MEASUREMENT OF POWER

MEASUREMENT OF POWER:

Aim of the experiment:

Three phase power measurement by two wattmeter method.

Theory:

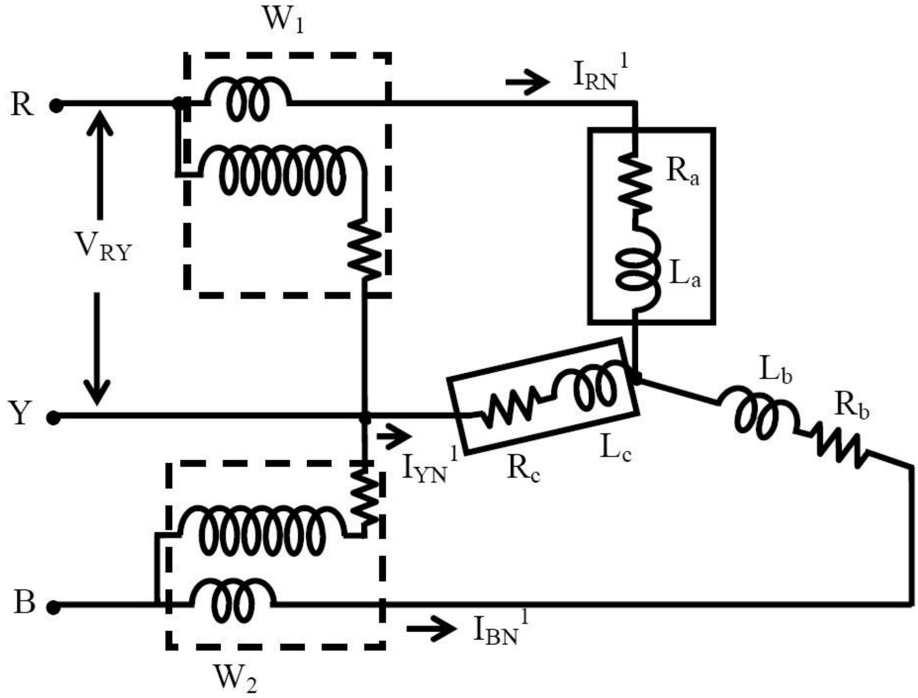


Fig 1: Connection diagram for three phase power measurement using two wattmeter method

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, W1 are IRN and.

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

So, the instantaneous power measured by the wattmeter W1 is.

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

Similarly the instantaneous power measured by the wattmeter W2 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.

