Aim of the experiment

Three phase power measurement by two wattmeter method.

Theory

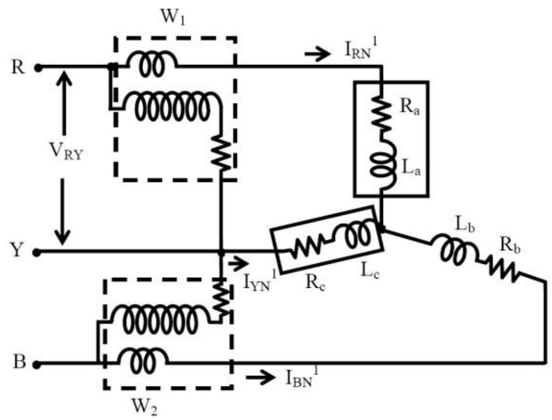


Fig 1: Connection diagram for three phase power measurement using two wattmeter method

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.

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

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,

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

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

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

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

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

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.

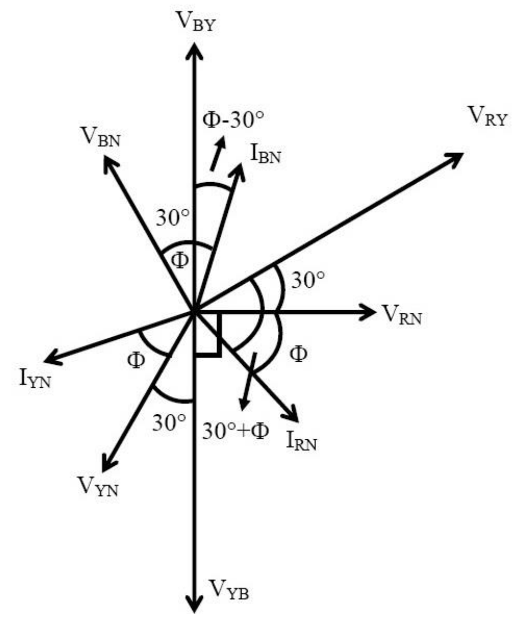


Fig 2: Phasor diagram of three phase balanced star connected circuit

Procedure

BALANCED LOAD :

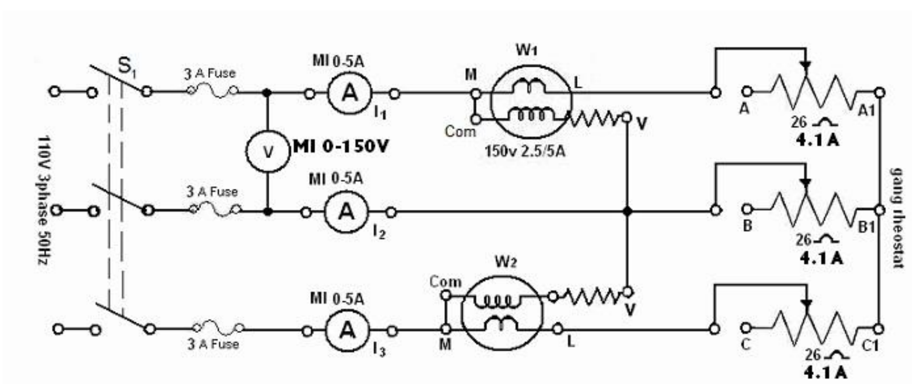


Fig. 1. Three phase power measurement circuit under balance condition

Connect the circuit as shown in Fig. 1.
Adjust the ganged rheostat for the maximum resistance.

Switch on the supply.
Close switch S_1.
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).
Vary the load resistance and obtain at least five sets of observations, the current should not exceed the limit (4.1 A).

UNBALANCED LOAD :

