EXPERIMENT-2
MEASUREMENT OF POWER

AIM

Three phase power measurement by two wattmeter method.

Theory

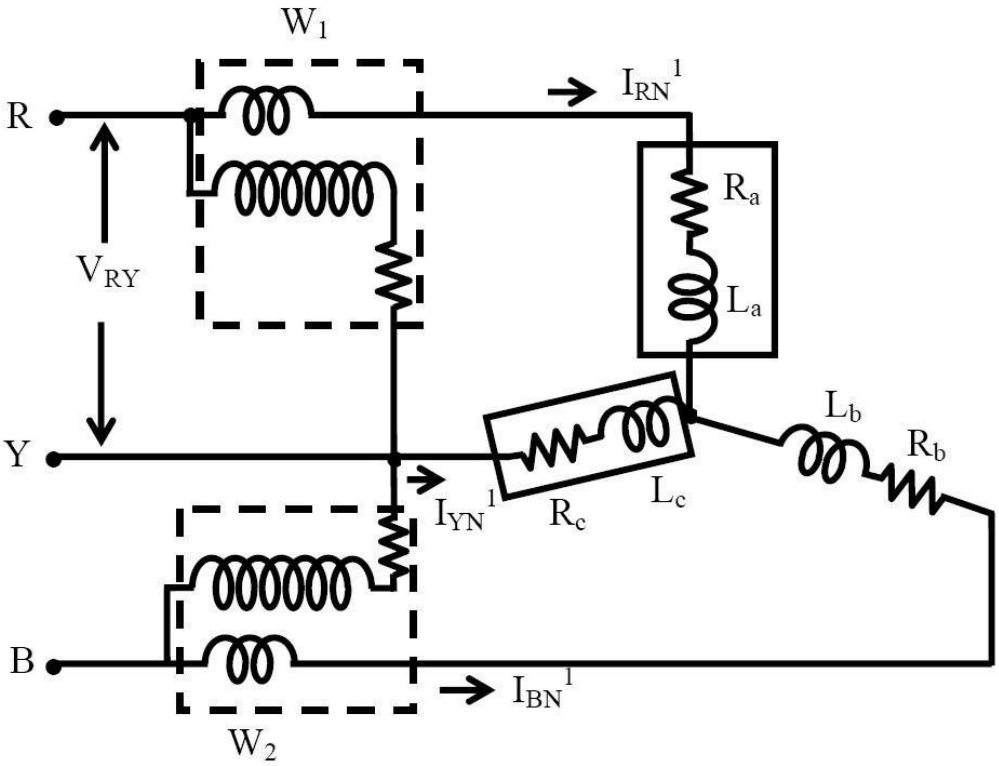


Fig 1: Connection diagram for three phase power measurement using two wattmeter method

