EXPERIMENT-2

Three Phase Power Measurement

Aim of the experiment

Three phase power measurement by two wattmeter method.

Theory:

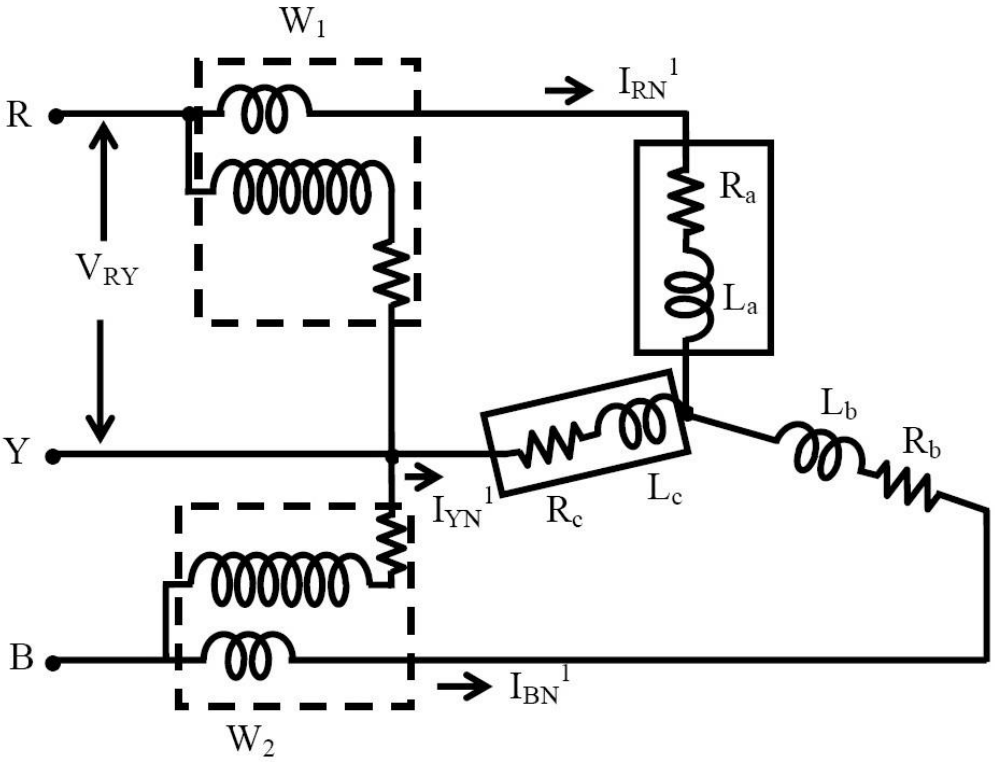


Fig 1: Connection diagram for three phase power measurement using two wattmeter method

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

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

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.