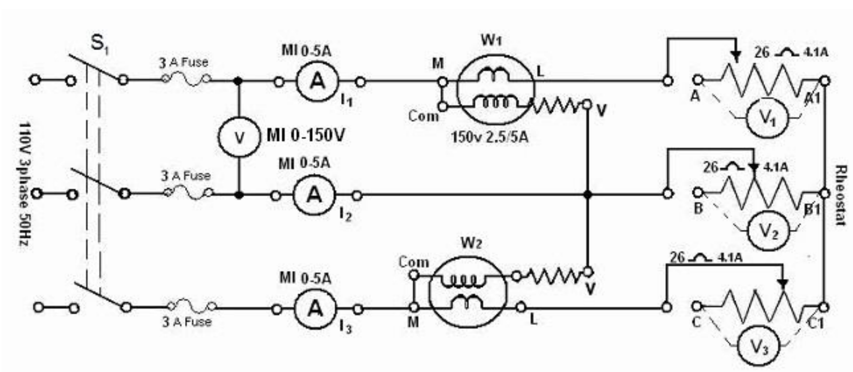


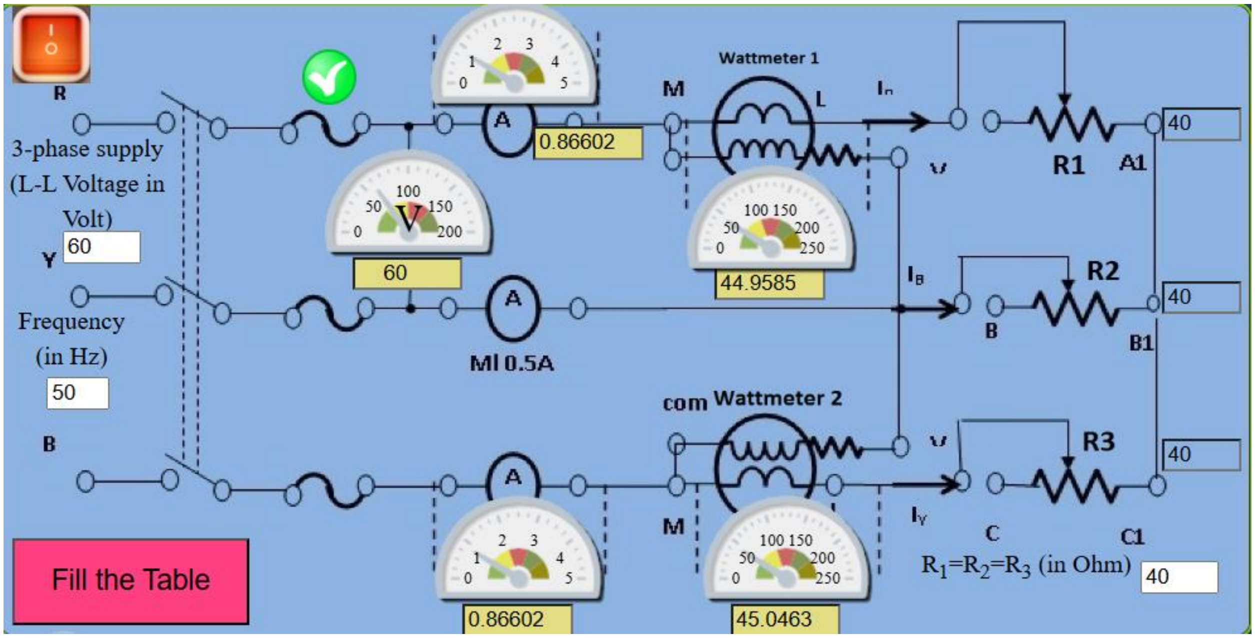
Fig. 2. Three phase power measurement circuit under unbalance condition

Connect the circuit as shown in Fig. 2.
Replace the ganged rheostat by three separate rheostats of 26 Ω, 4.1 A and connect in a star.
Adjust the three rheostats at the maximum values.
Switch on the supply and set the autotransformer to 110 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.