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 2.2

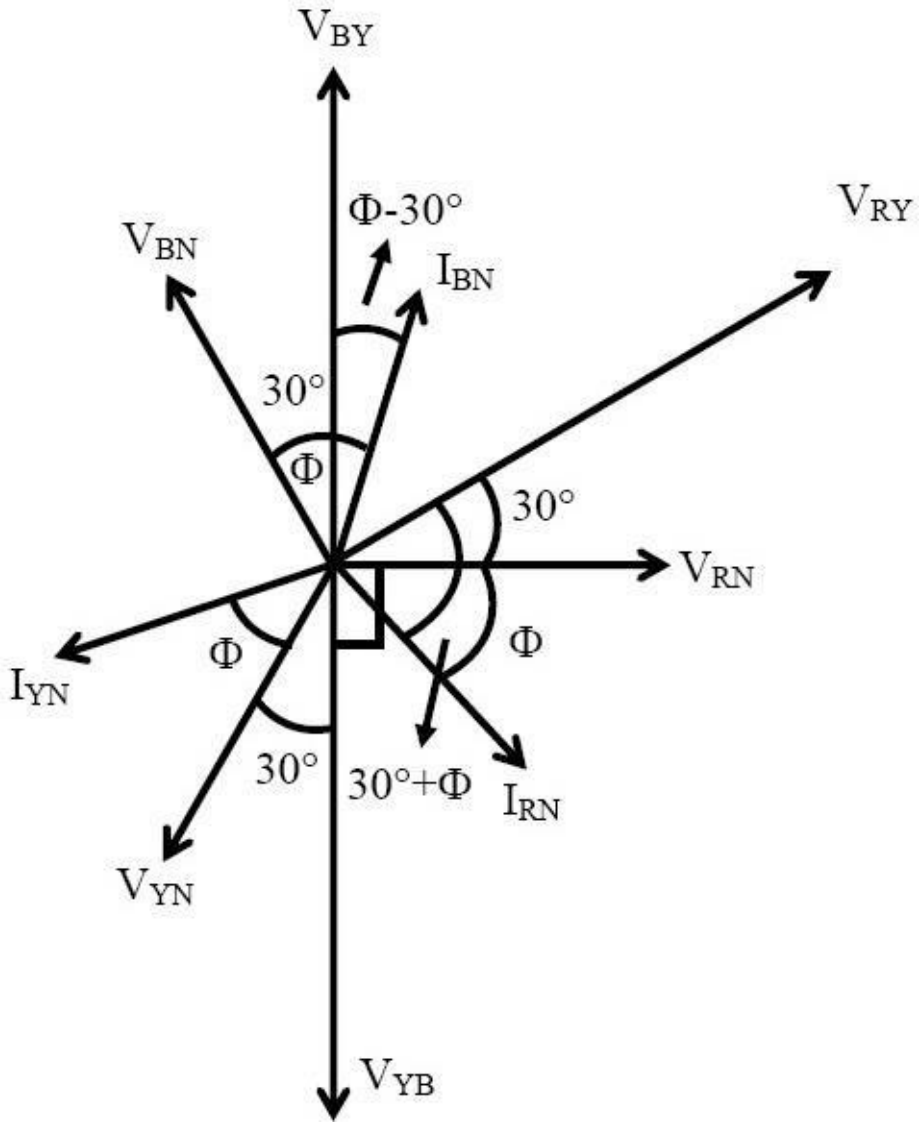


Fig 2: Phasor diagram of three phase balanced star connected circuit

Procedure

BALANCED LOAD :

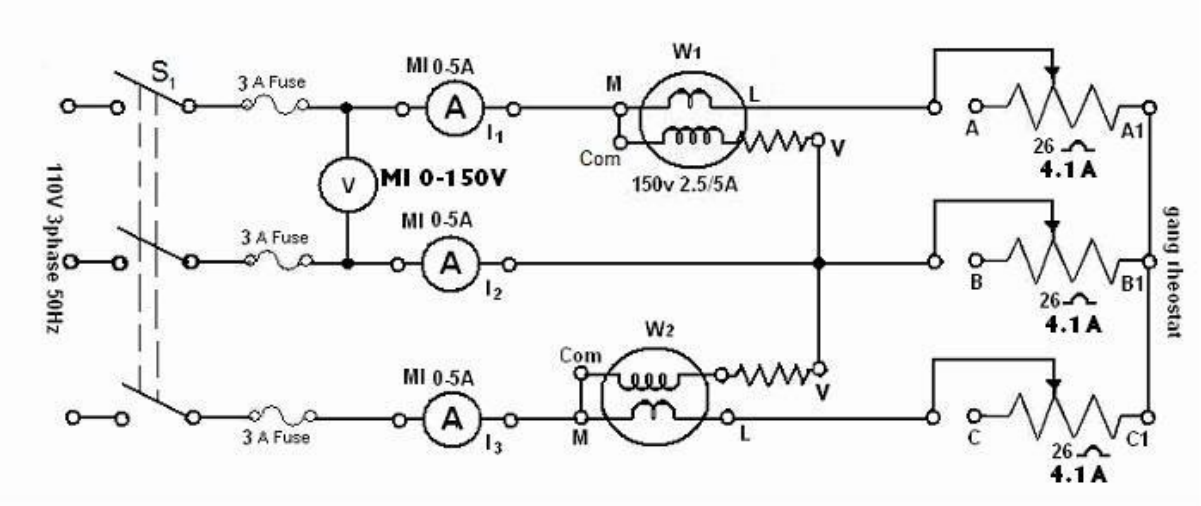


Fig. 1. Three phase power measurement circuit under balance condition

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 :

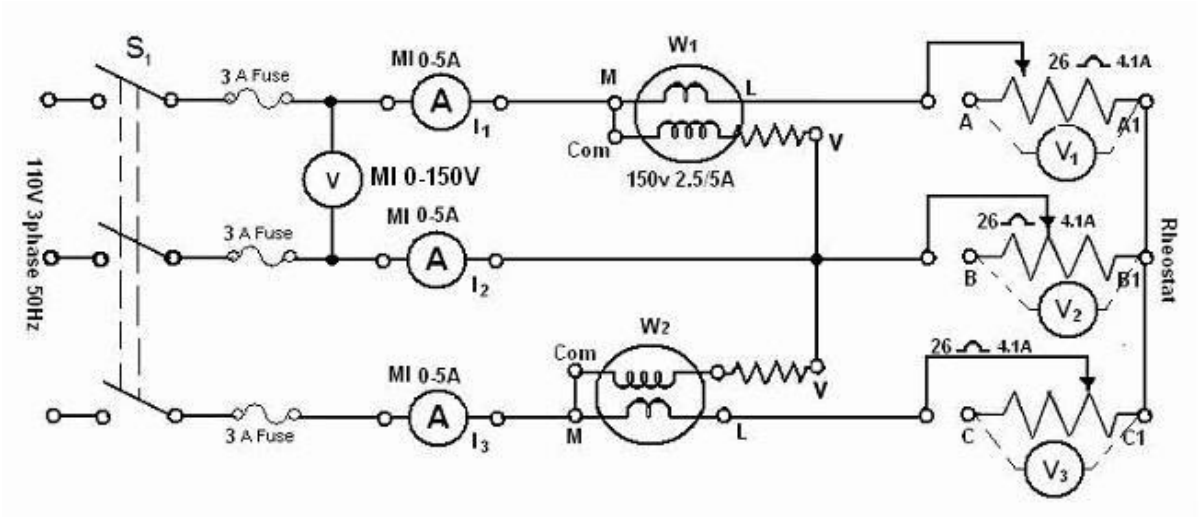


Fig. 2. Three phase power measurement circuit under unbalance condition

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.

