Three Phase Power Measurement

Aim of the experiment

Three phase power measurement by two wattmeter method.

Theory

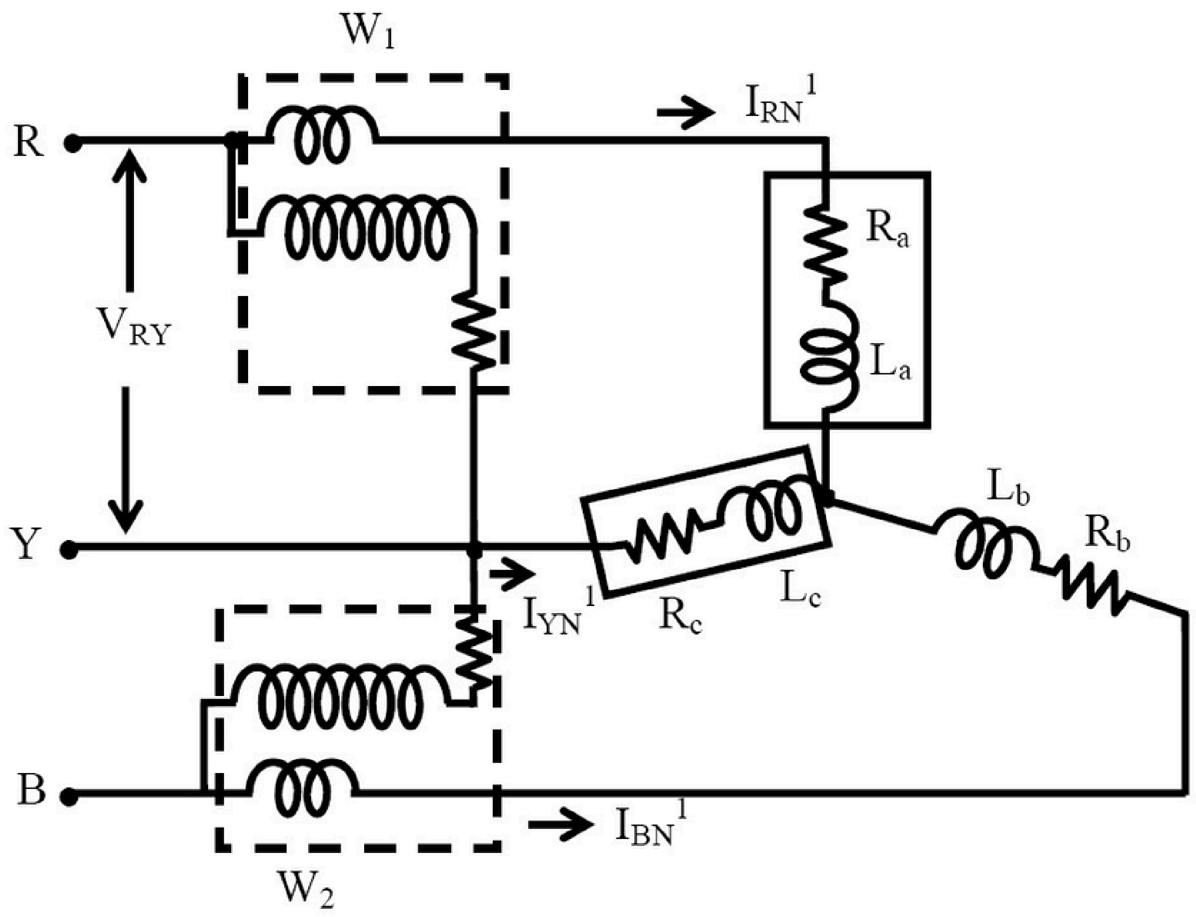


Fig 1: Connection diagram for three phase power measurement using two wattmeter method

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,

$$W= I_{RN}*V_{RN} + I_{YN}*V_{YN} + I_{BN}*V_{BN} \quad ...(1)$$

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,

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

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

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

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

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

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.