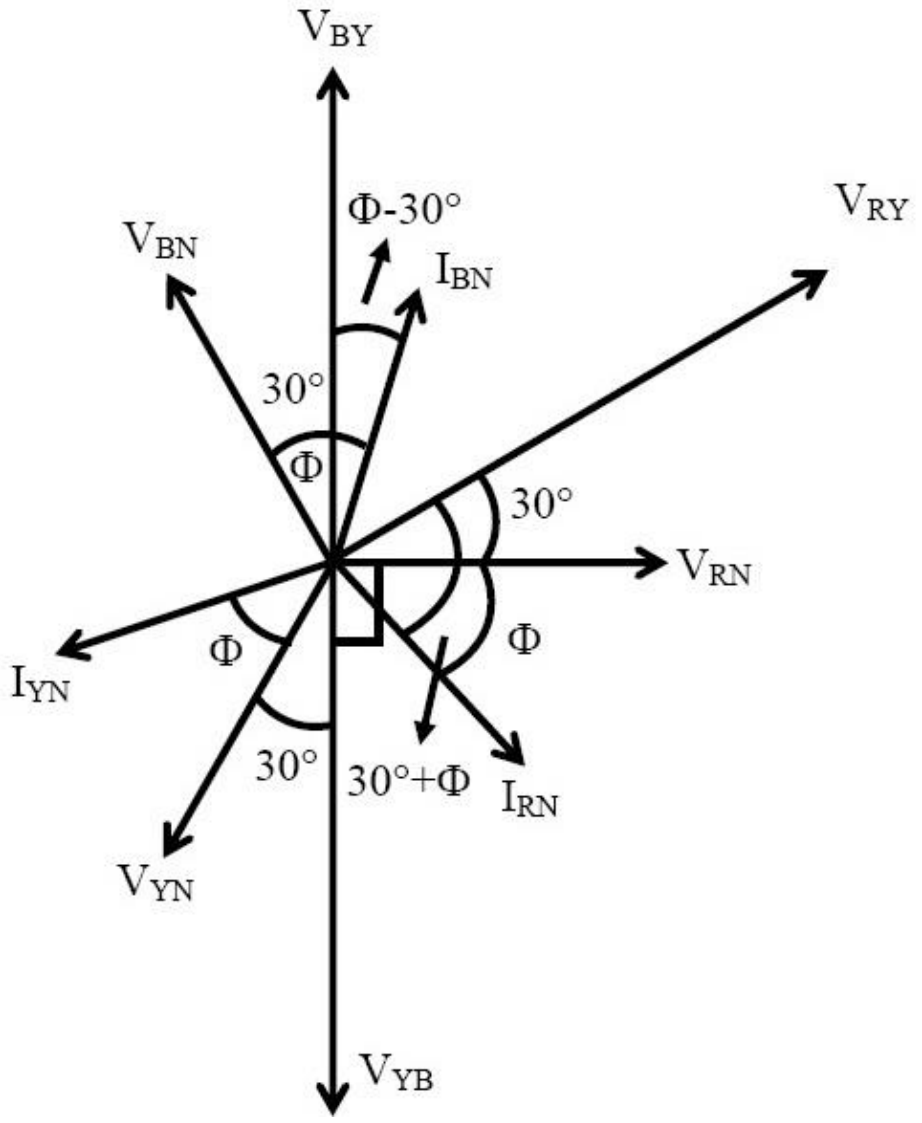


Fig 2: Phasor diagram of three phase balanced star connected circuit

Procedure:

BALANCED LOAD :

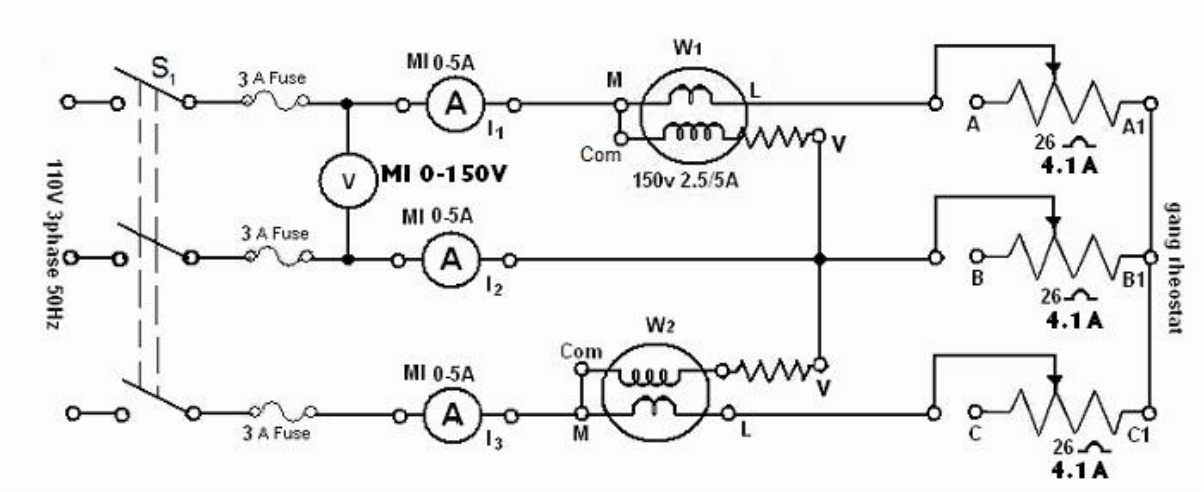


Fig. 1. Three phase power measurement circuit under balance condition

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 :

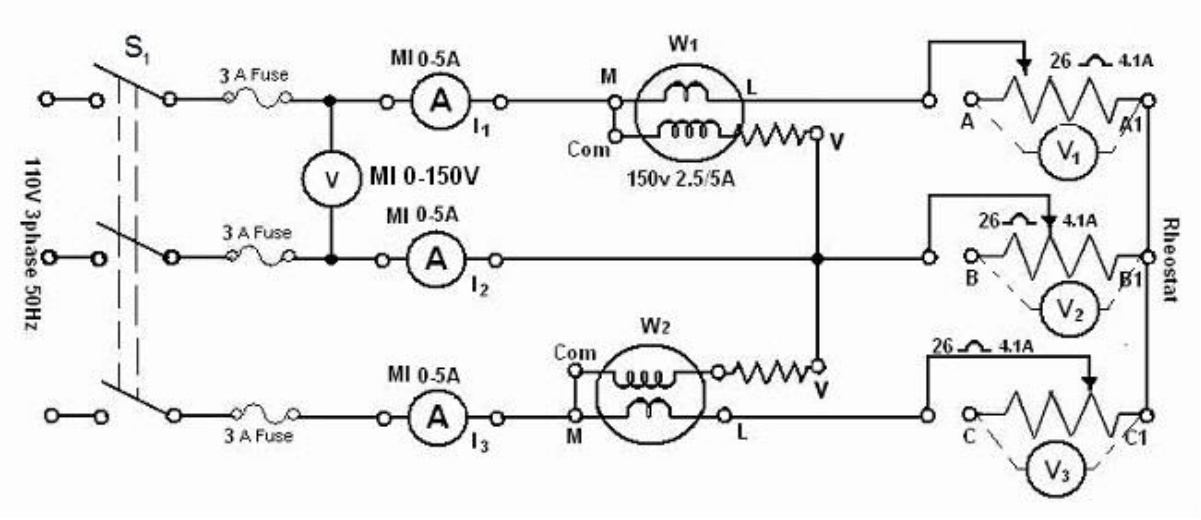


Fig. 2. Three phase power measurement circuit under unbalance condition

i. Connect the circuit as shown in Fig. 2.