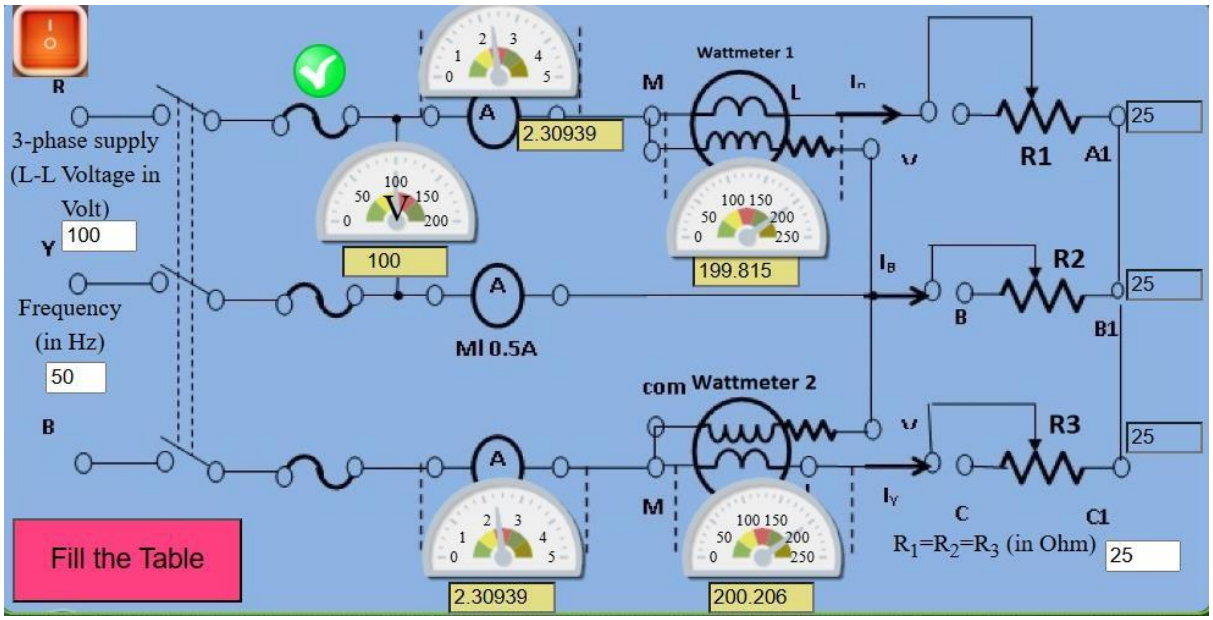
iii. Adjust the three rheostats at the maximum values.

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

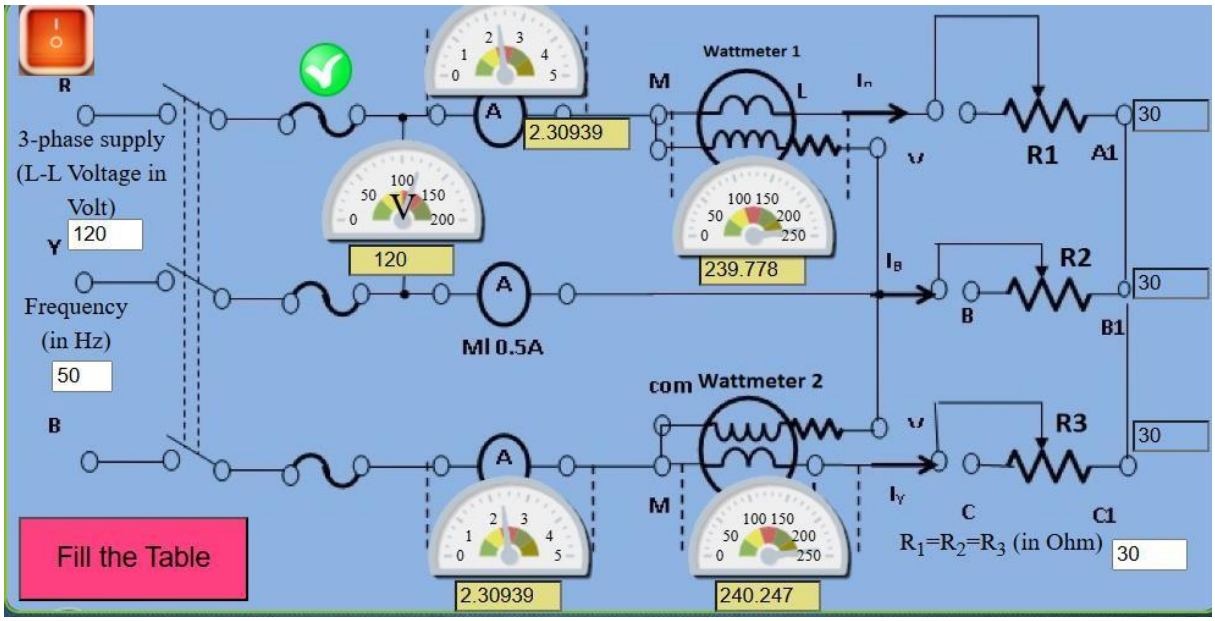
v. Close switch S_1 and take five sets of observation for different rheostat settings such that the reading of I_1, I_2 and I_3 in each set is appreciably different to create unbalanced loading condition. The current should not exceed the limits in each arm.