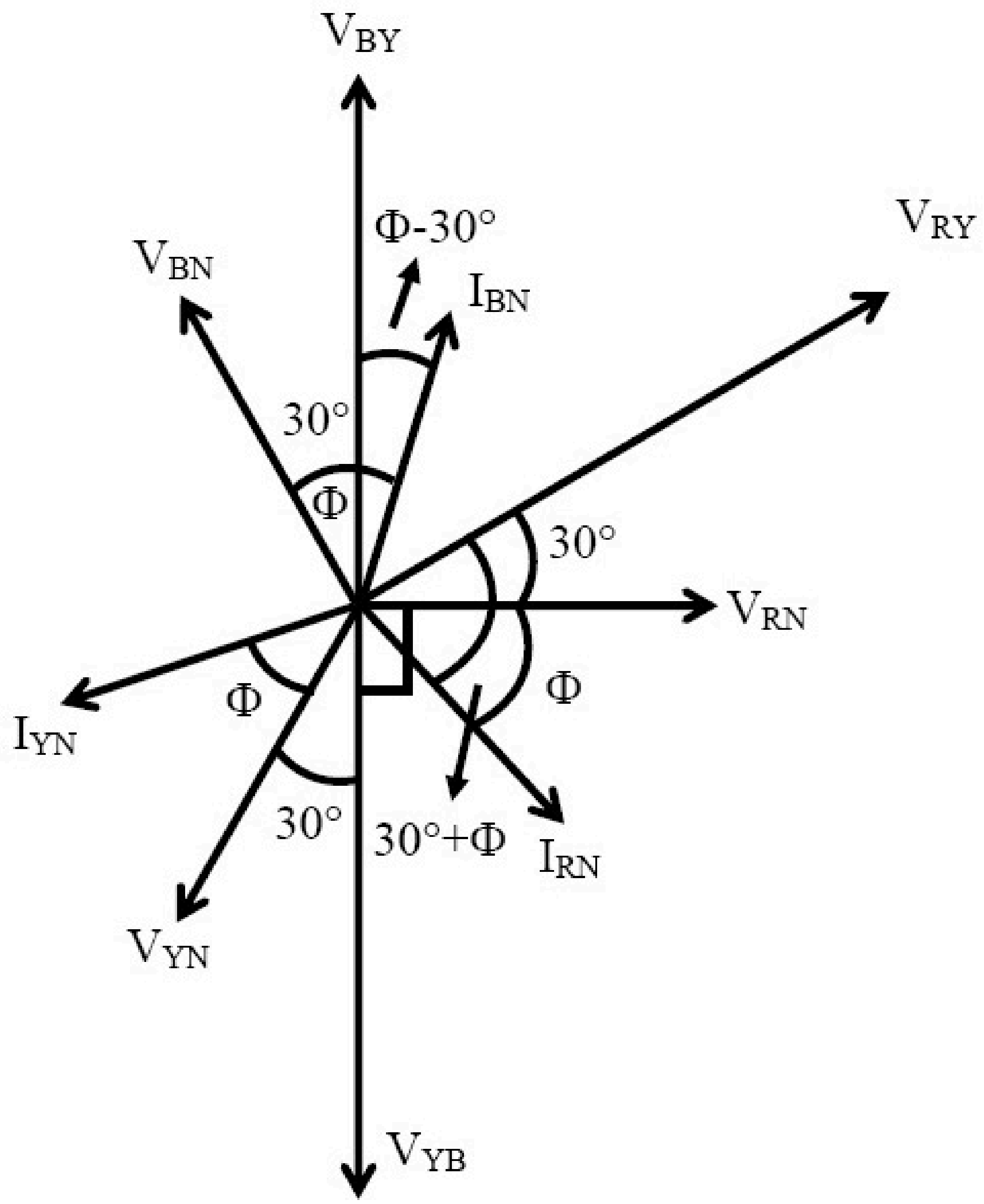


Fig 2: Phasor diagram of three phase balanced star connected circuit

Procedure

BALANCED LOAD :

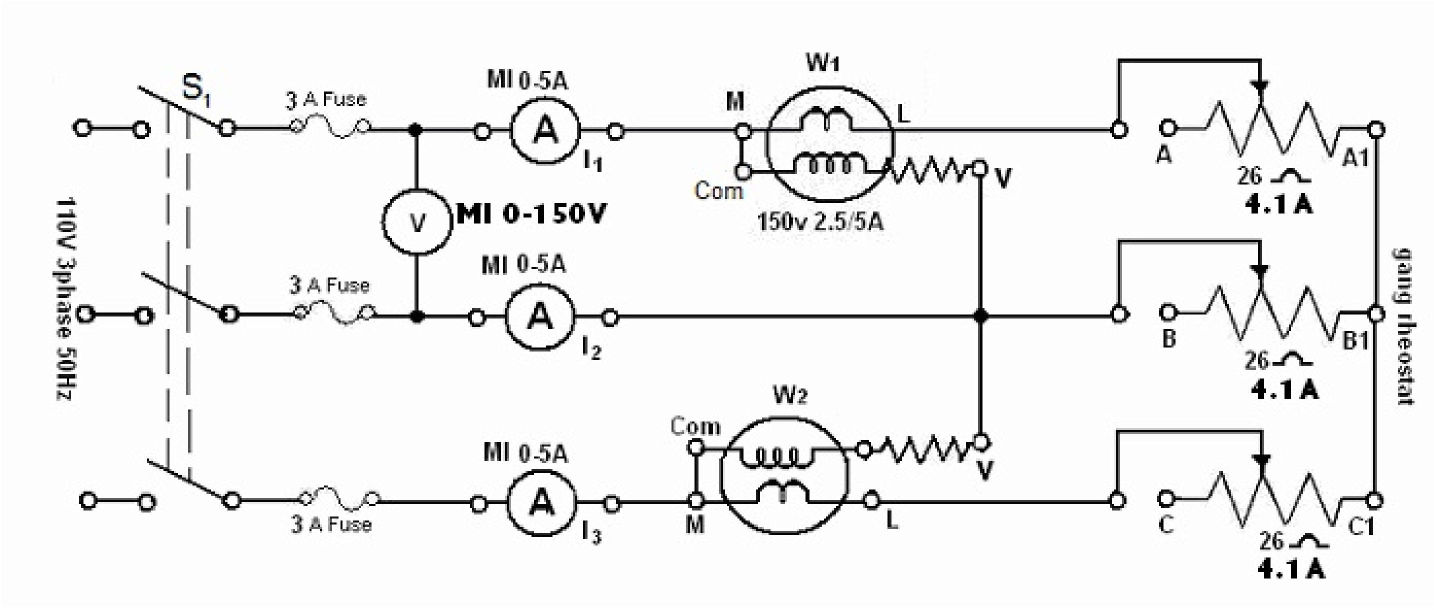


Fig. 1. Three phase power measurement circuit under balance condition

1. Connect the circuit as shown in Fig. 1.

2.Adjust the ganged rheostat for the maximum resistance.

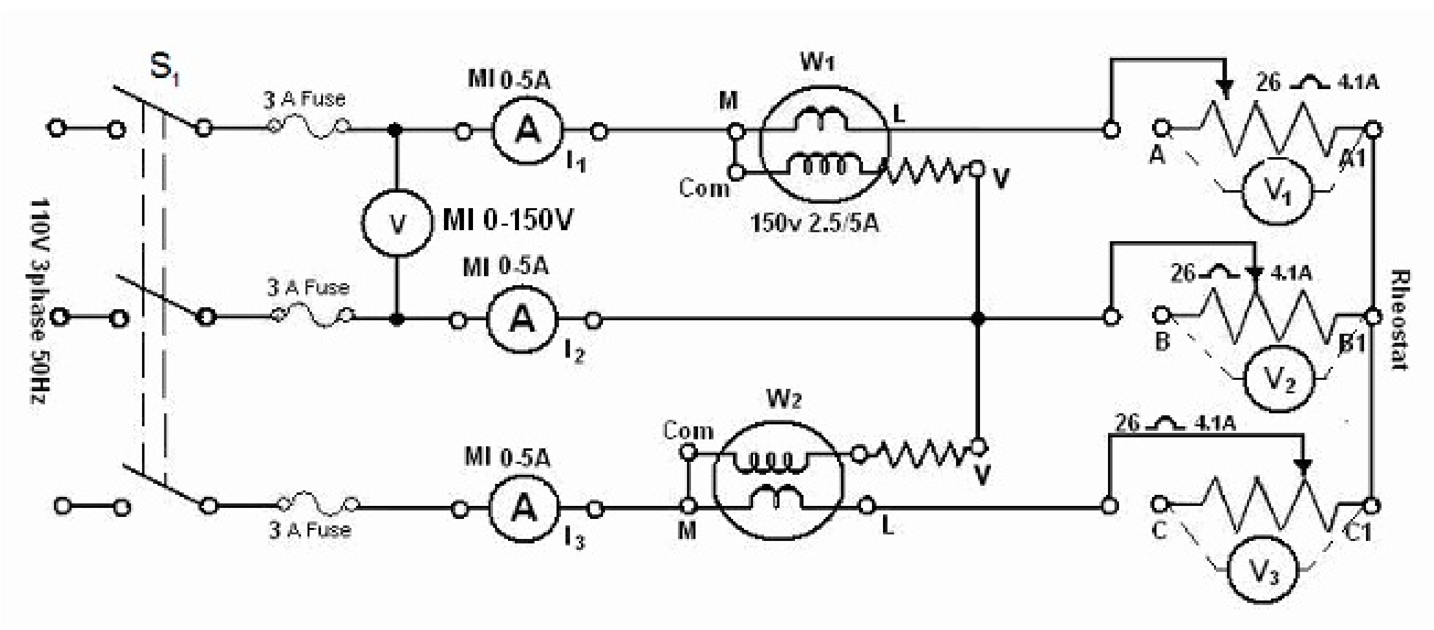
3.Switch on the supply.