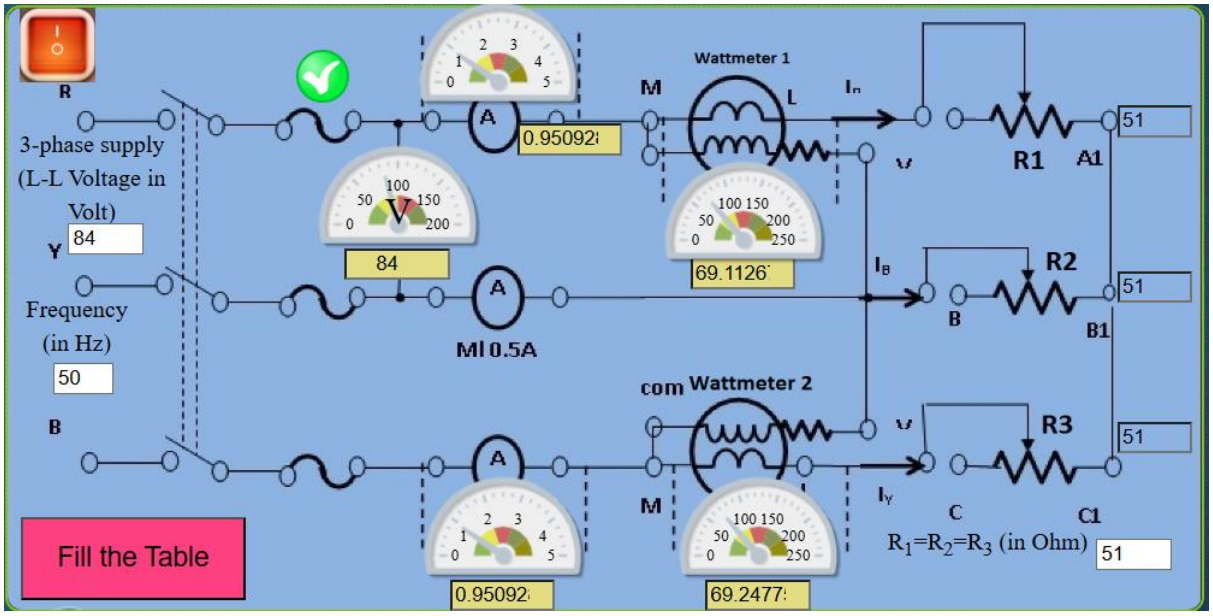
ii. Replace the ganged rheostat by three separate rheostats of 26 Ω, 4.1 A and connect in a star.

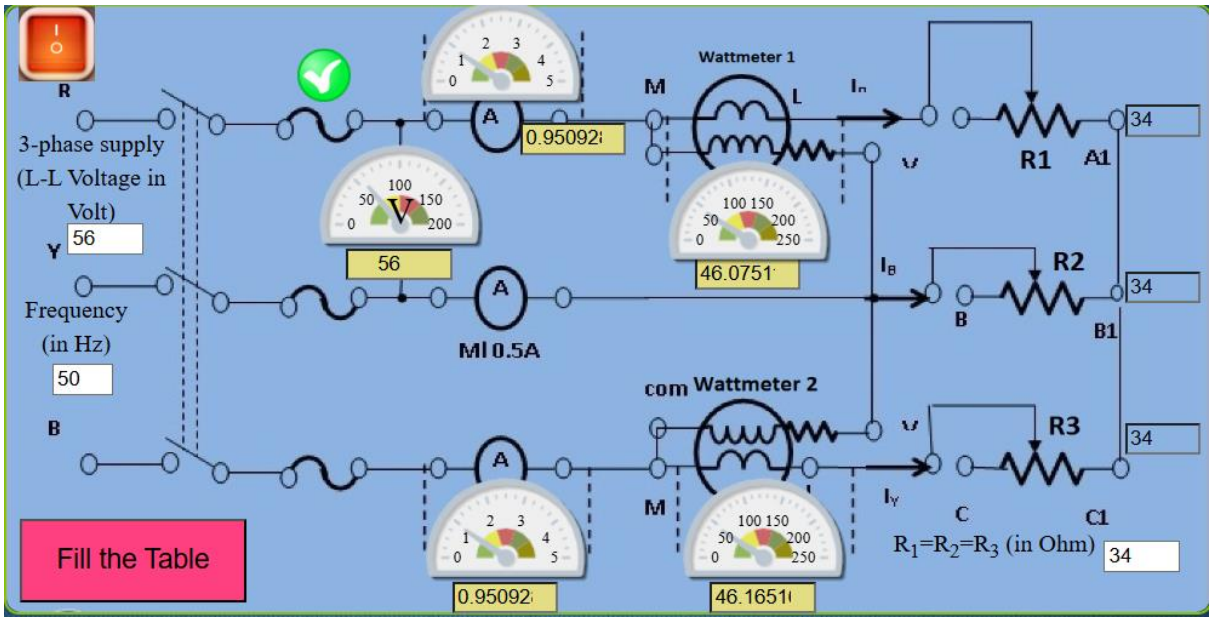
iii. Adjust the three rheostats at the maximum values.