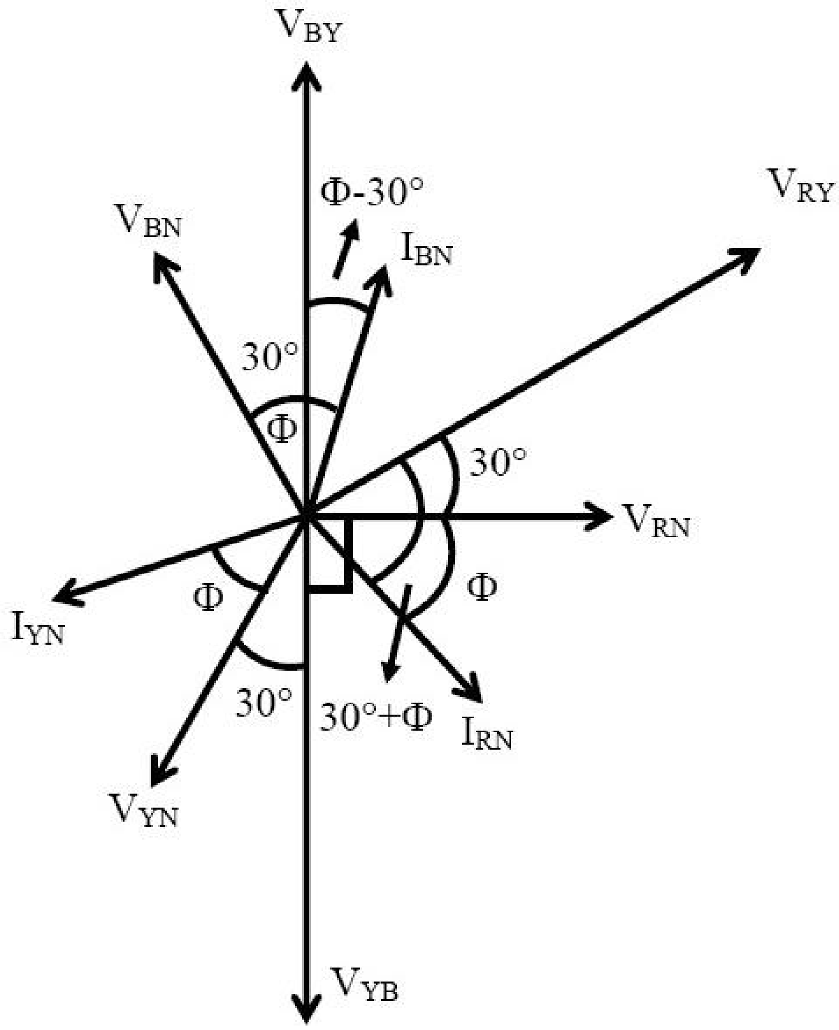


Fig 2: Phasor diagram of three phase balanced star connected circuitProcedure

Procedure:

BALANCED LOAD :

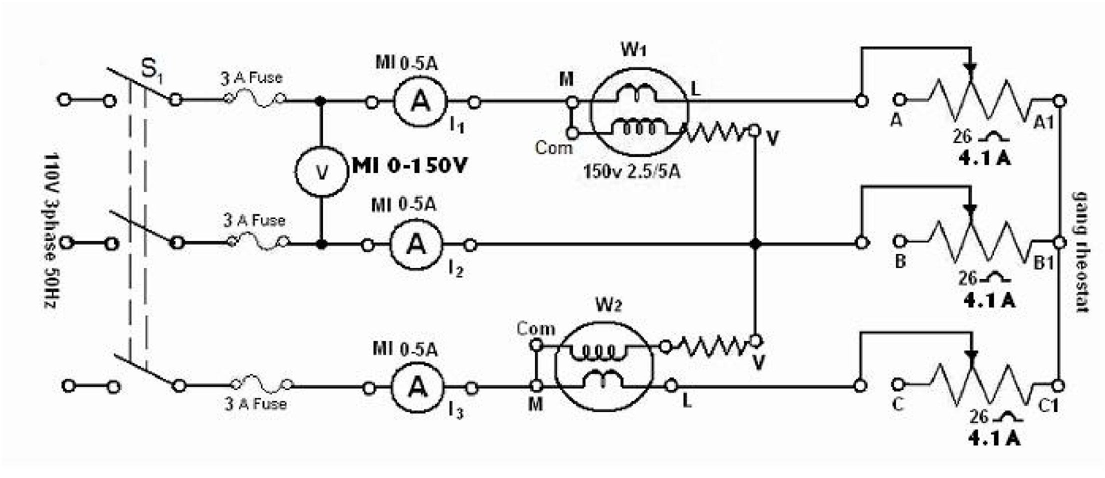


Fig. 1. Three phase power measurement circuit under balance condition

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 S1.
5. Read the meters to obtain VL, I1, I2 and I3. Note the wattmeter reading W1 and W2`(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 :