BALANCED LOAD:

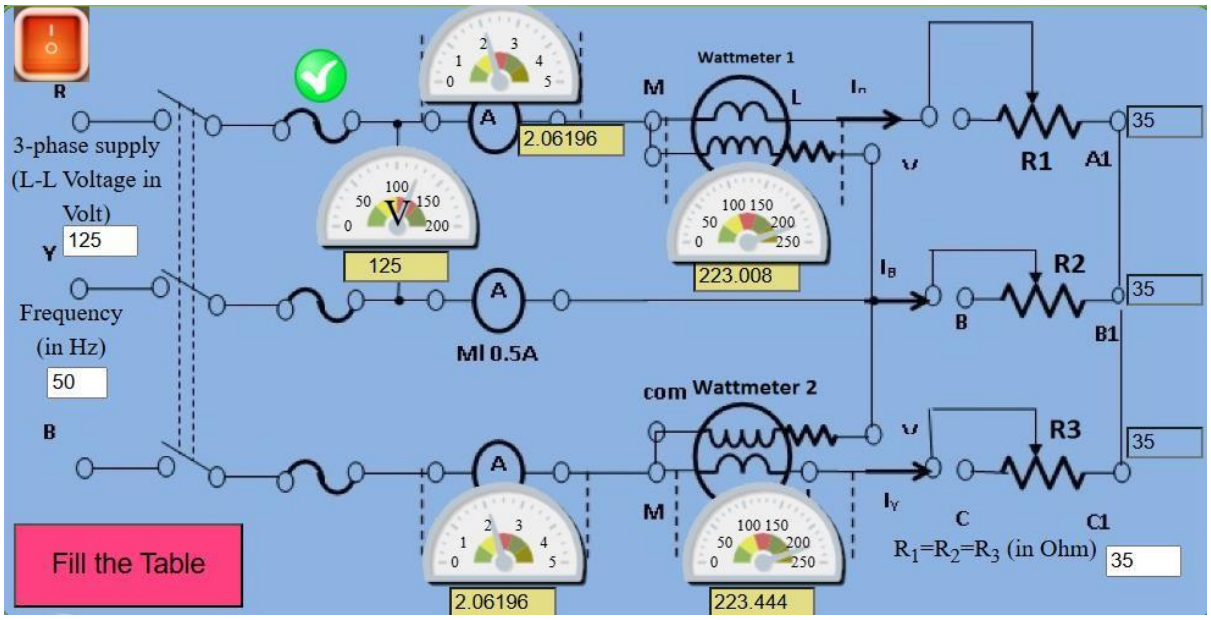
CASE 1


R
3-phase supply
(L-L Voltage in
Volt)
Y
100
Frequency
(in Hz)
50
B
Fill the Table
A
2.30939
Wattmeter 1
M
L
100
199.815
MI 0.5A
com Wattmeter 2
2.30939
200.206
R1
A1
R2
B
B1
R3
C
C1
25
25
25
R1=R2=R3 (in Ohm)
25