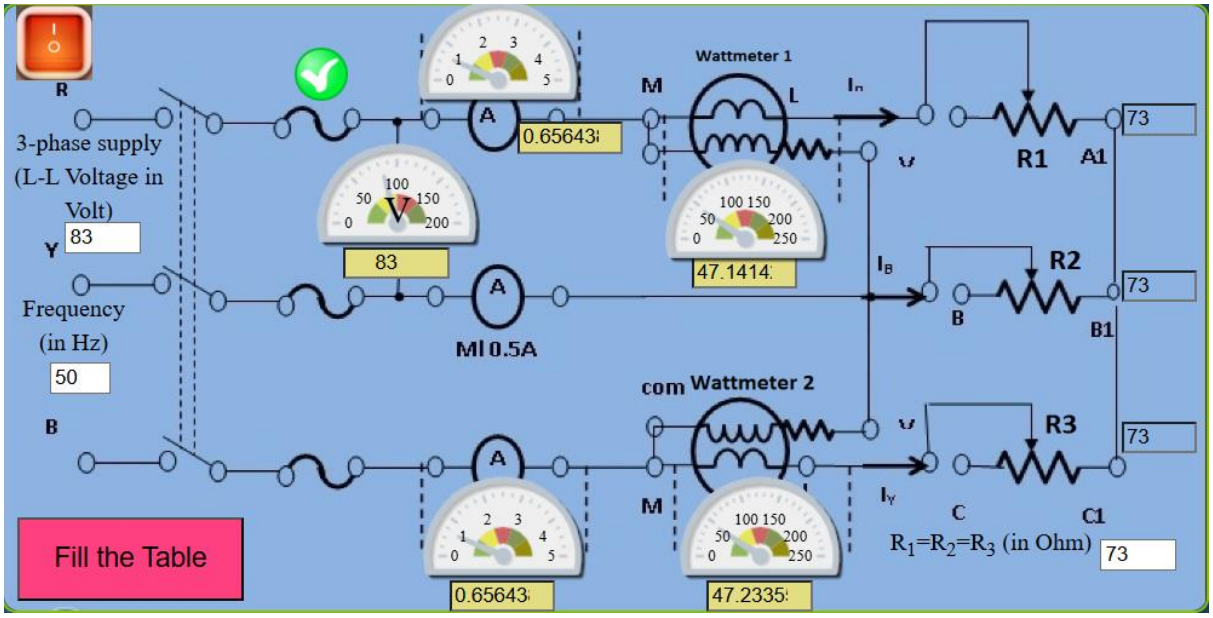
iv. Switch on the supply and set the autotransformer to 110 V.

