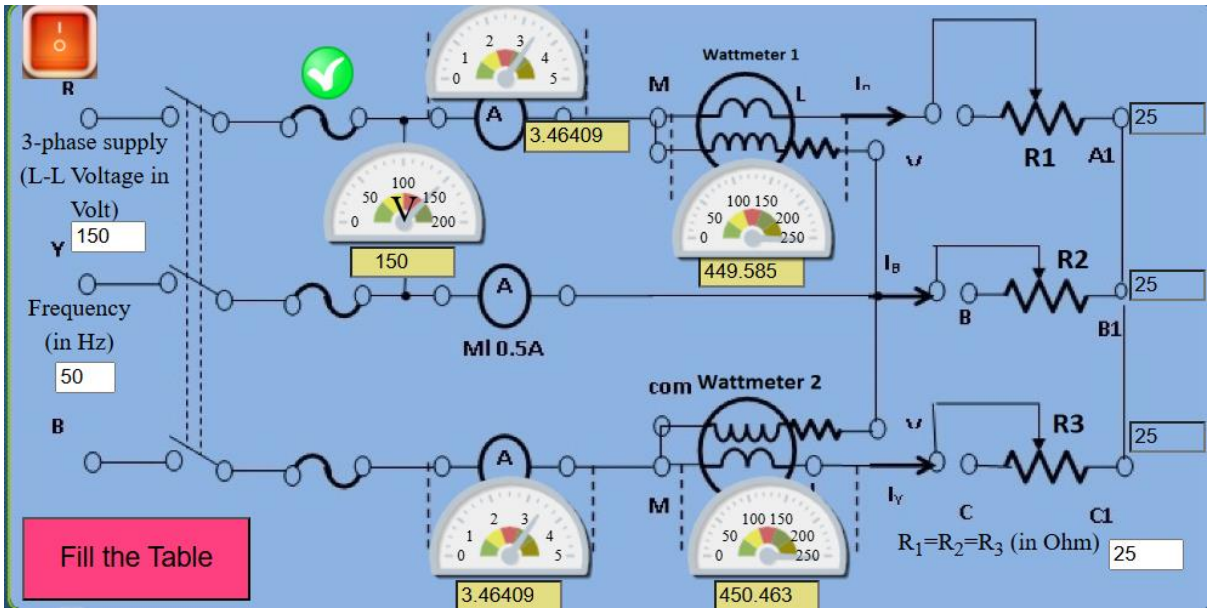
Case-1



Case –2



Case-3

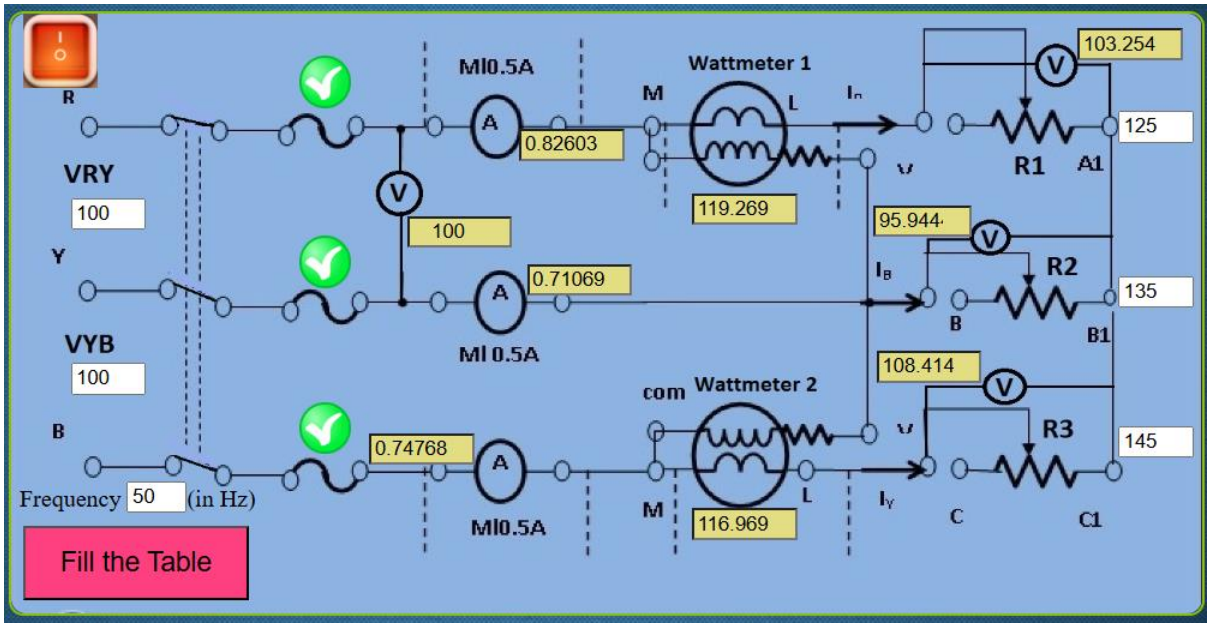


Tabulation

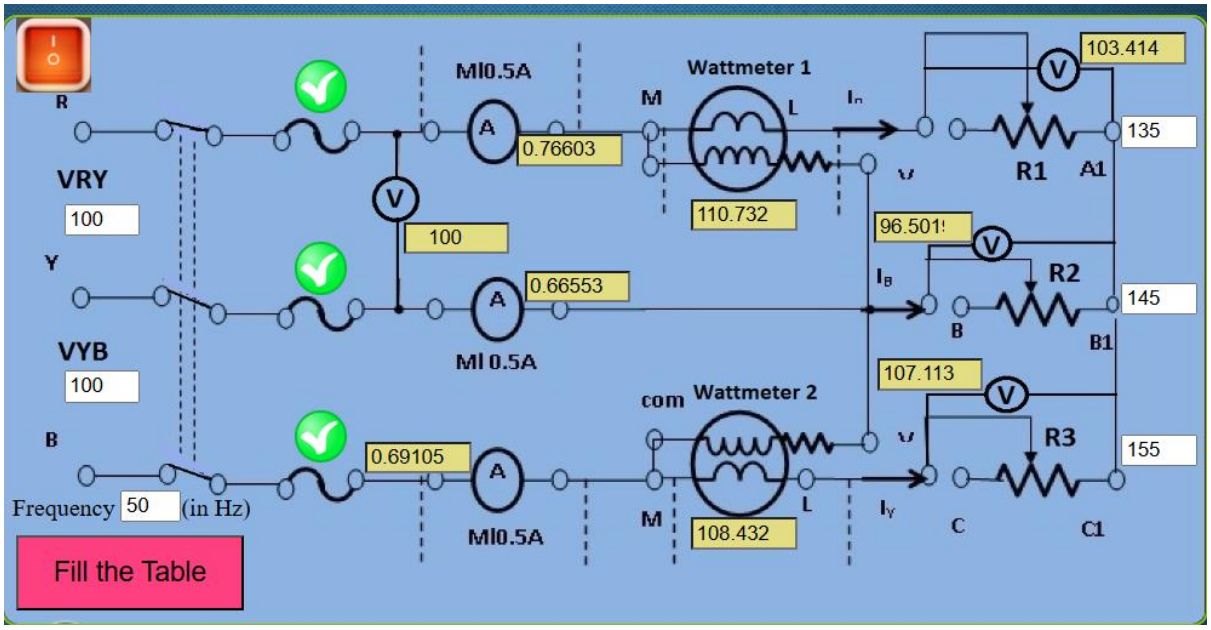
Serial no. of Observation	V_{RY}	I_R (Amp)	Cos(V_{RY}, I_R)	V_{BY}	I_B (Amp)	Cos(V_{BY}, I_B)	I_3(Amp)	W_1	W_2	W_C (Calculated power)	W_M(Measured Power=W_1+W_2)
1st	110	2.5403375	0.8652280	110	2.5403375	0.8669190	2.5403375	241.77684	242.24937	483.99861	484.02621
2nd	130	3.0022171	0.8652280	130	3.0022171	0.8669190	3.0022171	337.68831	338.34829	675.99806	676.03661