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 :



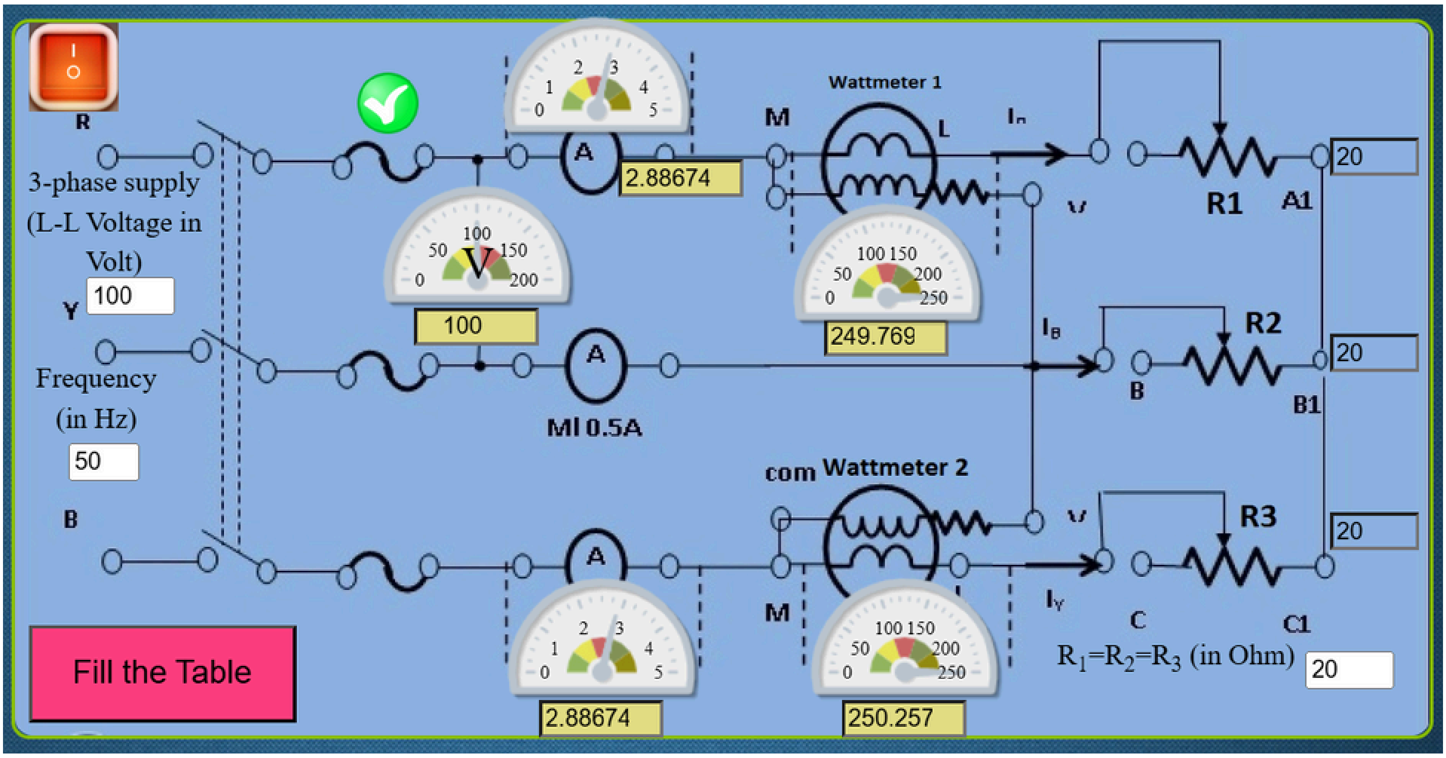
1. Fig. 2. Three phase power measurement circuit under unbalance condition
2.

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.