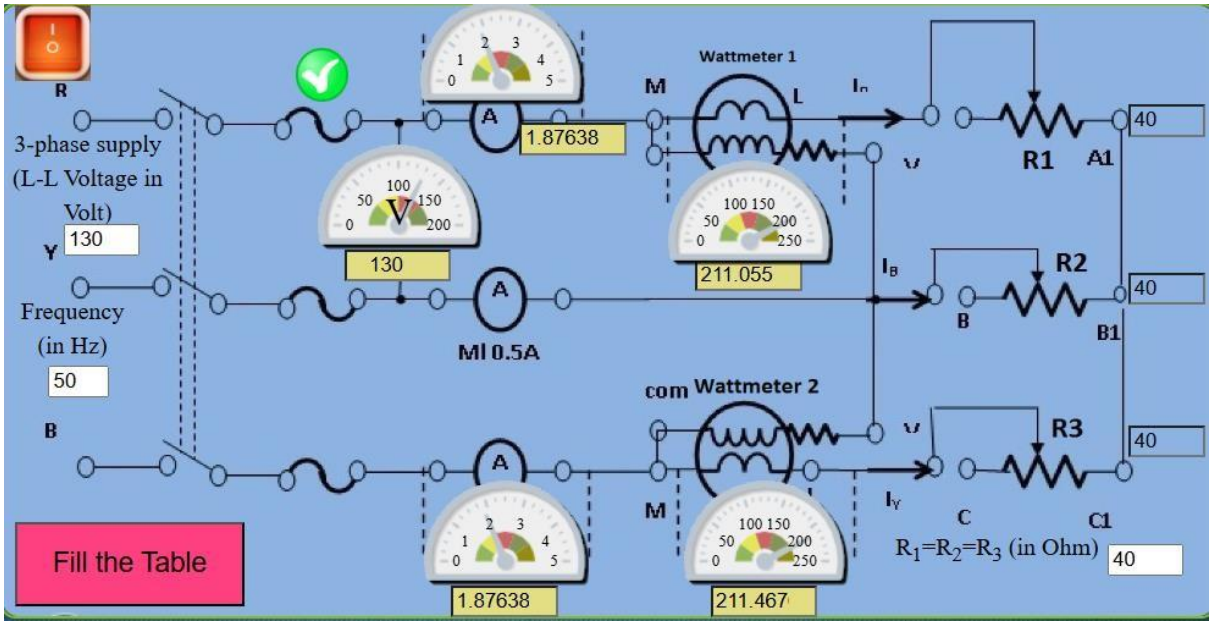
CASE 2


R
3-phase supply
(L-L Voltage in
Volt)
Y
120
Frequency
(in Hz)
50
B
Fill the Table
A
2.30939
Wattmeter 1
M
L
120
239.778
MI 0.5A
com Wattmeter 2
2.30939
240.247
R1
A1
R2
B
B1
R3
C
C1
30
30
30
R1=R2=R3 (in Ohm)
30

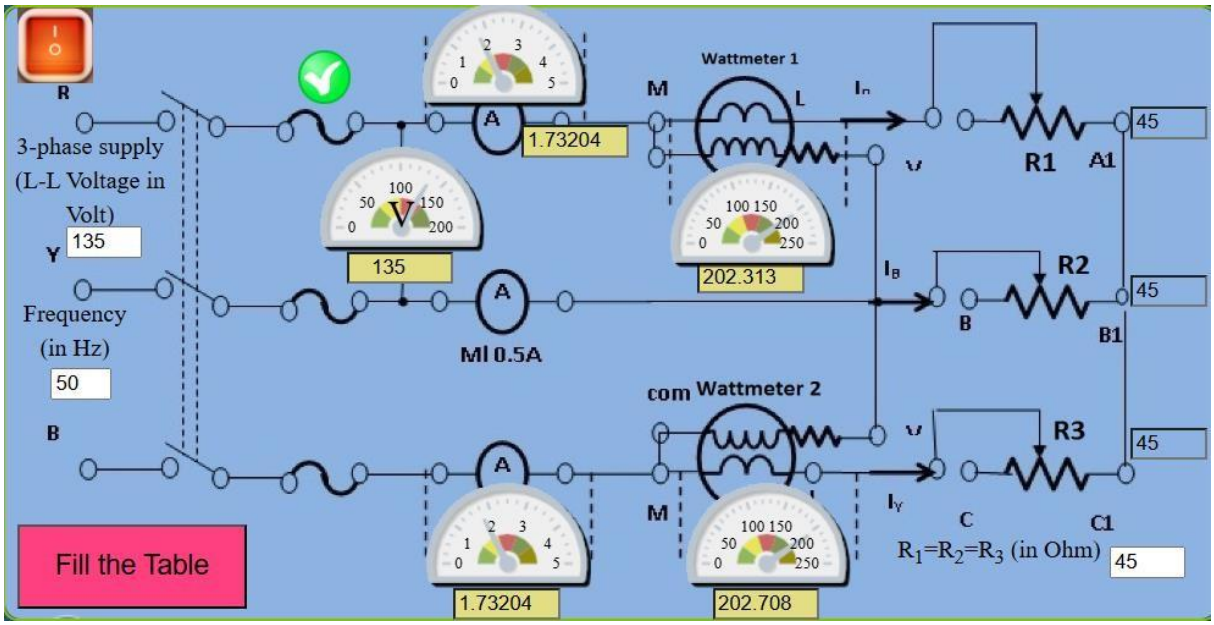
CASE 3


R
3-phase supply
(L-L Voltage in
Volt)
Y
125
Frequency
(in Hz)
50
B
Fill the Table
2.06196
125
MI 0.5A
Wattmeter 1
M
L
223.008
com Wattmeter 2
2.06196
223.444
R1
A1
R2
B
B1
R3
C
C1
$R_1=R_2=R_3$ (in Ohm)
35
35
35
35

CASE 4


R
3-phase supply
(L-L Voltage in
Volt)
Y
130
Frequency
(in Hz)
50
B
Fill the Table
1.87638
130
MI 0.5A
Wattmeter 1
M
L
211.055
com Wattmeter 2
1.87638
211.467
R1
A1
R2
B
B1
R3
C
C1
$R_1=R_2=R_3$ (in Ohm)
40
40
40
40