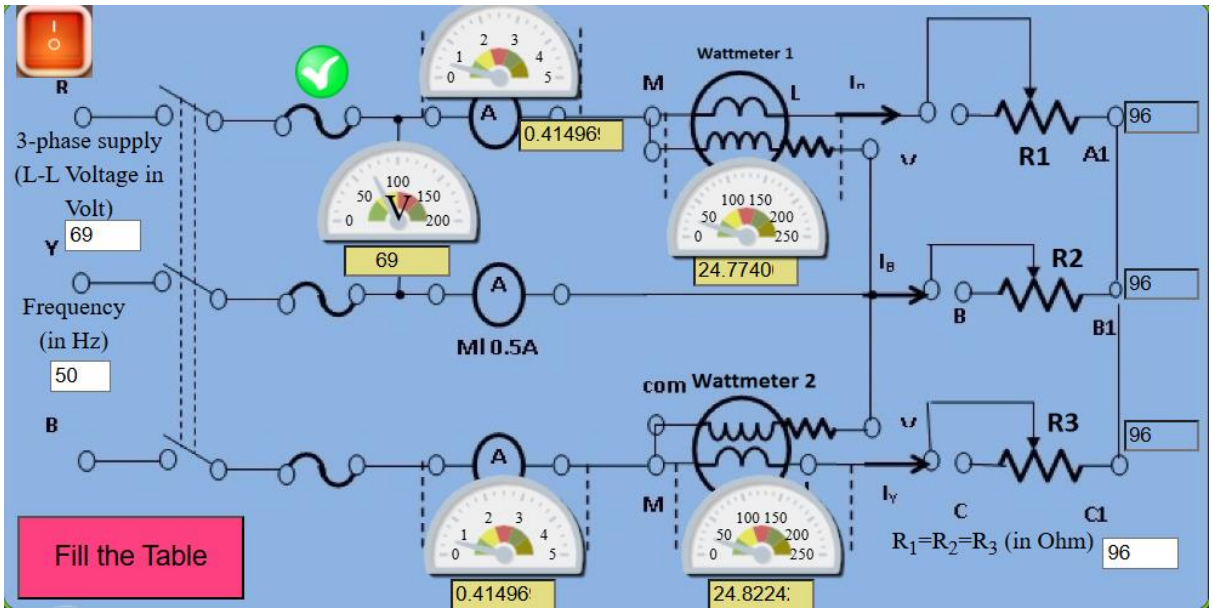
v. Close switch S_1 and take five sets of observation for different rheostat settings such that the reading of I_1, I_2 and I_3 in each set is appreciably different to create unbalanced loading condition. The current should not exceed the limits in each arm.

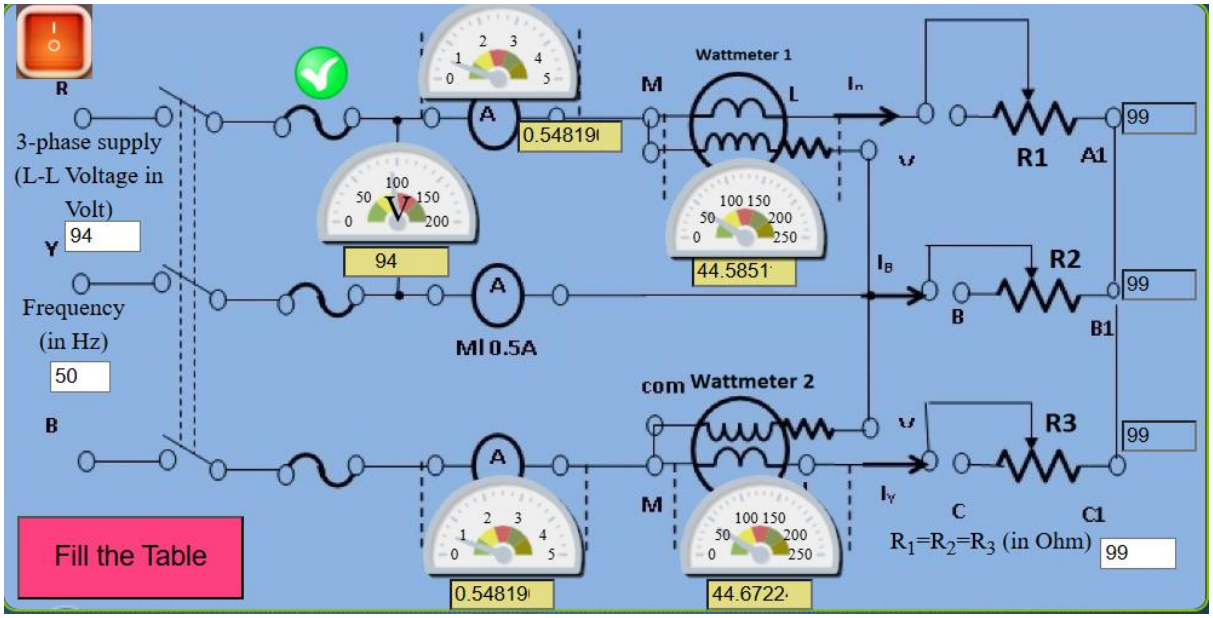
BALANCED LOAD:



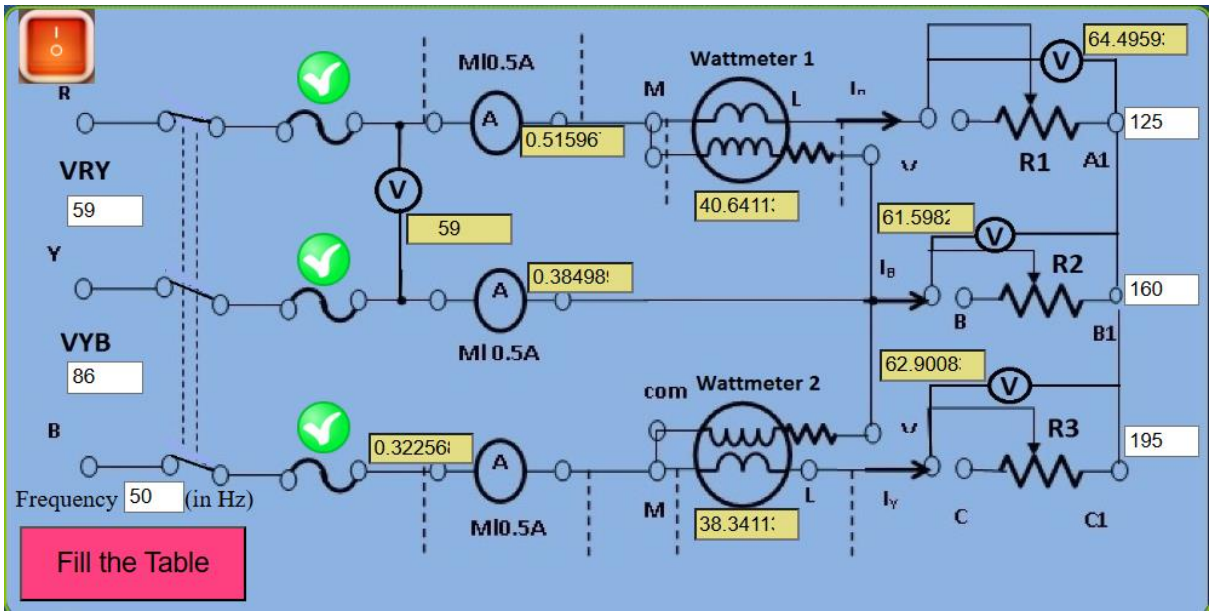


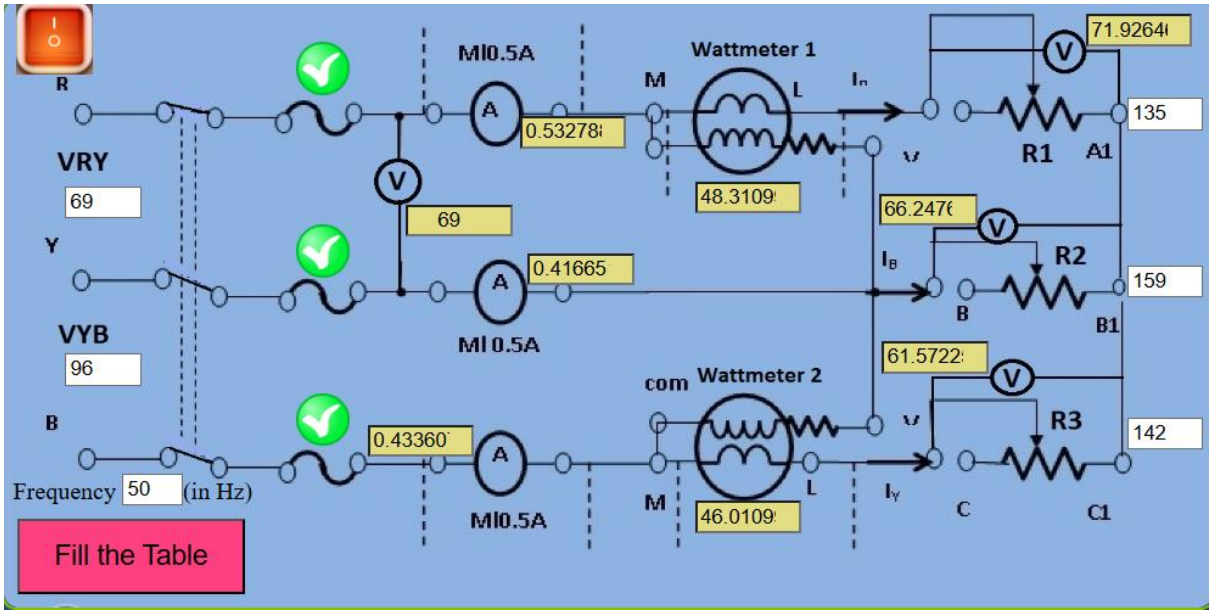

R
3-phase supply
(L-L Voltage in
Volt)
Y
83
Frequency
(in Hz)
50
B
Fill the Table
Wattmeter 1
M
L
A
0.65643
83
47.1414
MI 0.5A
com Wattmeter 2
0.65643
47.2335
I_R
I_B
I_Y
R1
R2
R3
A1
B1
C
C1
$R_1=R_2=R_3$ (in Ohm)
73
73
73
73