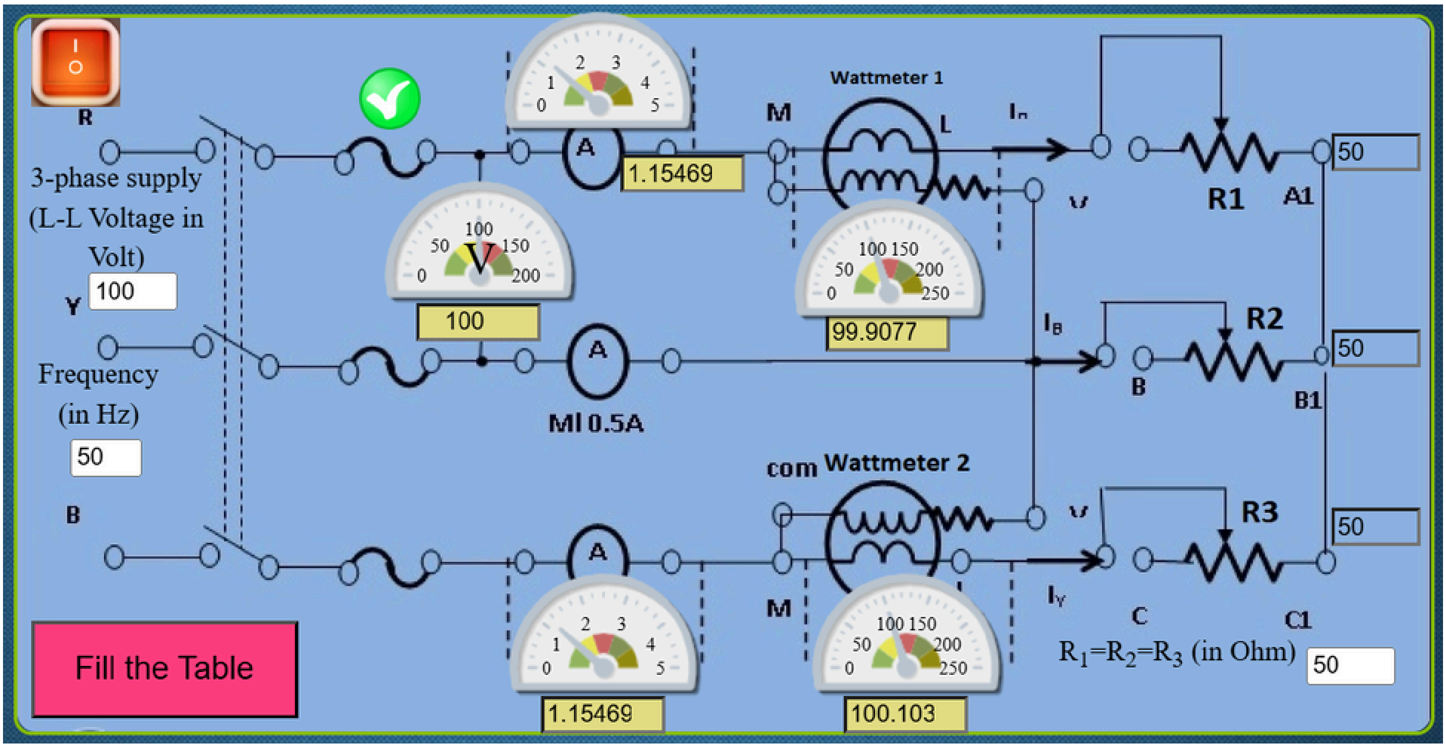
Simulation:

Balanced circuits:

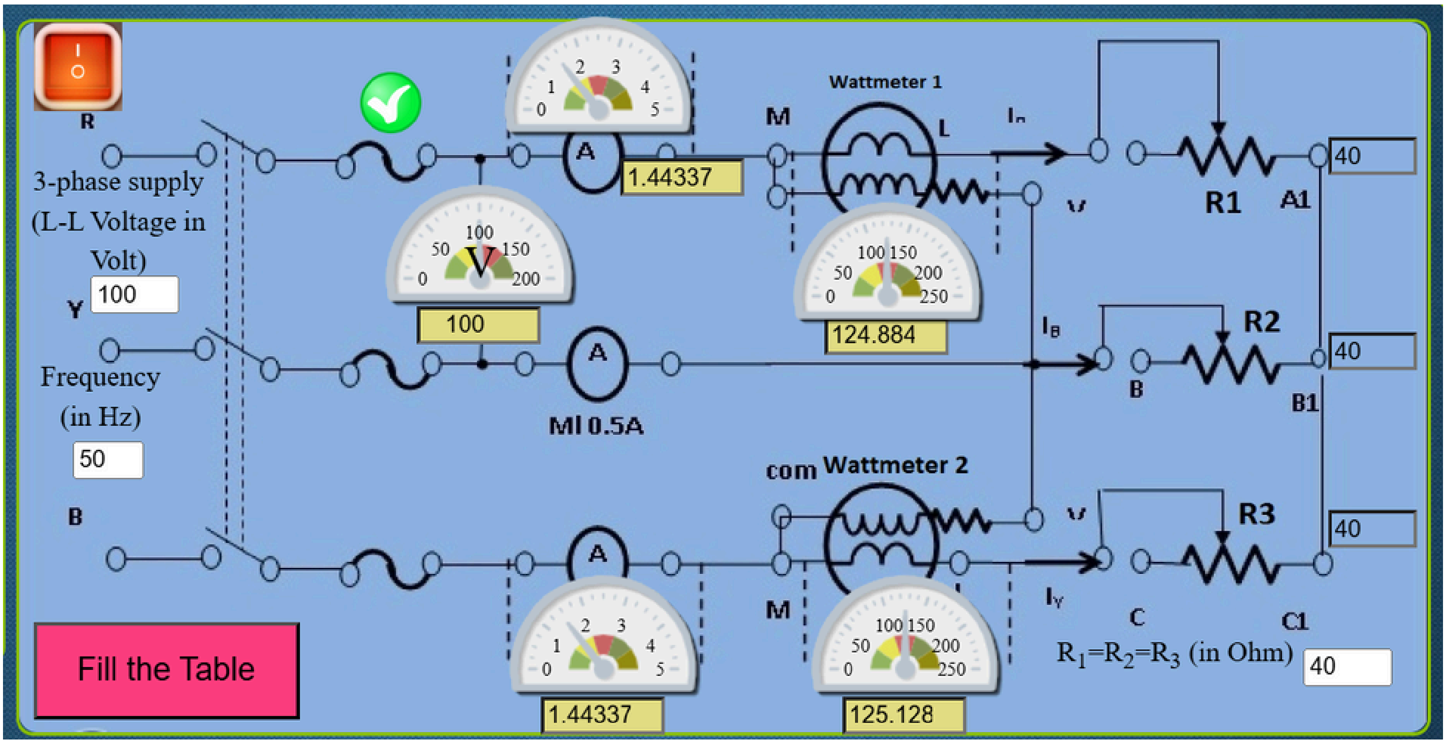
Circuit 1 :