CASE 5

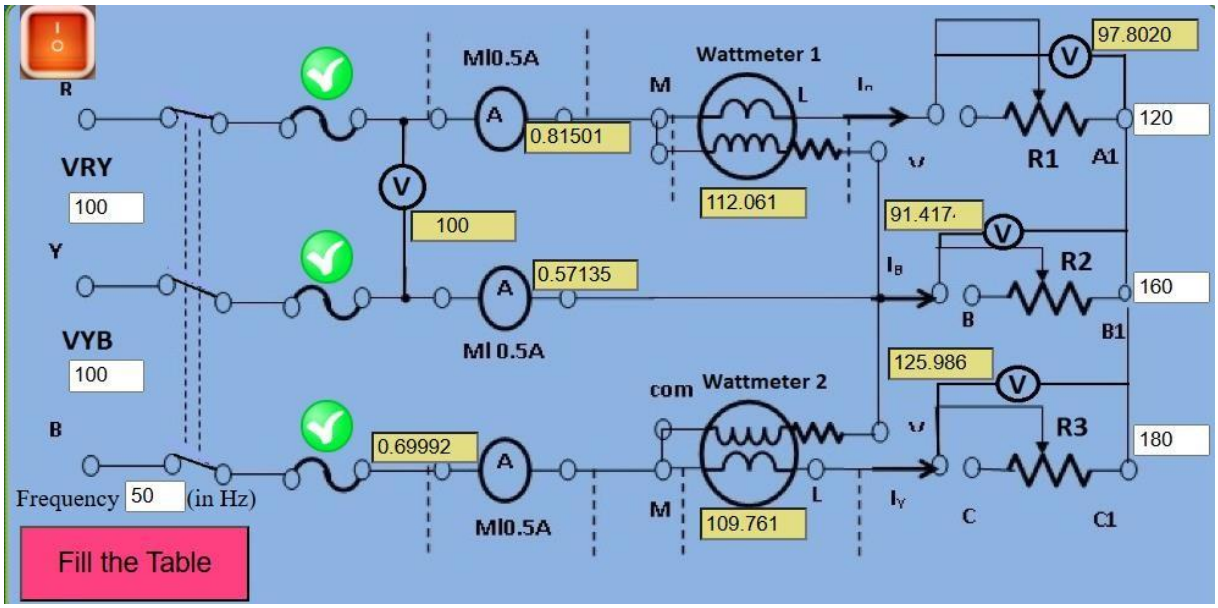


BALANCED LOAD TABULATION:

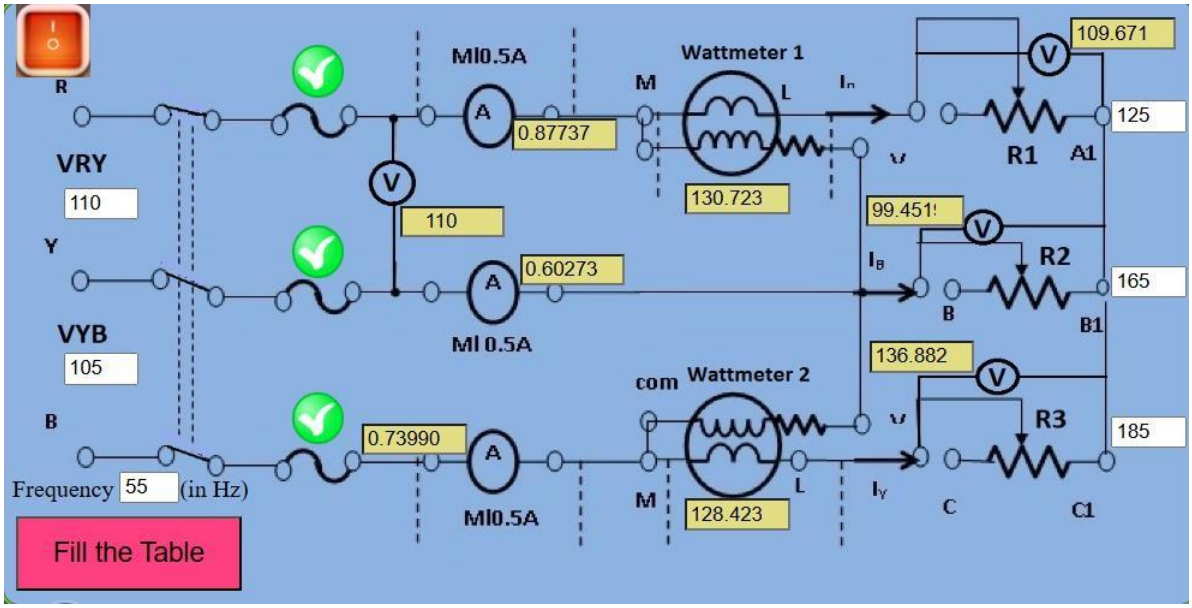
Serial no. of Observation	V_{RY}	I_R (Amp)	Cos(V_{RY}, I_R)	V_{BY}	I_B (Amp)	Cos(V_{BY}, I_B)	I_3(Amp)	W_1	W_2	W_C (Calculated power)	W_M(Measured Power=W_1+W_2)
1st	100	2.3093977	0.865228(	100	2.3093977	0.866919(	2.3093977	199.81557	200.2060(	399.99885	400.0216(
2nd	120	2.3093977	0.865228(	120	2.3093977	0.866919(	2.3093977	239.77868	240.24731	479.99862	480.0259(
3rd	125	2.0619622	0.865228(	125	2.0619622	0.866919(	2.0619622	223.00844	223.4443(	446.42729	446.4527(
4th	130	1.876385(	0.865228(	130	1.876385(	0.866919(	1.876385(	211.05519	211.46768	422.49879	422.5228(
5th	135	1.7320483	0.865228(	135	1.7320483	0.866919(	1.7320483	202.3132(	202.70867	404.99884	405.0219(