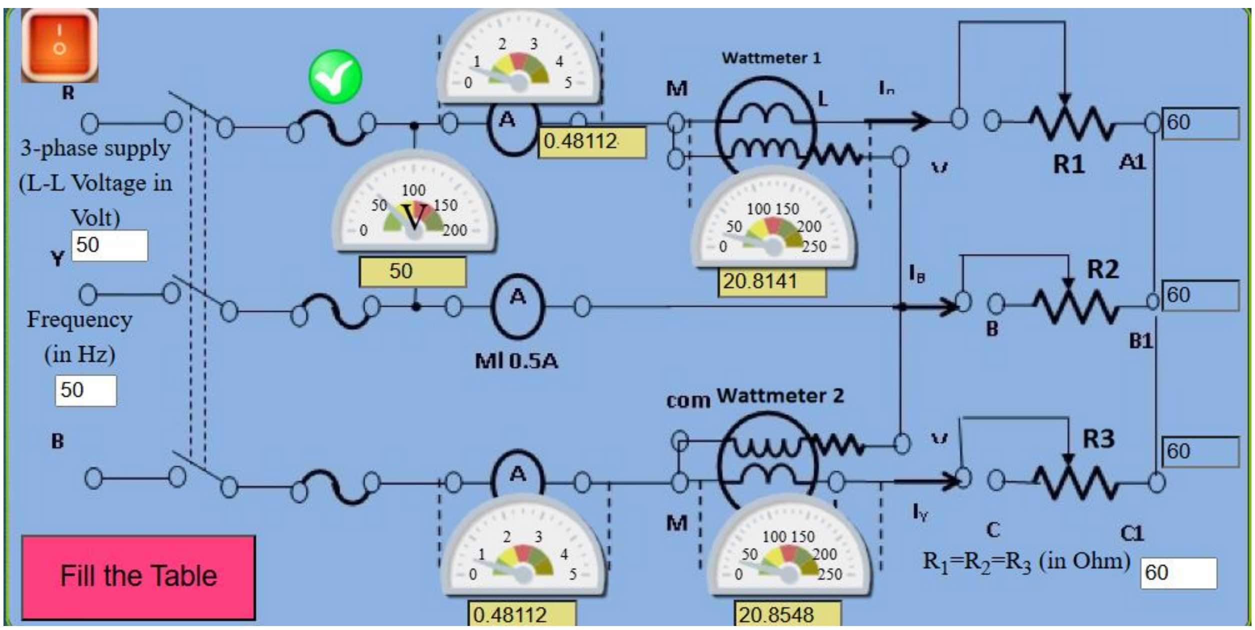
Simulation

Balanced Load

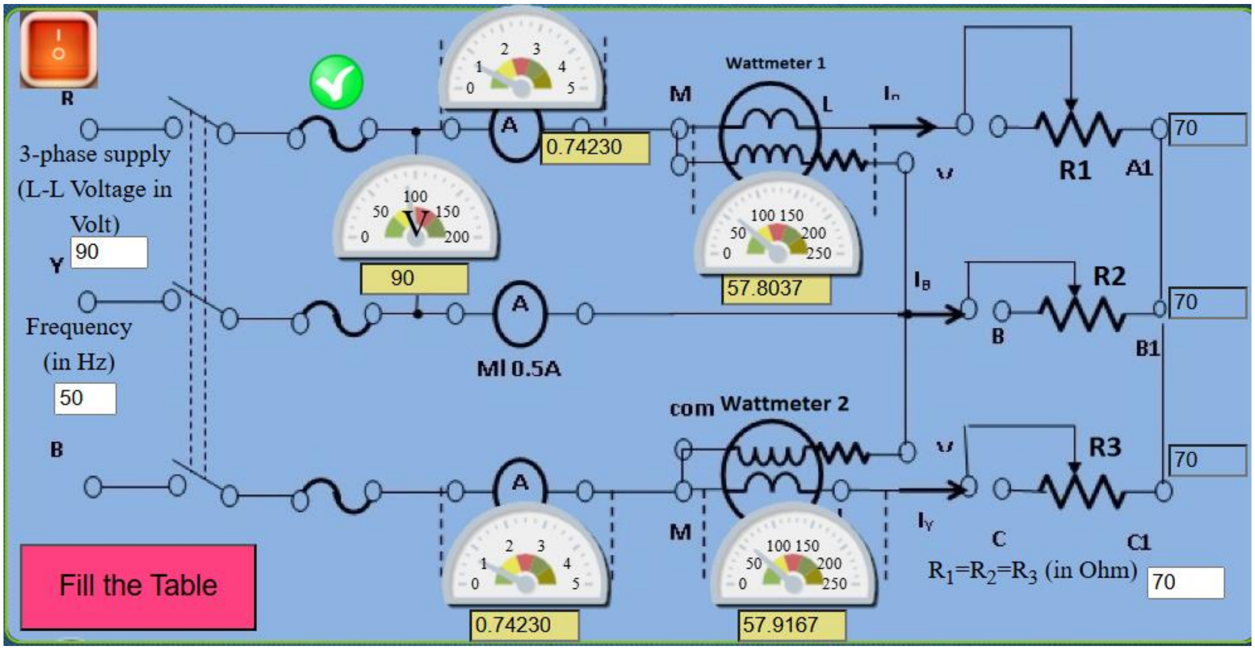
Case:1



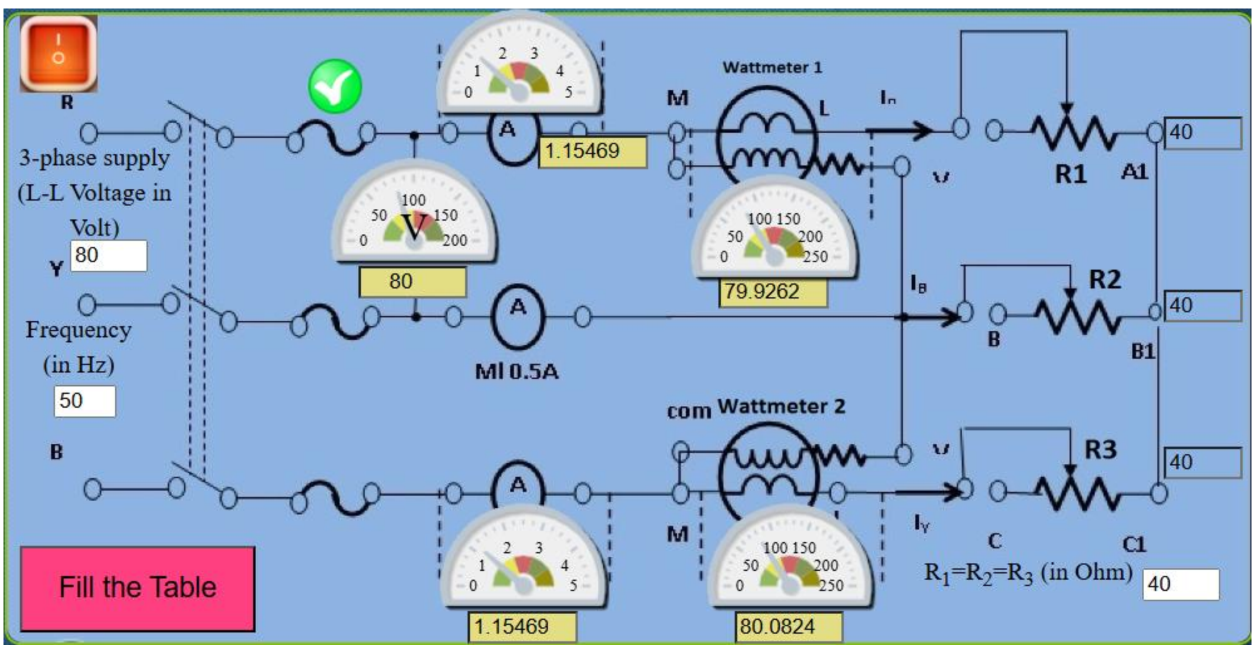
Case:2



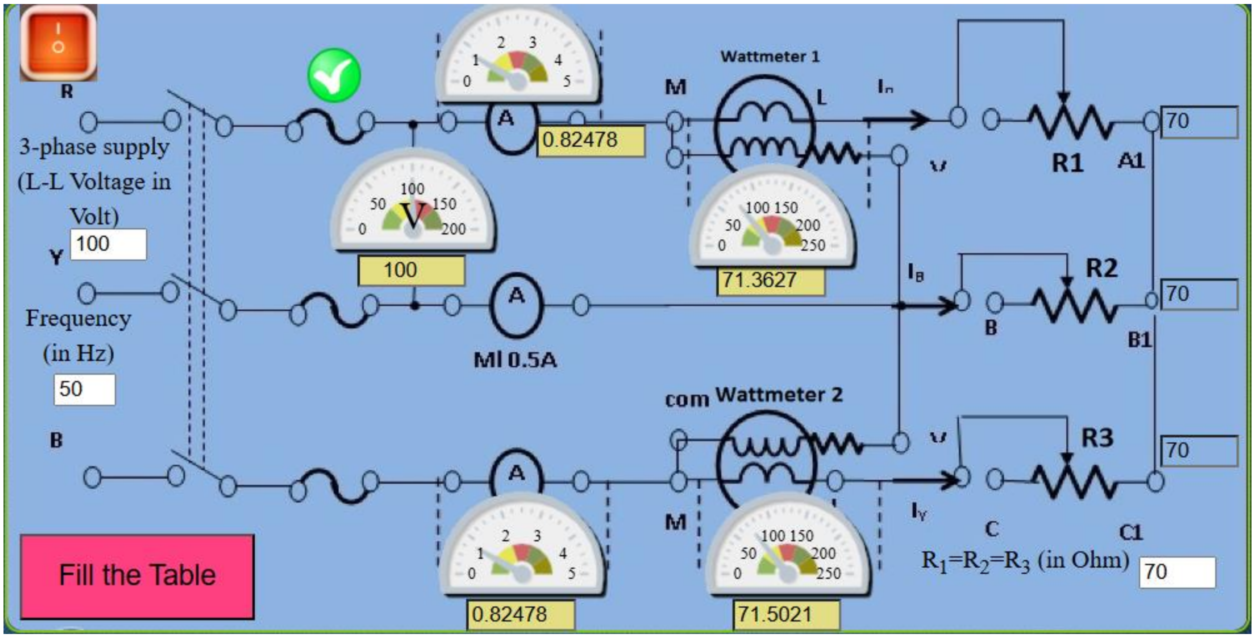
Case:3


R
3-phase supply
(L-L Voltage in
Volt)
90
Y
Frequency
(in Hz)
50
B
Fill the Table
0.74230
90
57.8037
Wattmeter 1
M
L
MI 0.5A
com Wattmeter 2
M
0.74230
57.9167
R1
A1
70
R2
B
B1
70
R3
C
C1
70
R1=R2=R3 (in Ohm)
70

Case:4


R
3-phase supply
(L-L Voltage in
Volt)
80
Y
Frequency
(in Hz)
50
B
Fill the Table
1.15469
80
79.9262
Wattmeter 1
M
L
MI 0.5A
com Wattmeter 2
M
1.15469
80.0824
R1
A1
40
R2
B
B1
40
R3
C
C1
40
R1=R2=R3 (in Ohm)
40