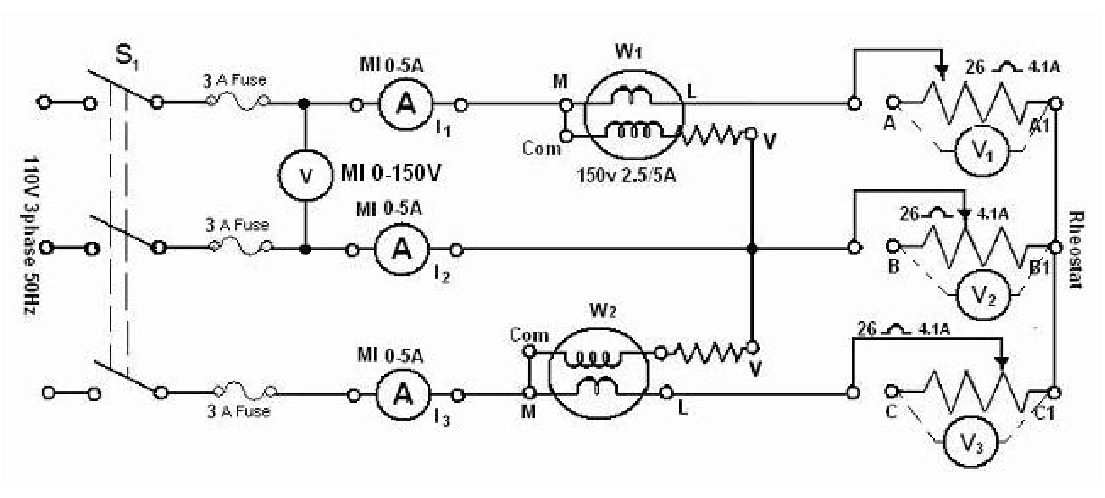


Fig. 2. Three phase power measurement circuit under unbalance condition

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.

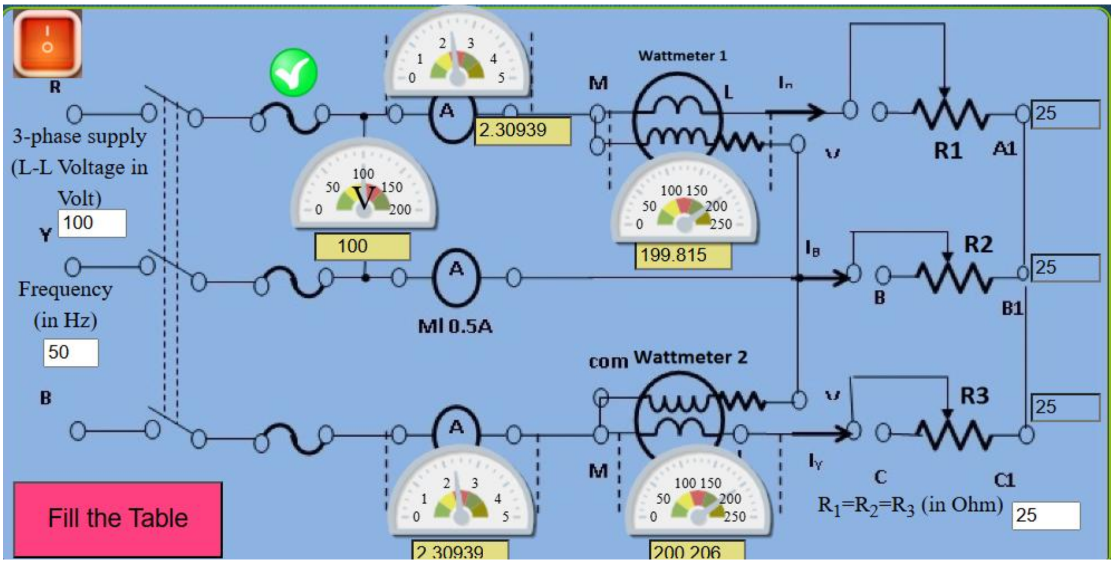
iv. Switch on the supply and set the autotransformer to 110 V.

v. Close switch S1 and take five sets of observation for different rheostat settings such that the reading of I1, I2 and I3 in each set is appreciably different to create unbalanced loading condition. The current should not exceed the limits in each arm.