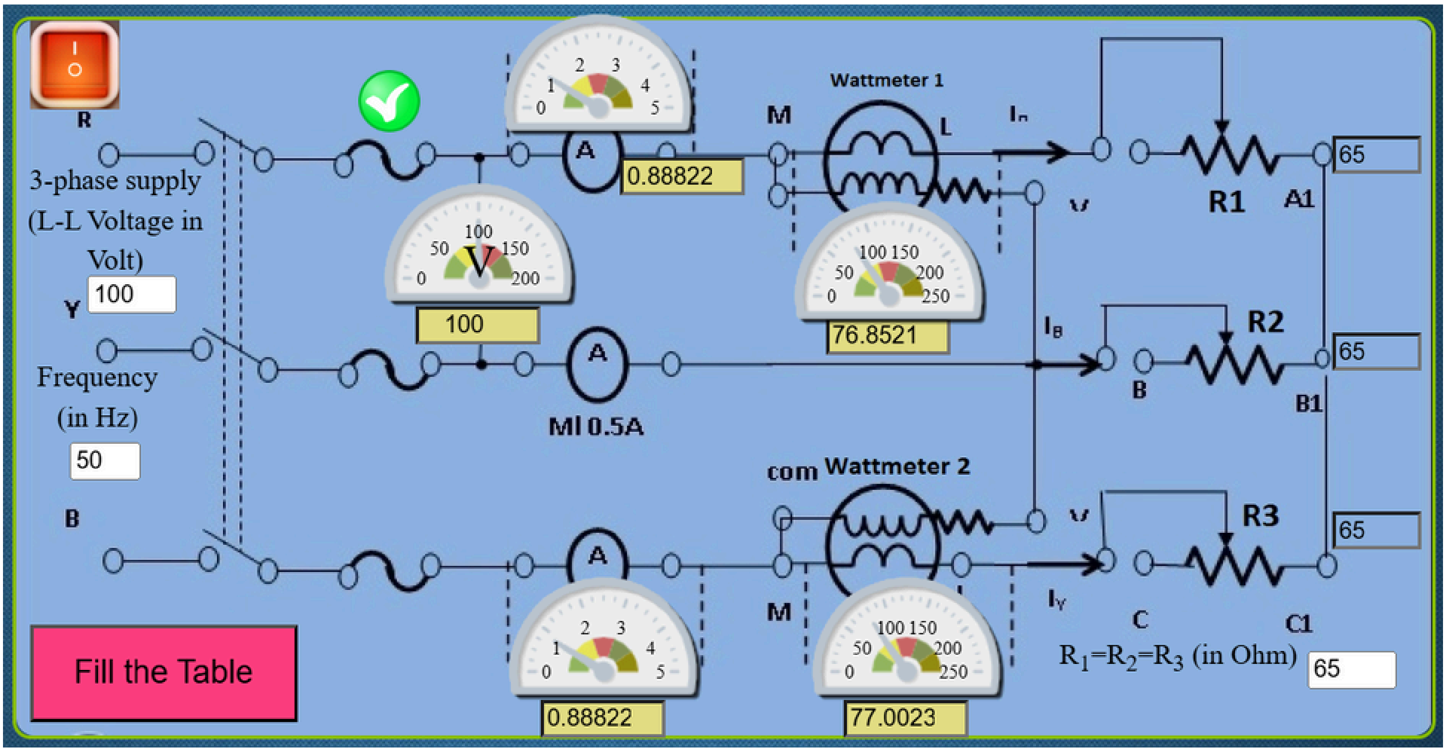
Circuit 2:



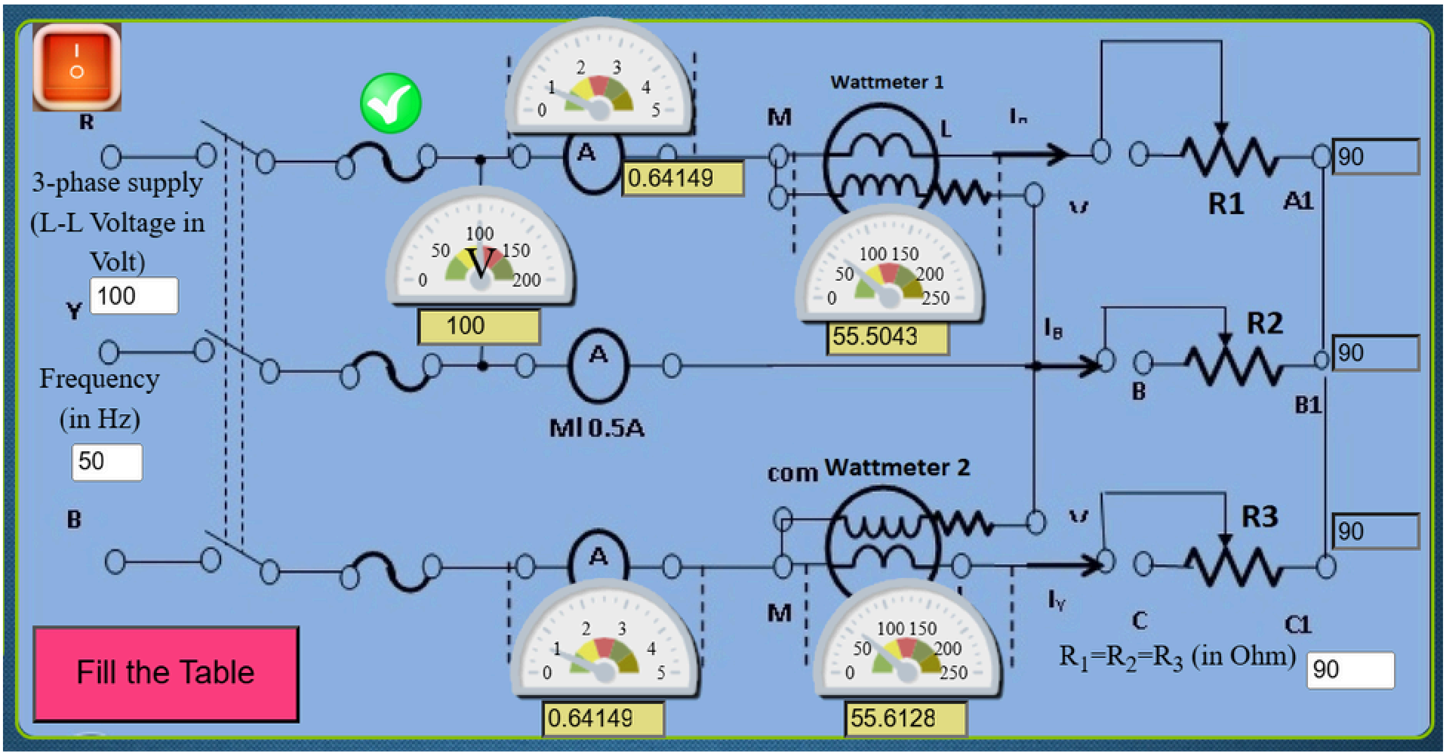
Circuit 3:



Circuit 4:



Circuit 5:

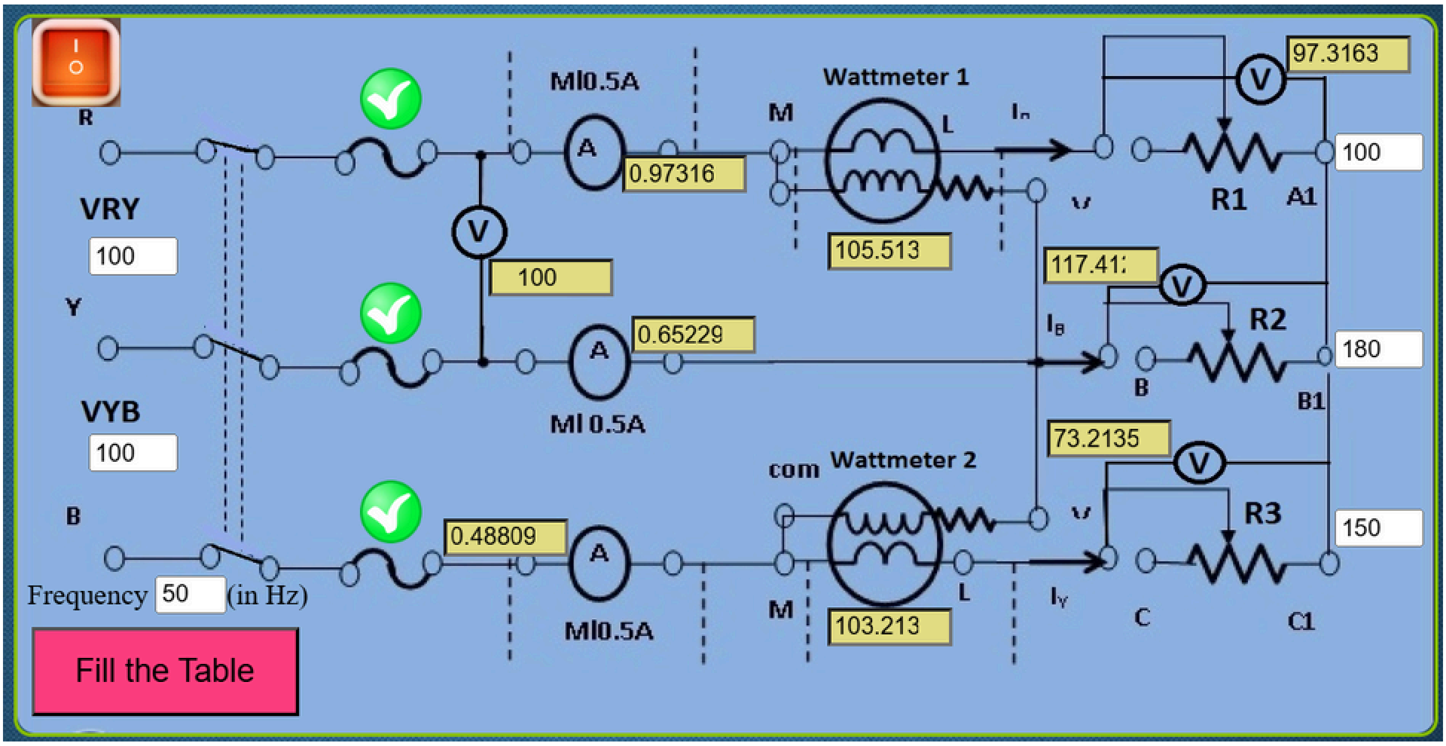


Observation :

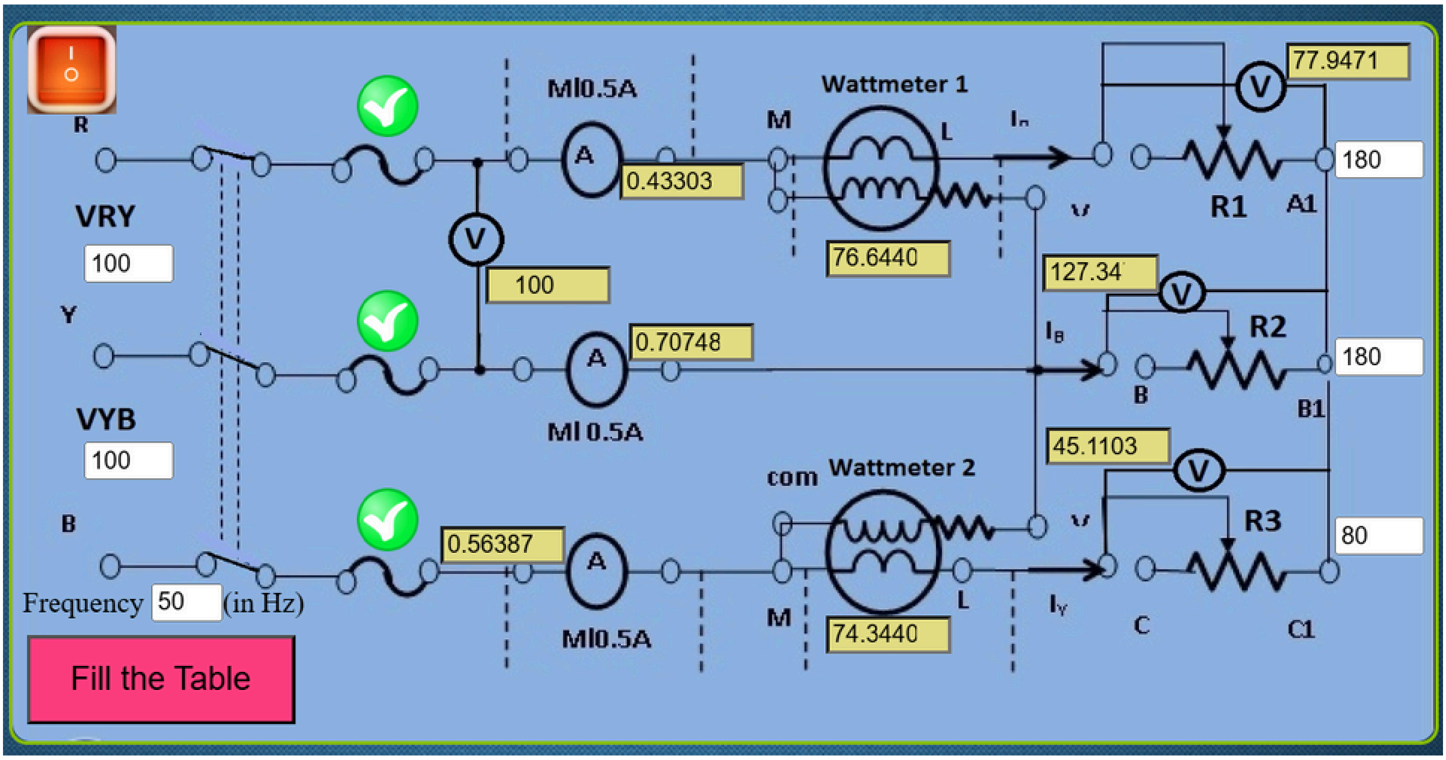
Serial no. of Observation	V_{RY}	I_R (Amp)	Cos(V_{RY}, I_R)	V_{BY}	I_B (Amp)	Cos(V_{BY}, I_B)	I_3(Amp)	W_1	W_2	W_C (Calculated power)	W_M(Measured Power=W_1+W_2)
1st	100	2.8867472	0.8652280	100	2.8867472	0.8669190	2.8867472	249.76946	250.25761	499.99856	500.02708
2nd	100	1.1546988	0.8652280	100	1.1546988	0.8669190	1.1546988	99.907785	100.10304	199.99942	200.01083
3rd	100	1.4433736	0.8652280	100	1.4433736	0.8669190	1.4433736	124.88473	125.12880	249.99928	250.01354
4th	100	0.8882299	0.8652280	100	0.8882299	0.8669190	0.8882299	76.852142	77.002343	153.84571	153.85448
5th	100	0.6414993	0.8652280	100	0.6414993	0.8669190	0.6414993	55.504325	55.612803	111.11079	111.11712