Case:5

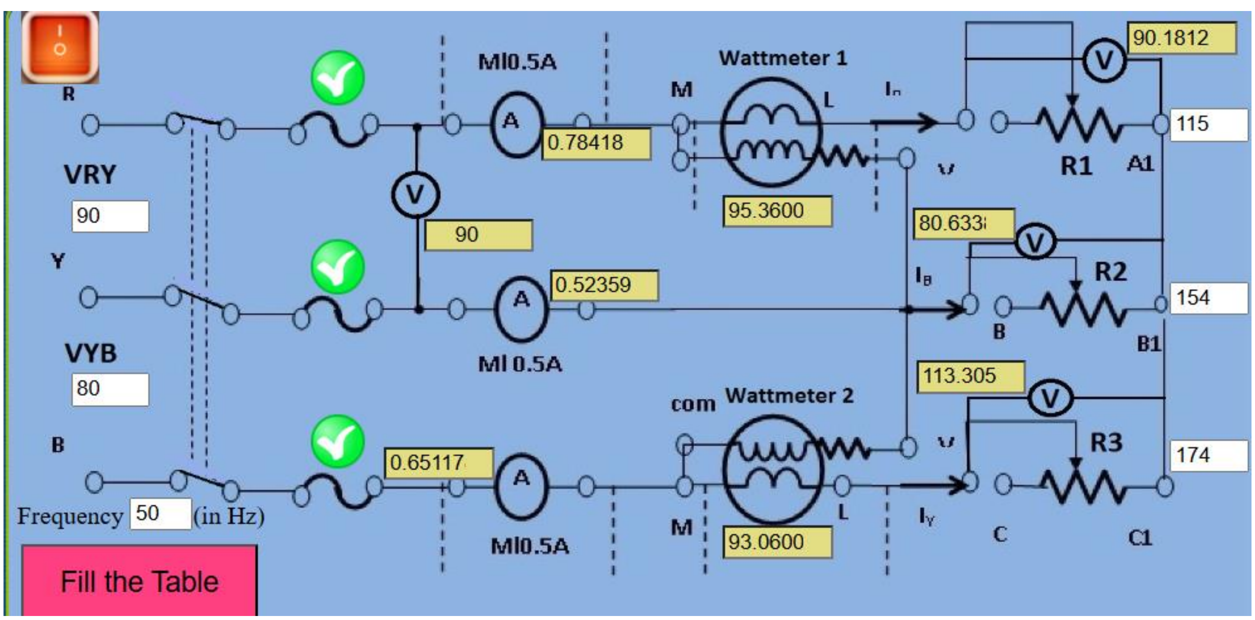


TABULATION

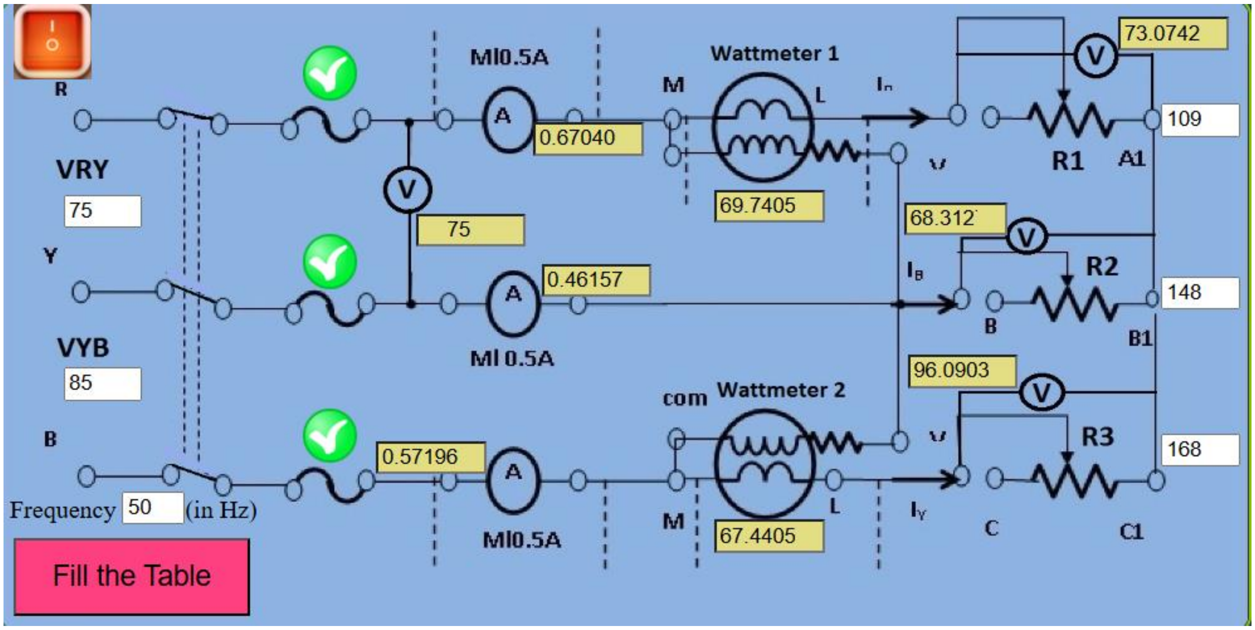
Serial no. of Observation	V_{RY}	I_R (Amp)	Cos(V_{RY}, I_R)	V_{BY}	I_B (Amp)	Cos(V_{BY}, I_B)	I_3(Amp)	W_1	W_2	W_C (Calculated power)	W_M(Measured Power=W_1+W_2)
1st	60	0.8660241	0.8652280	60	0.8660241	0.8669190	0.8660241	44.958503	45.046371	89.999742	90.004874
2nd	50	0.4811245	0.8652280	50	0.4811245	0.8669190	0.4811245	20.814121	20.854801	41.666547	41.668923
3rd	90	0.7423064	0.8652280	90	0.7423064	0.8669190	0.7423064	57.803790	57.916762	115.71395	115.72055
4th	80	1.1546988	0.8652280	80	1.1546988	0.8669190	1.1546988	79.926228	80.082437	159.99954	160.00866
5th	100	0.8247849	0.8652280	100	0.8247849	0.8669190	0.8247849	71.362703	71.502176	142.85673	142.86488