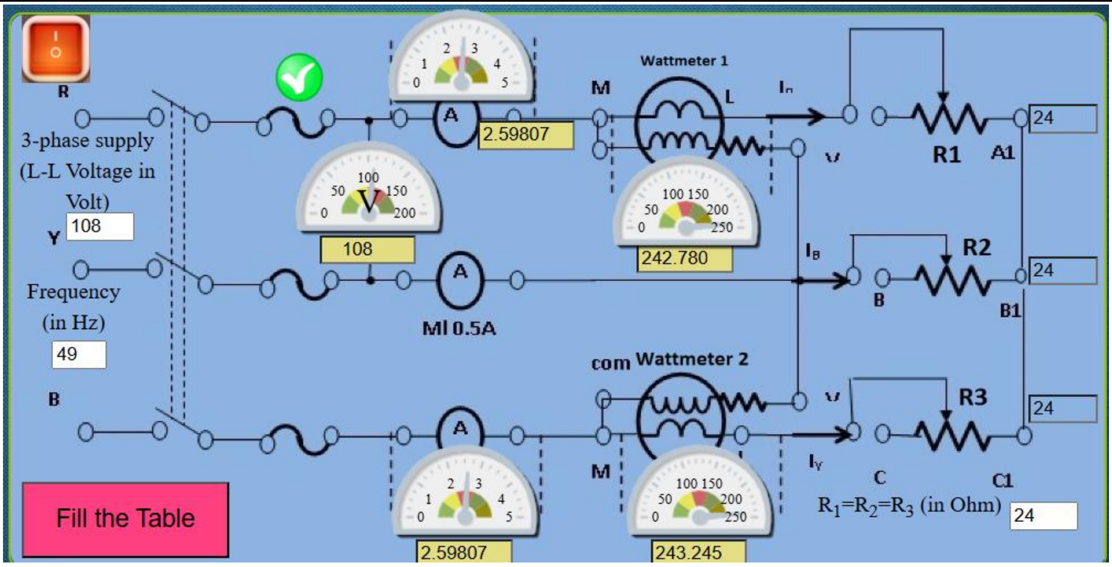
SIMULATION

BALANCED:

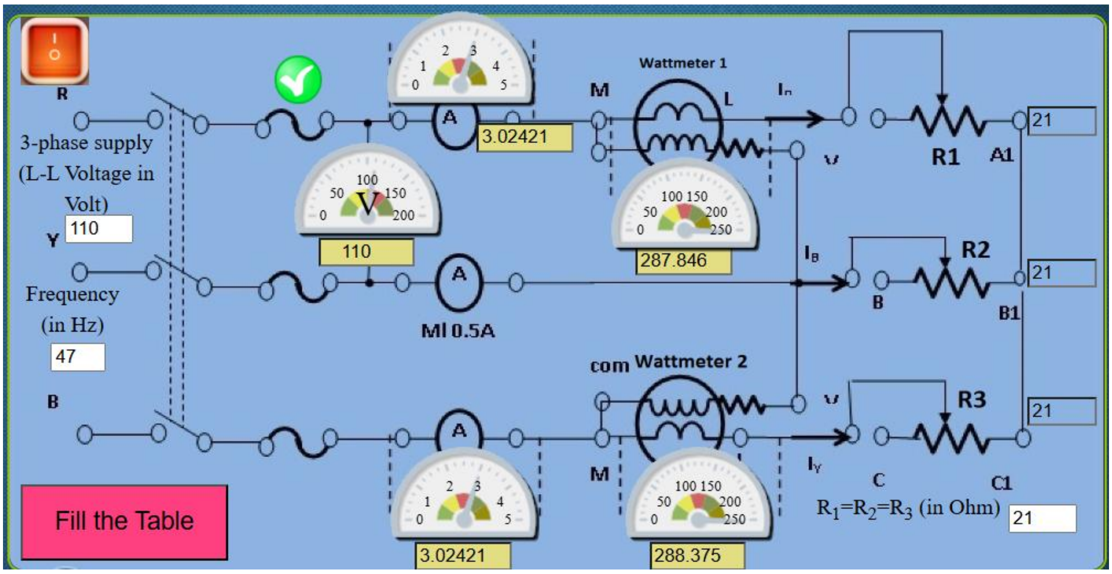
Case 1:



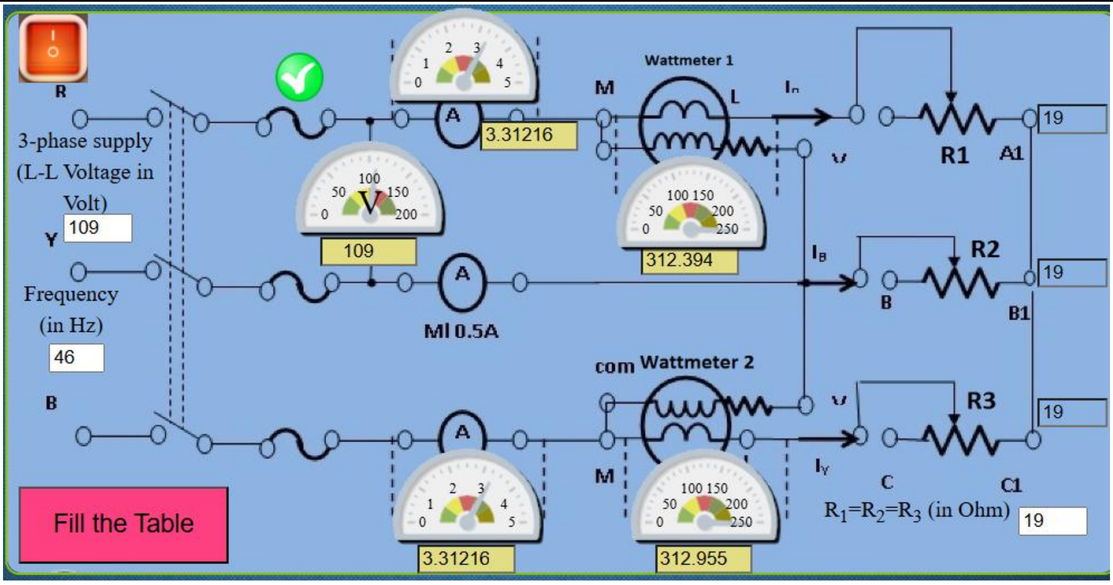
Case 2:


R
3-phase supply
(L-L Voltage in
Volt)
108
Y
Frequency
(in Hz)
49
B
Fill the Table
2.59807
108
MI 0.5A
2.59807
Wattmeter 1
M
L
242.780
com Wattmeter 2
M
243.245
R1
A1
24
R2
B
B1
24
R3
C
C1
24
$R_1=R_2=R_3$ (in Ohm)
24

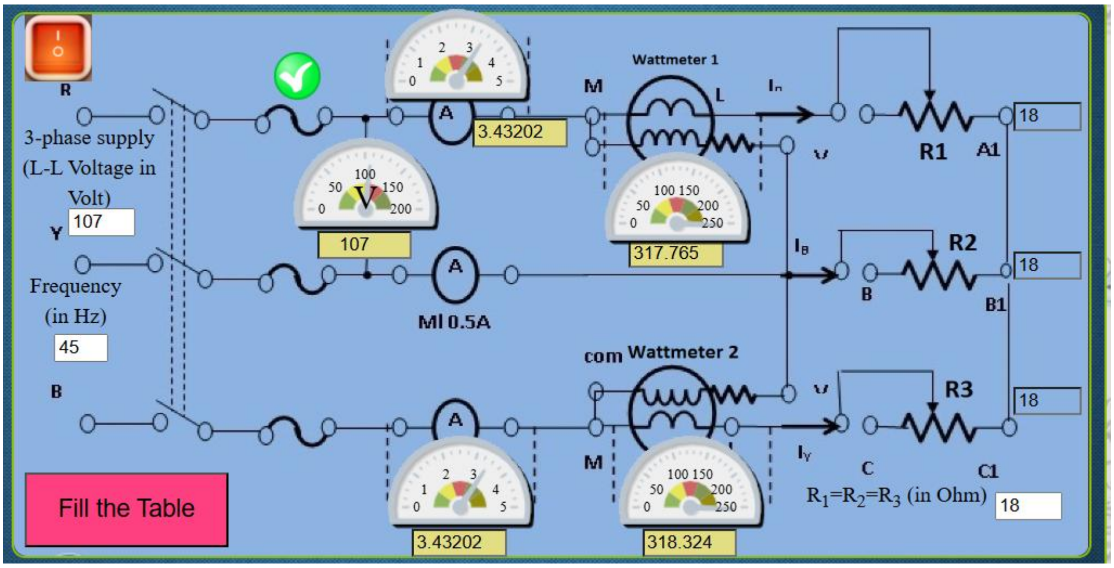
Case 3:


R
3-phase supply
(L-L Voltage in
Volt)
110
Y
Frequency
(in Hz)
47
B
Fill the Table
3.02421
110
MI 0.5A
3.02421
Wattmeter 1
M
L
287.846
com Wattmeter 2
M
288.375
R1
A1
21
R2
B
B1
21
R3
C
C1
21
$R_1=R_2=R_3$ (in Ohm)
21

Case 4:



Case 5:



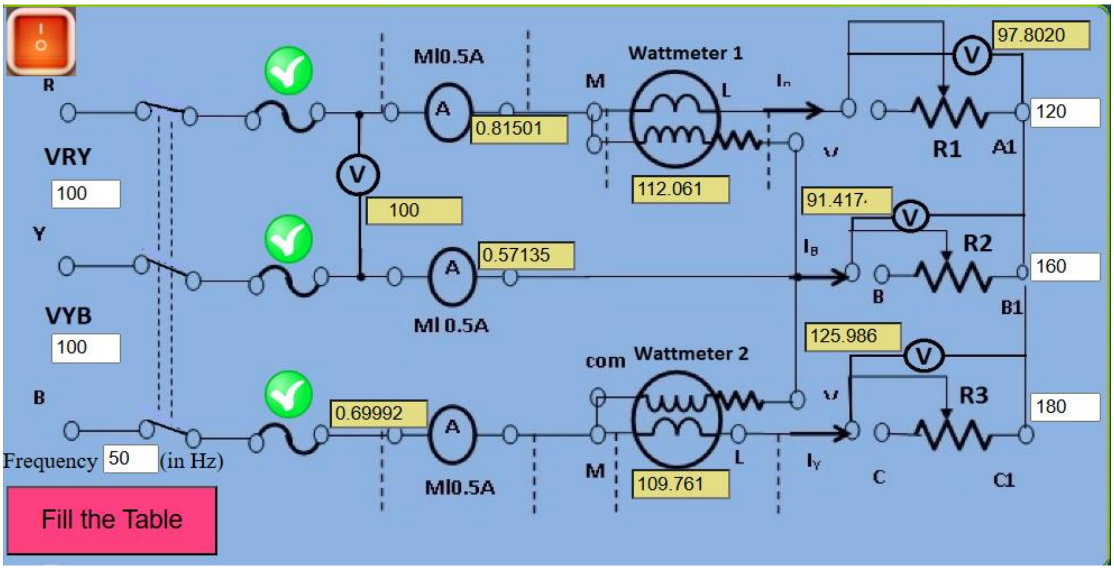
Tabulation for Balanced load:

Observation Table

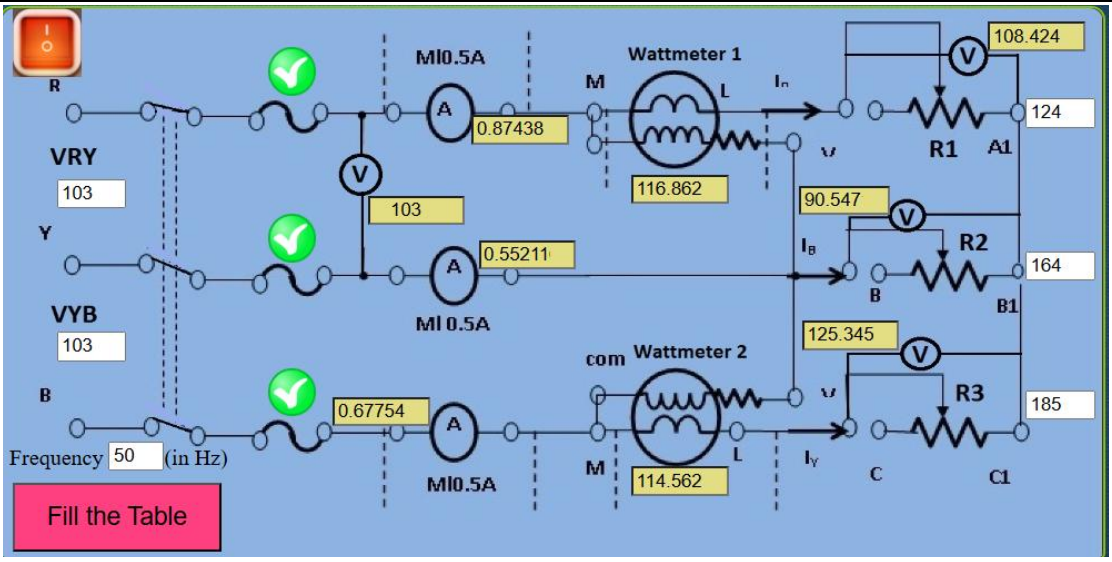
Serial no. of Observation	V_{RY}	I_R (Amp)	Cos(V_{RY}, I_R)	V_{BY}	I_B (Amp)	Cos(V_{BY}, I_B)	I_3(Amp)	W_1	W_2	W_C (Calculated power)	W_M(Measured Power=W_1+W_2)
1st	100	2.3093977	0.8652280	100	2.3093977	0.8669190	2.3093977	199.81557	200.20609	399.99885	400.02166
2nd	108	2.5980726	0.8652449	108	2.5980726	0.8669021	2.5980726	242.78069	243.24568	485.99866	486.02637
3rd	110	3.0242118	0.8652789	110	3.0242118	0.8668684	3.0242118	287.84654	288.37533	576.18901	576.22187
4th	109	3.3121633	0.8652958	109	3.3121633	0.8668516	3.3121633	312.39413	312.95579	625.31427	625.34993
5th	107	3.4320226	0.8653128	107	3.4320226	0.8668347	3.4320226	317.76573	318.32461	636.05408	636.09035