UNBALANCED LOAD:

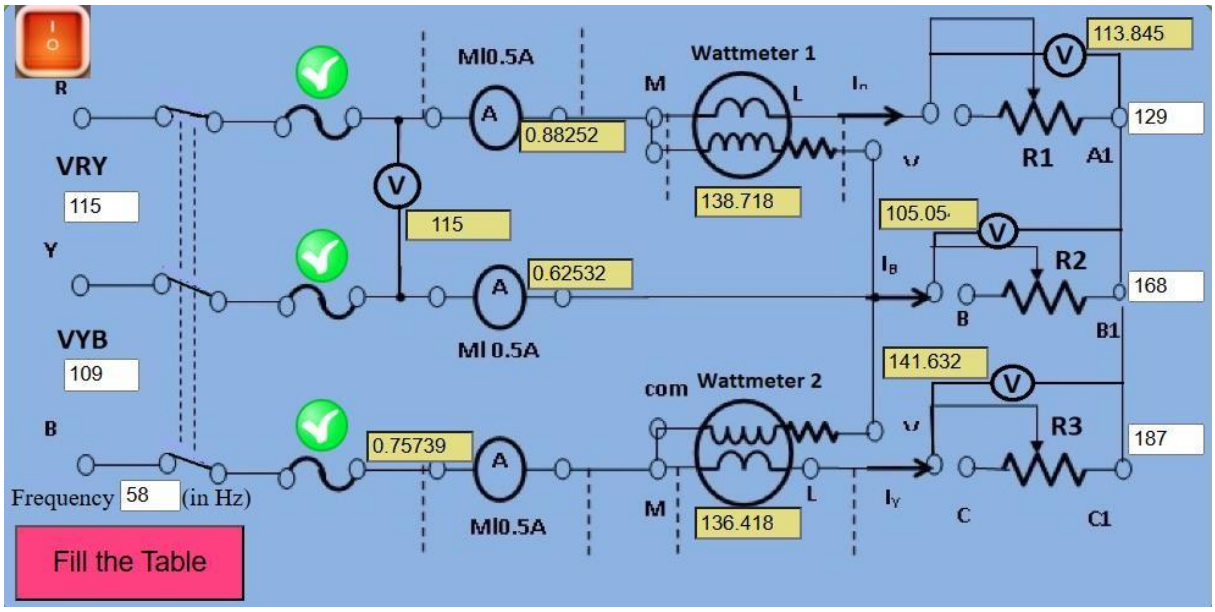
CASE 1


R
VRY
100
Y
VYB
100
B
Frequency 50 (in Hz)
Fill the Table
MI0.5A
0.81501
100
0.57135
MI 0.5A
0.69992
MI0.5A
Wattmeter 1
M
L
112.061
com
Wattmeter 2
M
L
109.761
97.8020
120
R1
A1
91.417
160
R2
B
B1
125.986
180
R3
C
C1