UNBLANCE LOADE

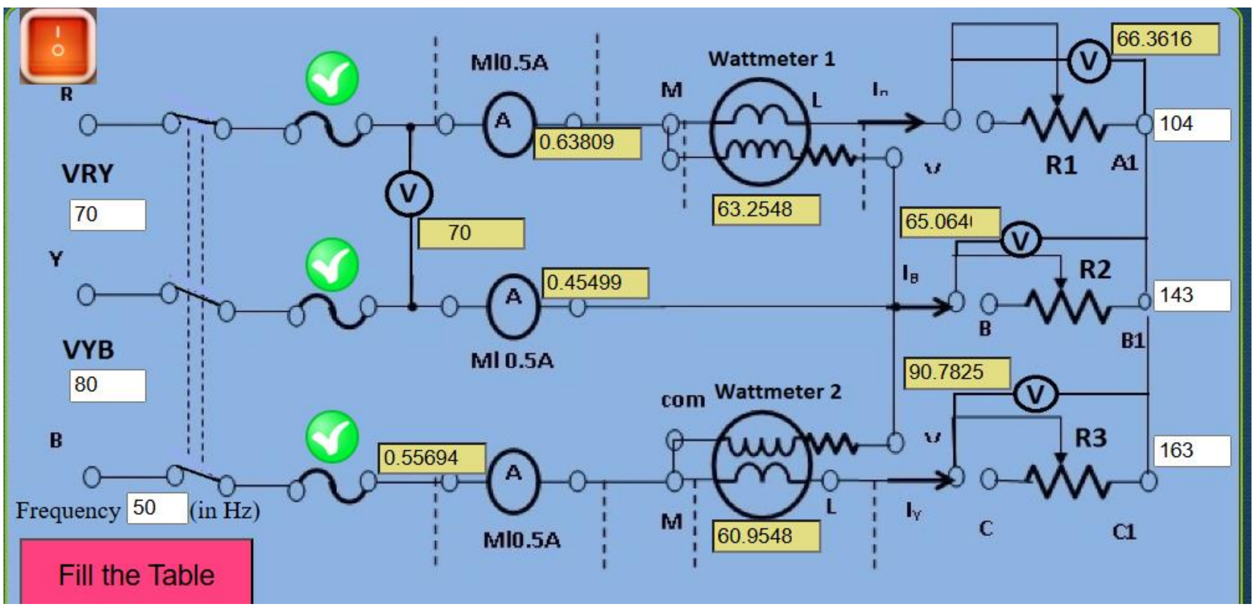
Case:1



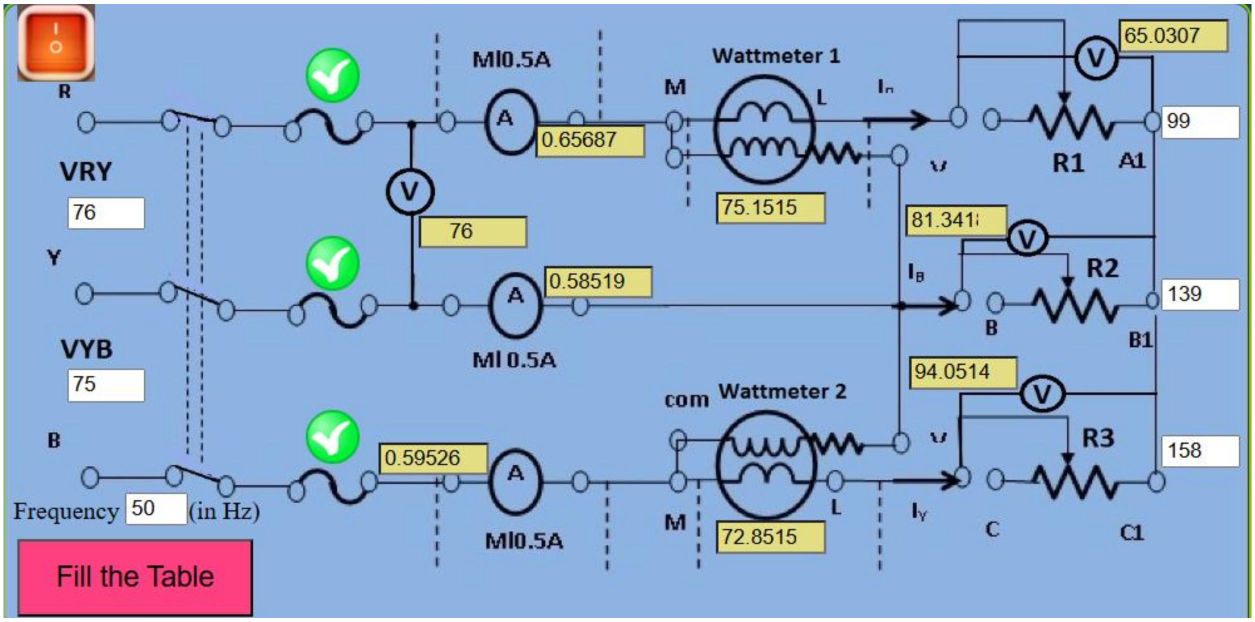
Case:2


73.0742
Wattmeter 1
MI0.5A
R
M
L
109
0.67040
R1
A1
VRY
75
69.7405
75
68.312
Y
R2
0.46157
148
B
VYB
MI 0.5A
B1
85
96.0903
com
Wattmeter 2
B
R3
0.57196
168
Frequency
50
(in Hz)
M
L
C
C1
MI0.5A
67.4405
Fill the Table