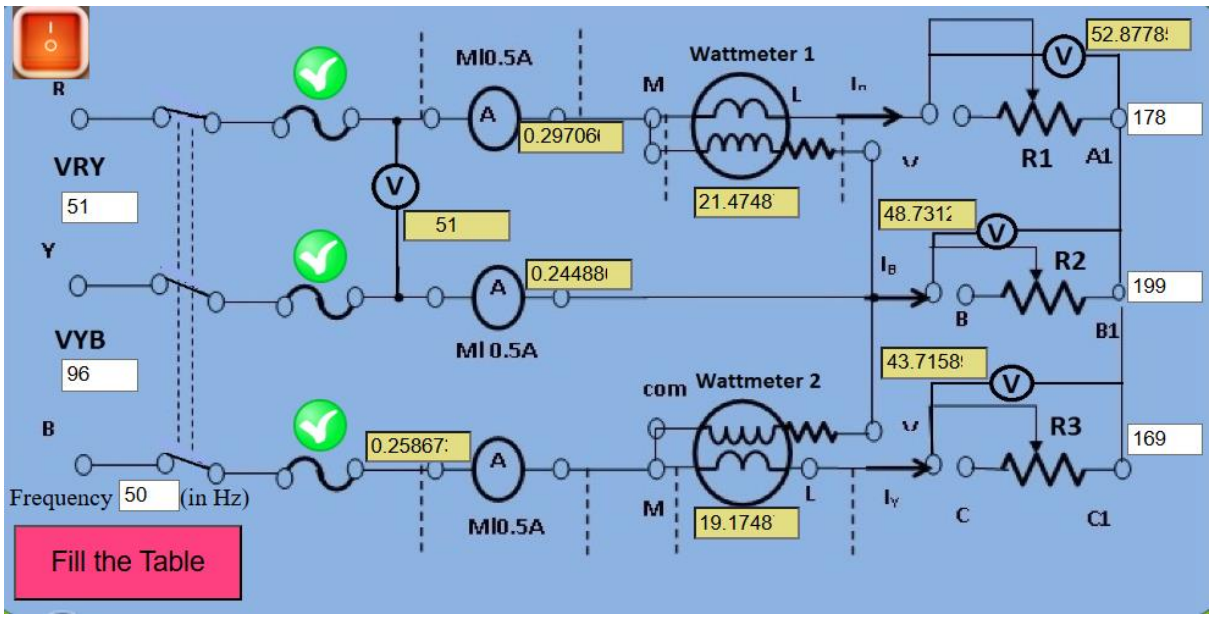

R
3-phase supply
(L-L Voltage in
Volt)
Y
69
Frequency
(in Hz)
50
B
Fill the Table
Wattmeter 1
M
L
A
0.41496
69
24.7740
MI 0.5A
com Wattmeter 2
0.41496
24.8224
I_R
I_B
I_Y
R1
R2
R3
A1
B1
C
C1
$R_1=R_2=R_3$ (in Ohm)
96
96
96
96

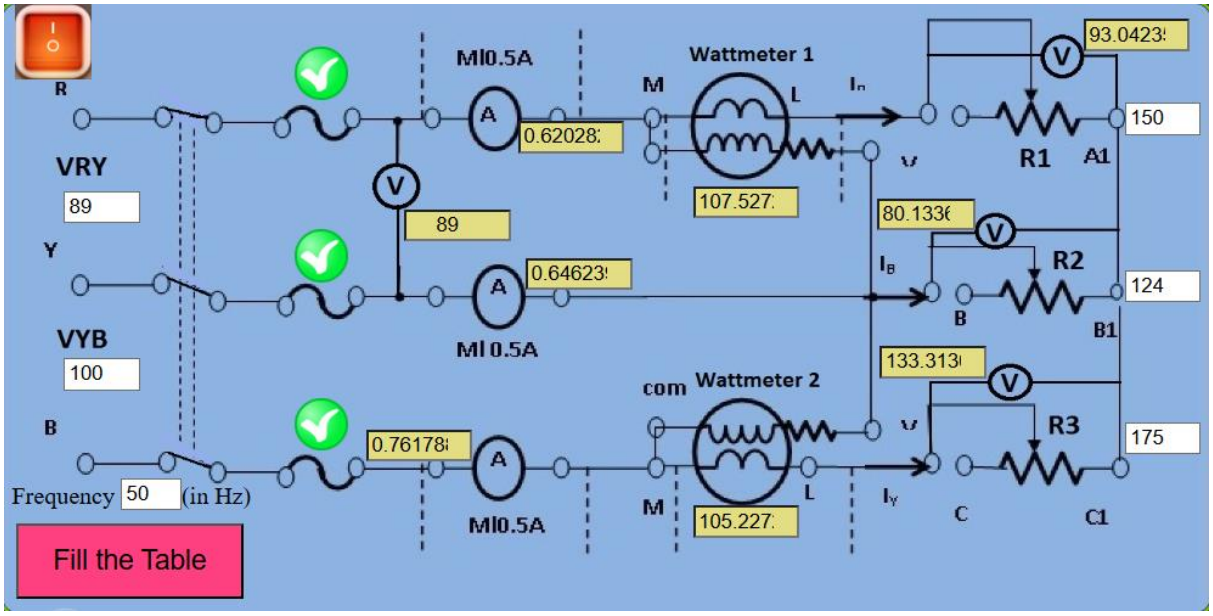


UNBALANCED LOAD:




R
VRY
69
Y
VYB
96
B
Frequency 50 (in Hz)
Fill the Table
MI0.5A
0.53278
69
0.41665
MI 0.5A
0.43360
MI0.5A
Wattmeter 1
M
L
48.3109
Wattmeter 2
com
M
L
46.0109
71.9264
135
R1
A1
66.247
159
R2
B
B1
61.5722
142
R3
C
C1


R
VRY
51
Y
VYB
96
B
Frequency 50 (in Hz)
Fill the Table
MI0.5A
0.29706
51
0.24488
MI 0.5A
0.25867
MI0.5A
Wattmeter 1
M
L
21.4748
Wattmeter 2
com
M
L
19.1748
52.8778
178
R1
A1
48.731
199
R2
B
B1
43.7158
169
R3
C
C1



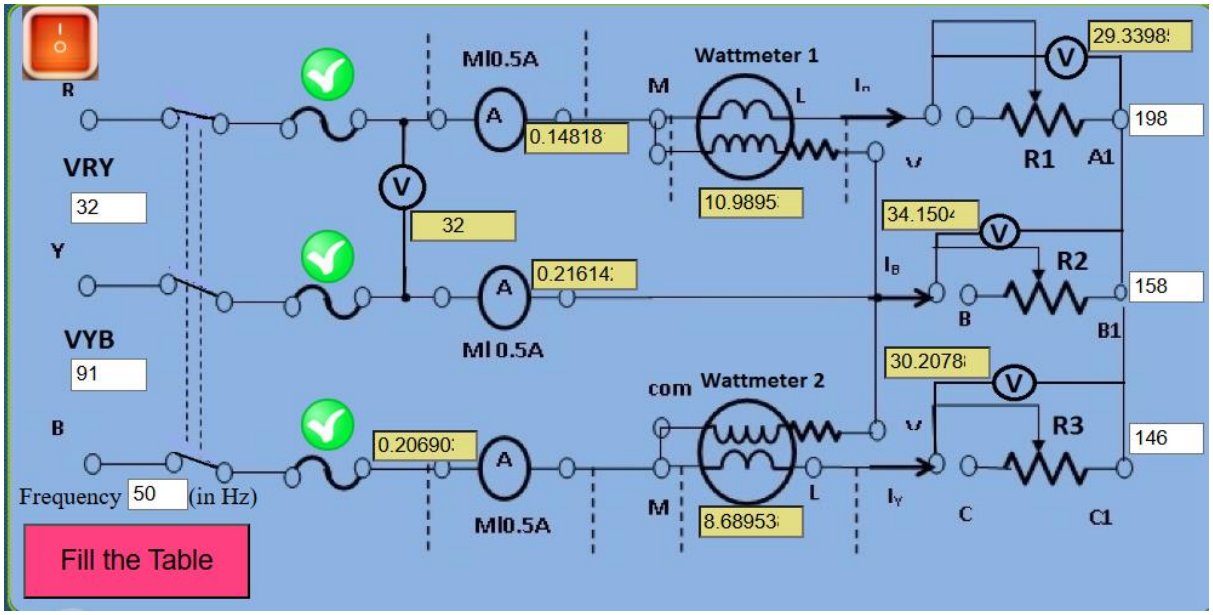


TABLE:

BALANCED LOAD

Observation Table

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	84	0.9509284	0.8652280	84	0.9509284	0.8669190	0.9509284	69.112679	69.247754	138.35254	138.36043
2nd	56	0.9509284	0.8652280	56	0.9509284	0.8669190	0.9509284	46.075119	46.165169	92.235030	92.240289
3rd	83	0.6564384	0.8652280	83	0.6564384	0.8669190	0.6564384	47.141420	47.233554	94.369593	94.374974
4th	69	0.4149699	0.8652280	69	0.4149699	0.8669190	0.4149699	24.774008	24.822427	49.593608	49.596436
5th	94	0.5481903	0.8652280	94	0.5481903	0.8669190	0.5481903	44.585110	44.672248	89.252269	89.257359

UNBALANCED LOAD

Observation Table

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	64.495936	61.598245	62.900832	0.5159674	0.3849890	0.3225683	77.282274	40.641137	38.341137	78.982274
2nd	71.926468	66.247650	61.572250	0.5327886	0.4166518	0.4336073	92.621998	48.310999	46.010999	94.321998
3rd	52.877855	48.731265	43.715894	0.2970666	0.2448807	0.2586739	38.949755	21.474877	19.174877	40.649755
4th	93.042357	80.133657	133.31305	0.6202823	0.6462391	0.7617888	211.05444	107.52722	105.22722	212.75444
5th	29.339856	34.150458	30.207886	0.1481810	0.2161421	0.2069033	17.979077	10.989538	8.6895388	19.679077

RESULT:

Thus, the measurement of power is simulated and validated.