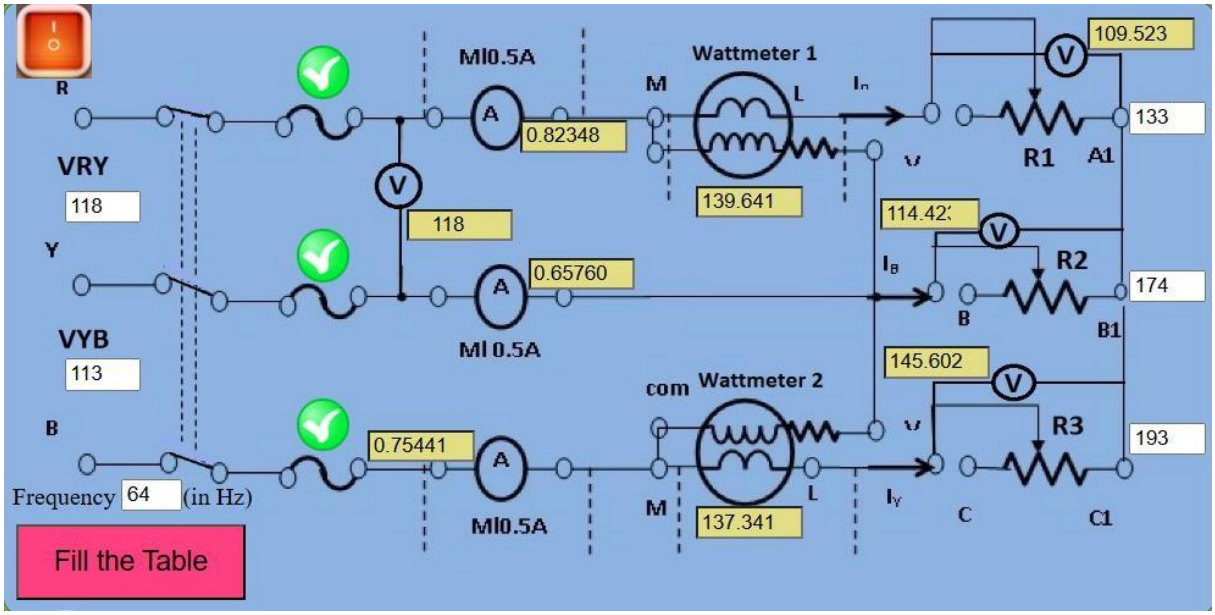
CASE 2


R
VRY
110
Y
VYB
105
B
Frequency 55 (in Hz)
Fill the Table
MI0.5A
0.87737
110
0.60273
MI 0.5A
0.73990
MI0.5A
Wattmeter 1
M
L
130.723
com
Wattmeter 2
M
L
128.423
109.671
125
R1
A1
99.451
165
R2
B
B1
136.882
185
R3
C
C1

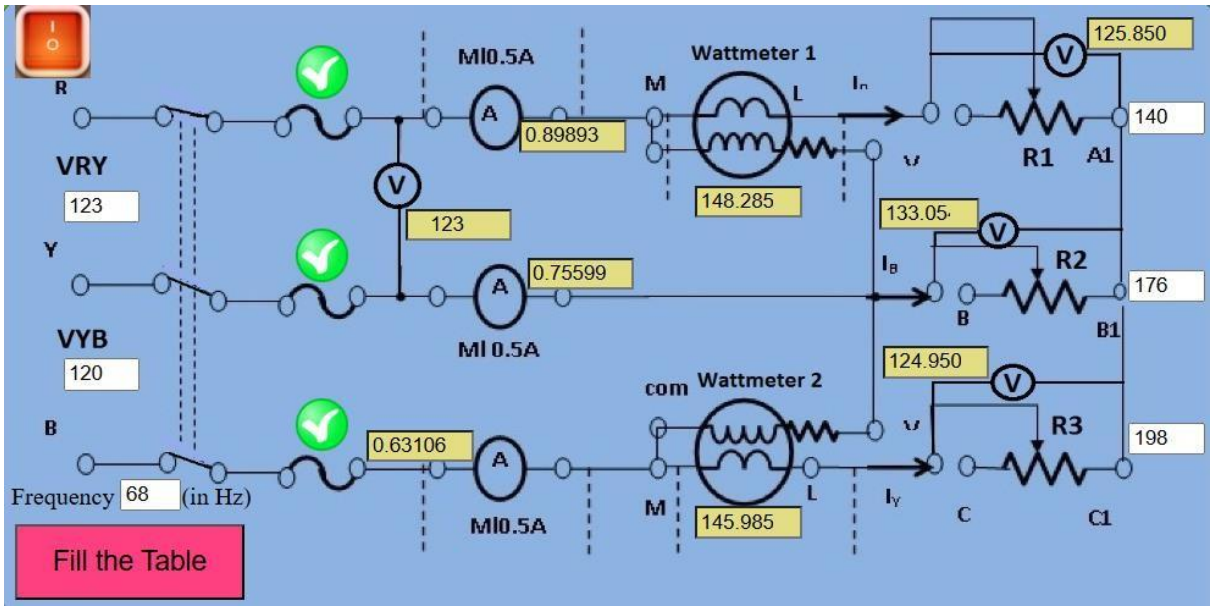
CASE 3



CASE 4



CASE 5



UNBALANCED LOAD 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	91.41745C	125.9866Z	0.8150173	0.571359C	0.699925E	220.1238E	112.06192	109.7619Z	221.8238E
2nd	109.6718C	99.451914	136.8824Z	0.8773744	0.6027388	0.7399049	257.4467E	130.7233E	128.4233E	259.1467E
3rd	113.84533	105.05481	141.6329E	0.8825219	0.6253263	0.7573955	273.4367Z	138.7183E	136.4183E	275.1367Z
4th	109.52367	114.42317	145.6028E	0.8234863	0.6576044	0.7544189	275.2820C	139.6410C	137.3410C	276.9820C
5th	125.8507Z	133.0545C	124.9507C	0.8989337	0.7559915	0.6310641	292.5714E	148.2857Z	145.9857Z	294.2714E

RESULT:

Measurement of power is simulated and validated.