Unbalanced:

Case 1:

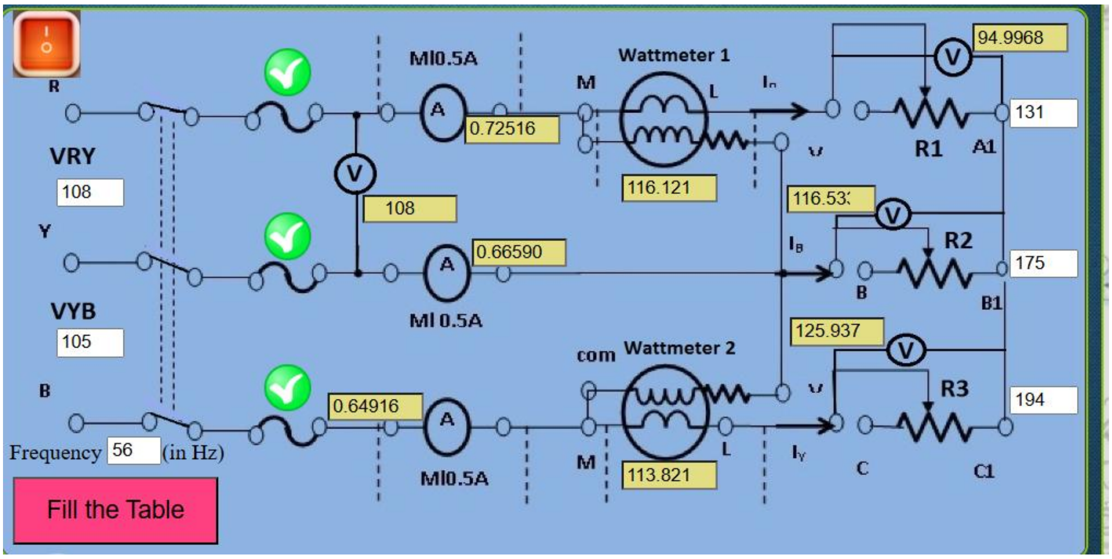


Case 2:



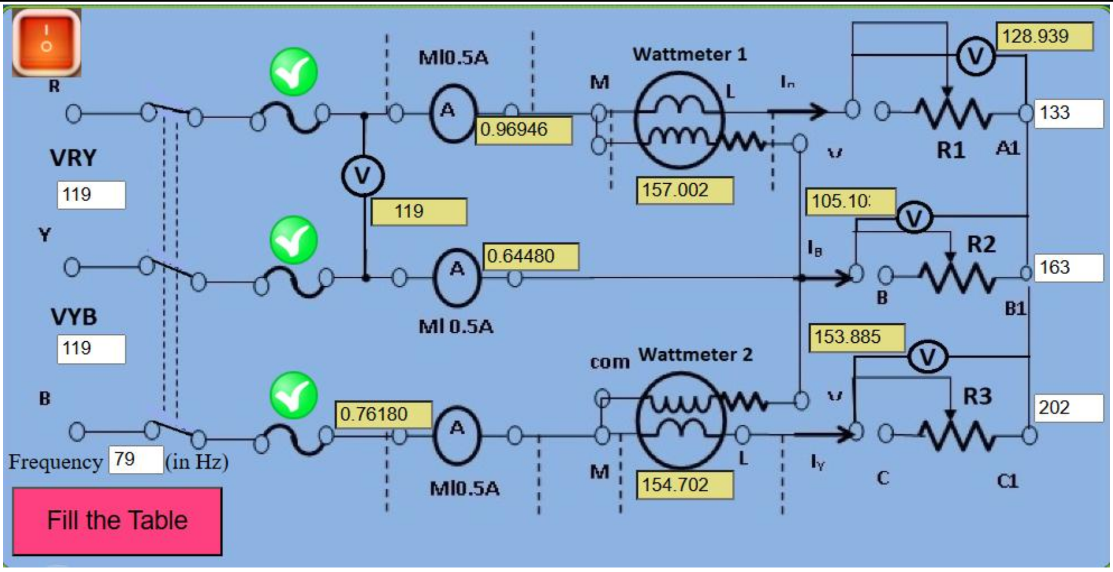
R
VRY
103
Y
VYB
103
B
Frequency
50
(in Hz)
Fill the Table
MI0.5A
0.87438
103
0.55211
MI 0.5A
0.67754
MI0.5A
Wattmeter 1
M
L
116.862
com
Wattmeter 2
M
L
114.562
108.424
124
R1
A1
90.547
R2
164
B
B1
125.345
R3
185
C
C1