Unbalanced ciruits :

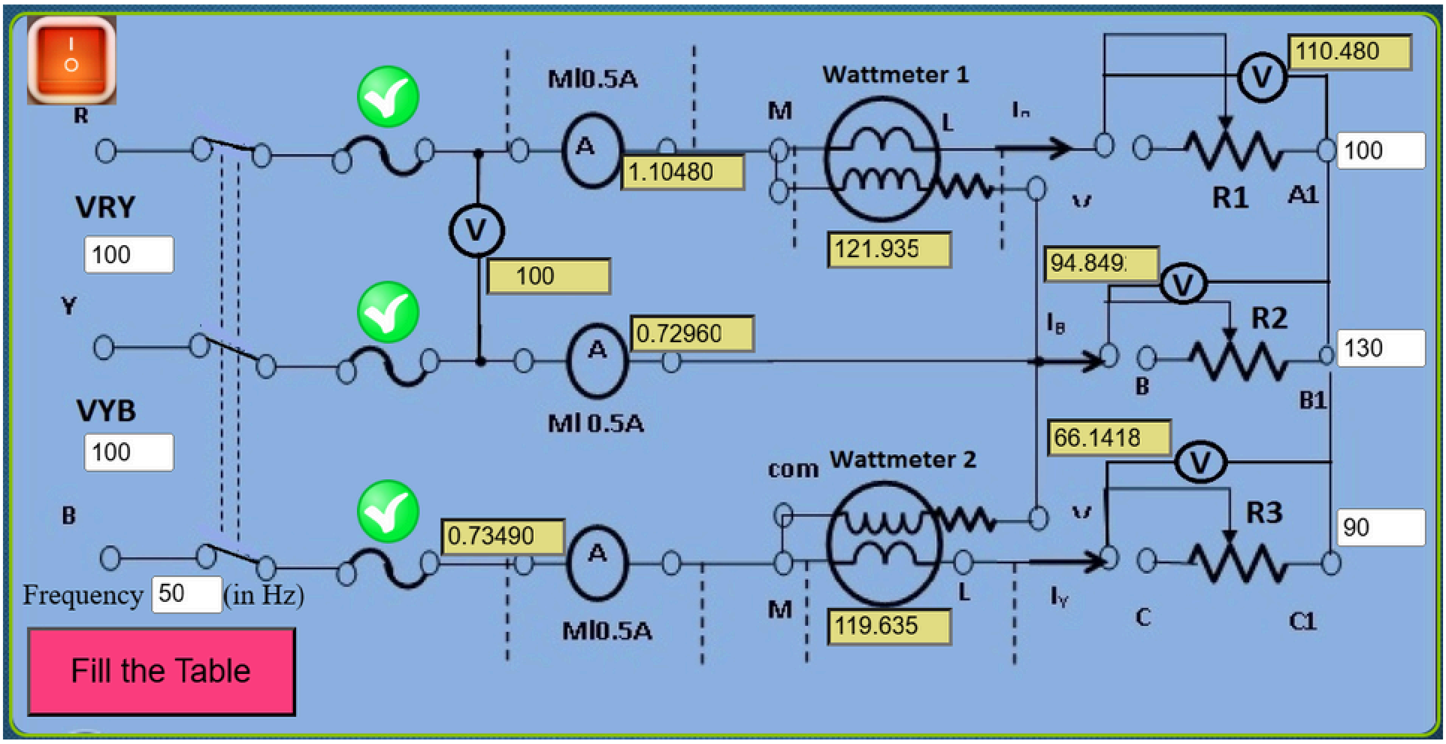
circuit 1:



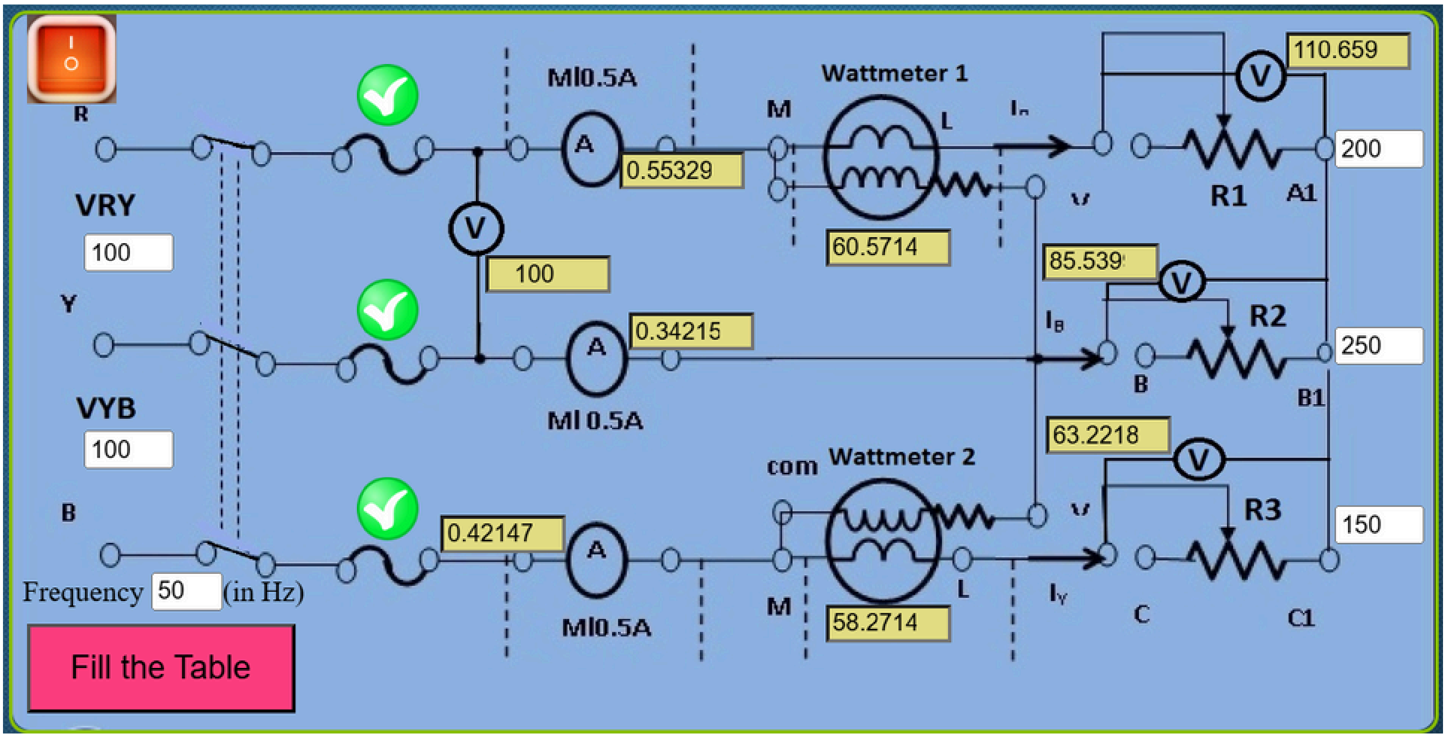
Circuits 2 :



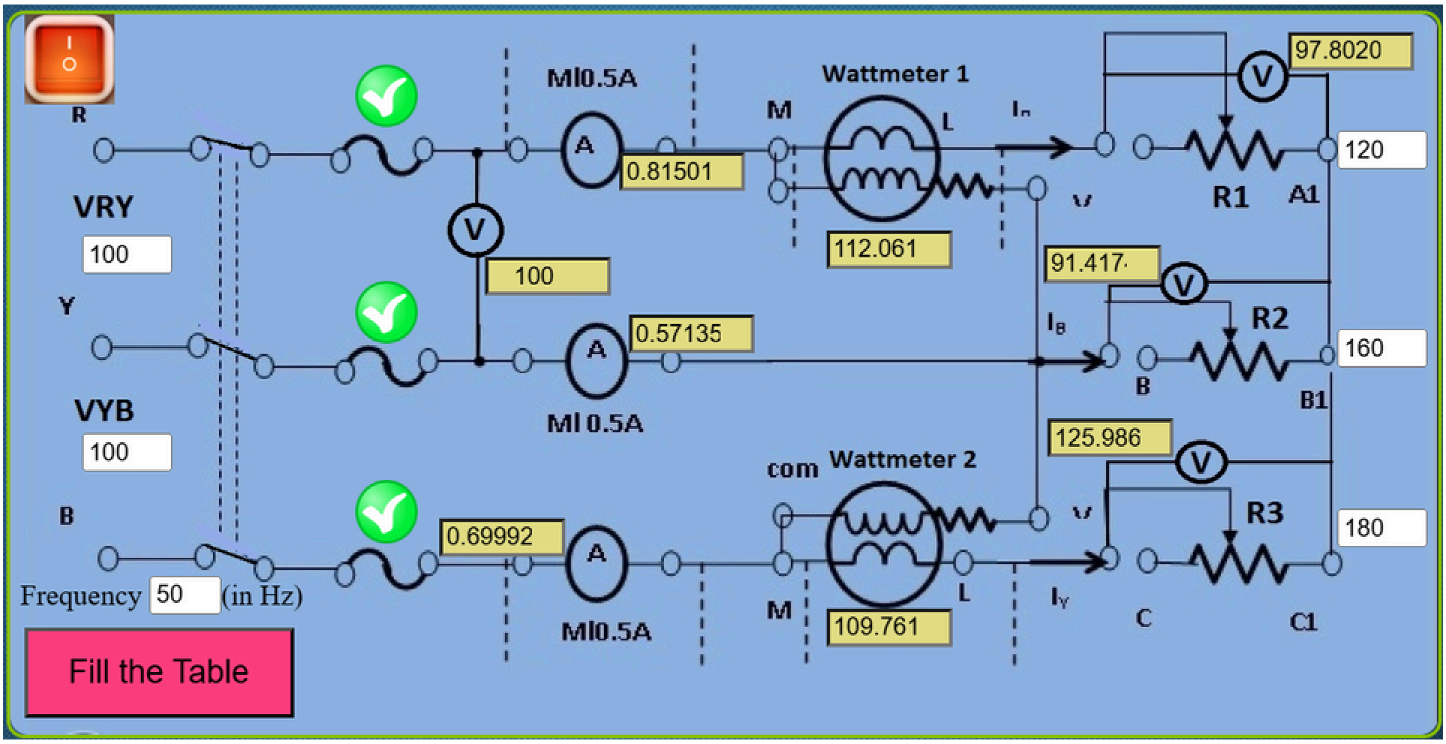
circuits 3:



circuits 4:



circuits 5:



observation :

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	97.316341	117.41294	73.213585	0.9731634	0.6522941	0.4880905	207.02734	105.51367	103.21367	208.72734
2nd	77.947110	127.34791	45.110374	0.4330395	0.7074883	0.5638796	149.28816	76.644084	74.344084	150.98816
3rd	110.48081	94.849242	66.141813	1.1048081	0.7296095	0.7349090	239.87122	121.93561	119.63561	241.57122
4th	110.65980	85.539997	63.221823	0.5532990	0.3421599	0.4214788	117.14299	60.571495	58.271495	118.84299
5th	97.802081	91.417450	125.98662	0.8150173	0.5713590	0.6999256	220.12385	112.06192	109.76192	221.82385

Result :

Thus the measurement of power is simulated and validated.