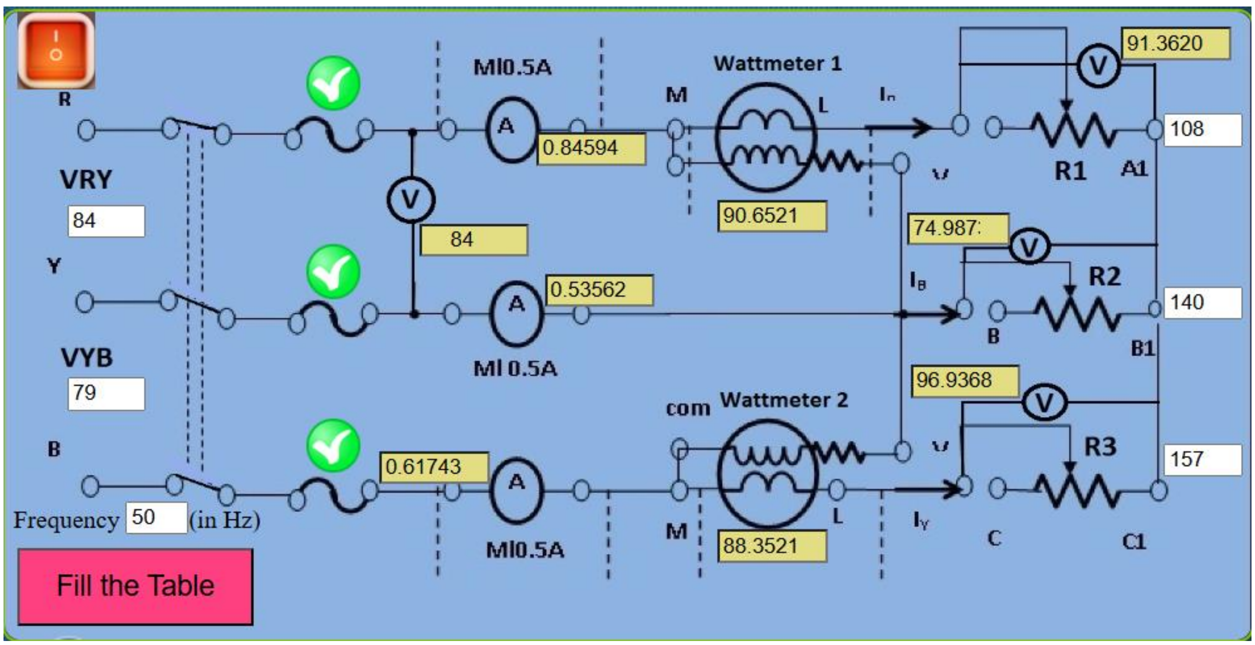
Case:3


66.3616
Wattmeter 1
MI0.5A
R
M
L
104
0.63809
R1
A1
VRY
70
63.2548
70
65.064
Y
R2
0.45499
143
B
VYB
MI 0.5A
B1
80
90.7825
com
Wattmeter 2
B
R3
0.55694
163
Frequency
50
(in Hz)
M
L
C
C1
MI0.5A
60.9548
Fill the Table

Case:4



Case:5



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	90.181212	80.633876	113.30503	0.7841844	0.5235966	0.6511783	186.72012	95.360060	93.060060	188.42012
2nd	73.074281	68.312766	96.090320	0.6704062	0.4615727	0.5719661	135.48118	69.740591	67.440591	137.18118
3rd	66.361640	65.064048	90.782571	0.6380926	0.4549933	0.5569482	122.50978	63.254892	60.954892	124.20978
4th	65.030710	81.341838	94.051490	0.6568758	0.5851930	0.5952625	146.30312	75.151560	72.851560	148.00312
5th	91.362080	74.987321	96.936853	0.8459451	0.5356237	0.6174321	177.30423	90.652116	88.352116	179.00423

RESULT

Thus the measurement of power is simulated and validated