Case 3:

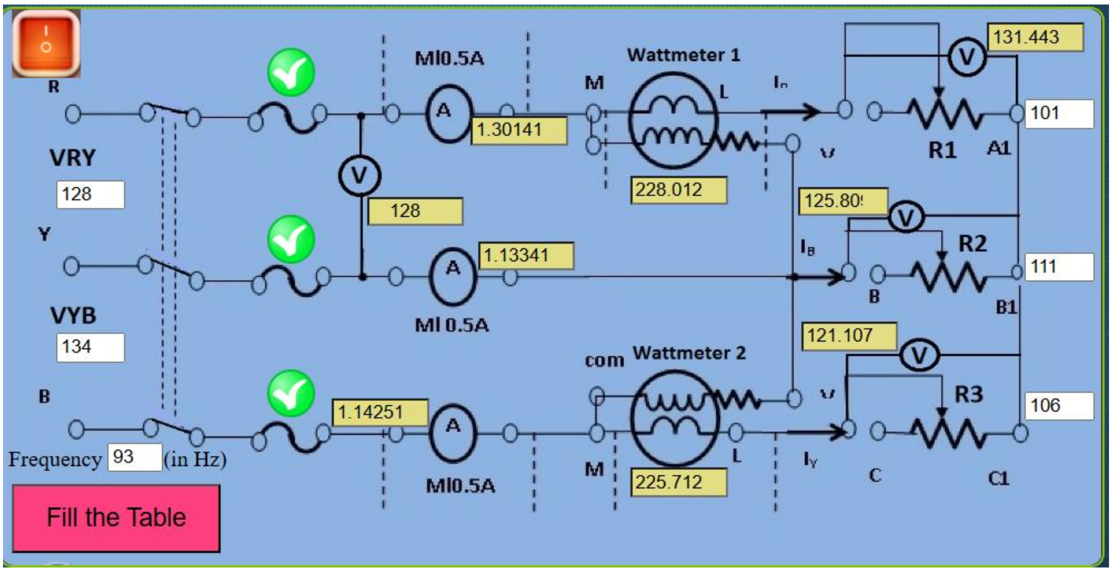


R
VRY
108
Y
VYB
105
B
Frequency
56
(in Hz)
Fill the Table
MI0.5A
0.72516
108
0.66590
MI 0.5A
0.64916
MI0.5A
Wattmeter 1
M
L
116.121
com
Wattmeter 2
M
L
113.821
94.9968
131
R1
A1
R2
175
B
B1
125.937
R3
194
C
C1

Case 4:



Case 5:



Tabulation for 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	97.802081	91.417450	125.98662	0.8150173	0.5713590	0.6999256	220.12385	112.06192	109.76192	221.82385
2nd	108.42402	90.547178	125.34560	0.8743873	0.5521169	0.6775438	229.72436	116.86218	114.56218	231.42436
3rd	94.996842	116.53391	125.93768	0.7251667	0.6659081	0.6491633	228.24356	116.12178	113.82178	229.94356
4th	128.93946	105.10327	153.88519	0.9694696	0.6448053	0.7618078	310.00500	157.00250	154.70250	311.70500
5th	131.44323	125.80938	121.10700	1.3014181	1.1334178	1.1425188	452.02425	228.01212	225.71212	453.72425

RESULT:

Thus the Measurement of Power is Simulated and validated