3rd	150	3.4640966	0.8652280	150	3.4640966	0.8669190	3.4640966	449.58503	450.46371	899.99742	900.04874

UnbalancedLoad :

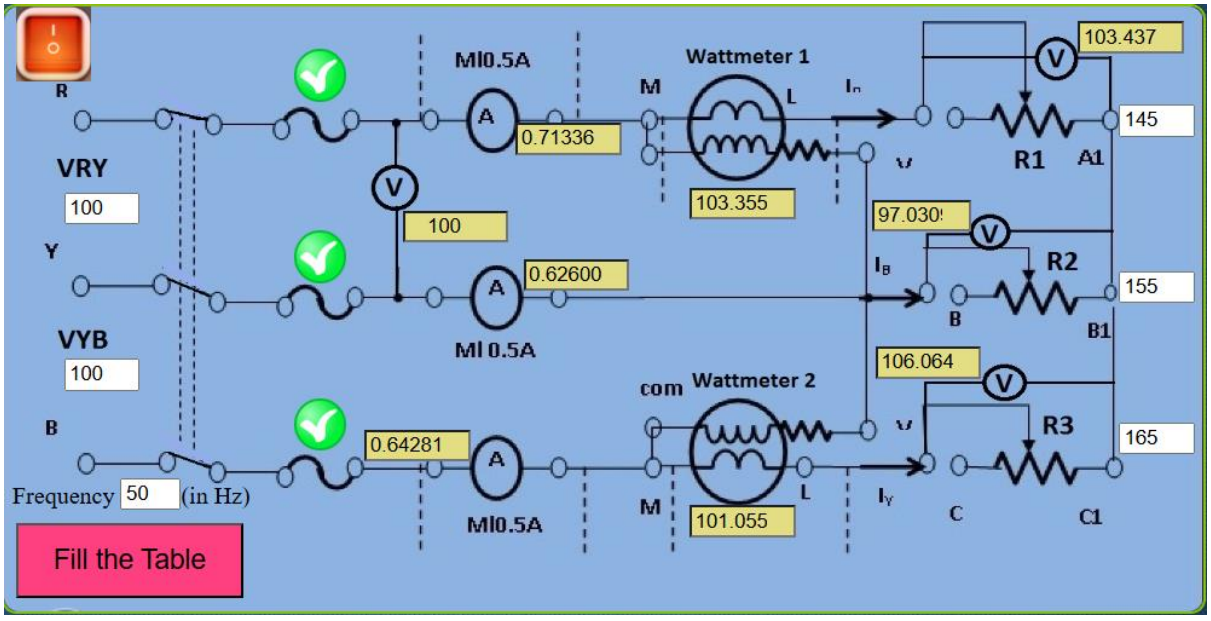
Case-1



Case-2



Case-3



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	103.25402	95.944428	108.41470	0.8260322	0.7106994	0.7476875	234.53913	119.26956	116.96956	236.23913
2nd	103.41455	96.501991	107.11325	0.7660337	0.6655309	0.6910532	217.46506	110.73253	108.43253	219.16506
3rd	103.43750	97.030953	106.06488	0.7133620	0.6260061	0.6428175	202.71072	103.35536	101.05536	204.41072

RESULT

Thus the measurement of power is simulated and validated.