Ex. No.:2

Date: 25/10/15

Three Phase Power, Energy Measurement

Aim

To measure the Power and Energy consumed by a three phase resistive load.

Materials Required

S. No.	Name of the apparatus	Range / Type	Quantity
1	32 Amps, 3 pole Fuse Switch	-	1 No.
2	U.P.F. Watt meters double element	0-300 W	1 No.
3	Ammeter	0 – 10 A	1 No.
4	Voltmeter	0 – 300 V	1 No.
5	Three Phase Energy Meter	Digital	1 No.
6	Wooden Board	4' x 3.5'	1 No.
7	Wires	1/18"	As required

Theory

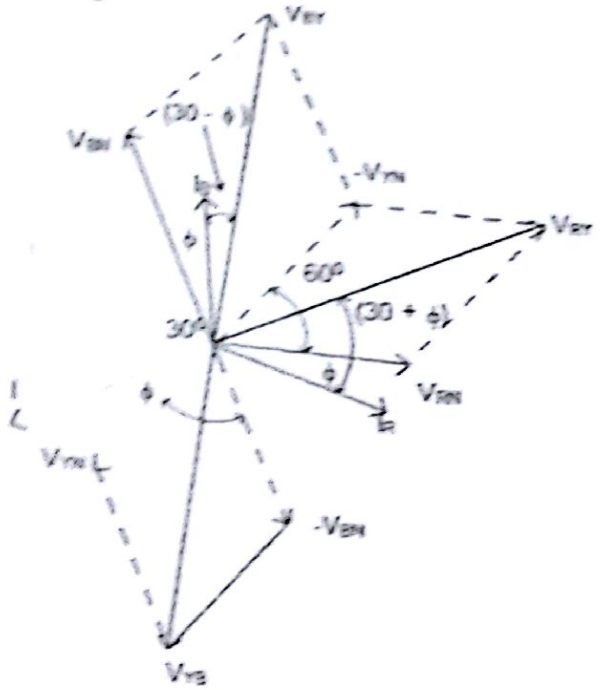
Assuming the phase sequence to be RYB, the phase voltages are V_{RN}, V_{YN} and V_{BN}. Let the phase angle between the phase voltage and phase current be Φ degree. If the load is assumed to be inductive in nature then current in each phase lags the phase voltage by Φ degrees.

From the circuit diagram

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

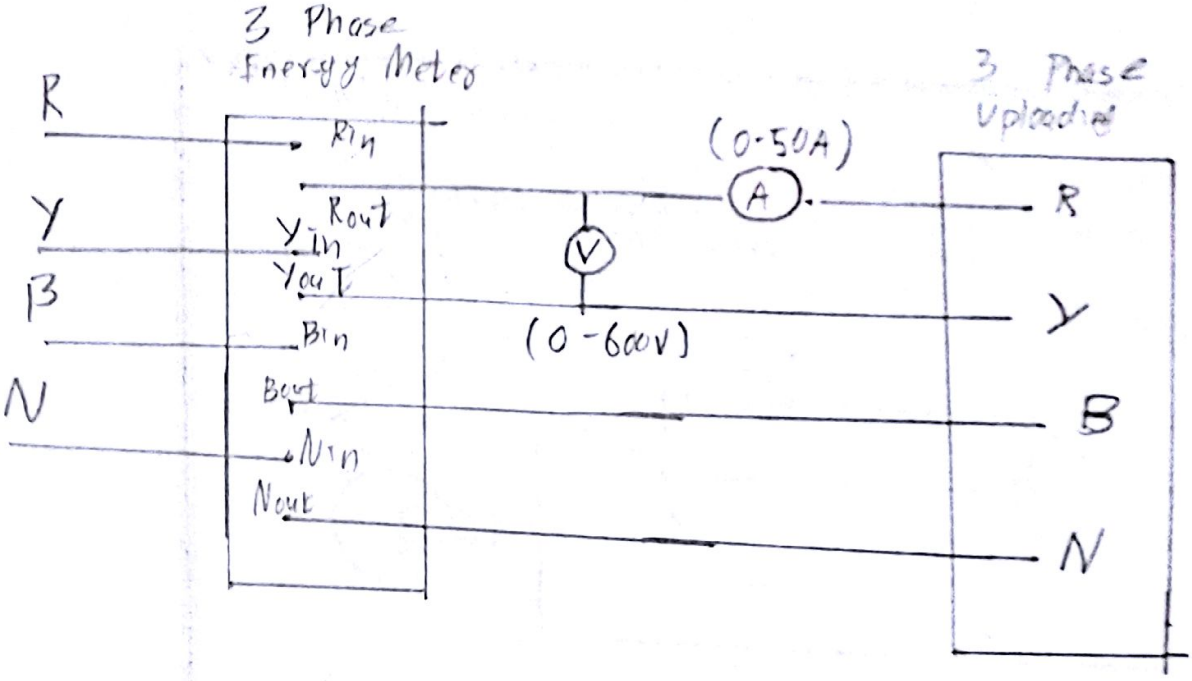
$V_{BY} = V_{BN} - V_{YN}$

Vector diagram



Taking V_{RN} as reference voltage,

Wattmeter reading $W_1 = V_{RY} I_R \cos$



Measurement of Energy StopWatch

SNo	V	I	Time (sec)	Energy $P=\sqrt{3}V_L I_L T_L$	Energy from Watt Meter $P=V_L I_L T_L$
1	410	1	290	205940.541	118900
2	410	1.9	185	249616.502	14415
3	410	3.3	128	299963.487	173184
4	410	4.1	105	305715.628	176505
5	410	4.6	85	277665.065	160310

Table measurement of power

SNo	V	I	W
1	440	1	360
2	440	2.6	840
3	440	3.4	1200
4	440	4.4	1520
5	440	4.6	1680

$W_1 = V_{BY}\, I_B \cos(30 - \Phi)$

Wattmeter reading $W_2 = V_{RY}\, I_R \cos$

$= V_{RY}\, I_R \cos(30 + \Phi)$

Total power = $W = W_1 + W_2$

$= V_{BY}\, I_B \cos(30 - \Phi) + V_{RY}\, I_R \cos(30 + \Phi)$

But

$V_{BY} = V_{RY} = V_L$ and $I_B = I_R = I_L$

$W = V_L I_L \cos(30 - \Phi) + V_L I_L \cos(30 + \Phi)$

$= V_L I_L [\cos(30 - \Phi) + \cos(30 + \Phi)]$

$= V_L I_L [\cos 30 \cos\Phi + \sin 30 \sin\Phi + \cos 30 \cos\Phi - \sin 30 \sin\Phi]$

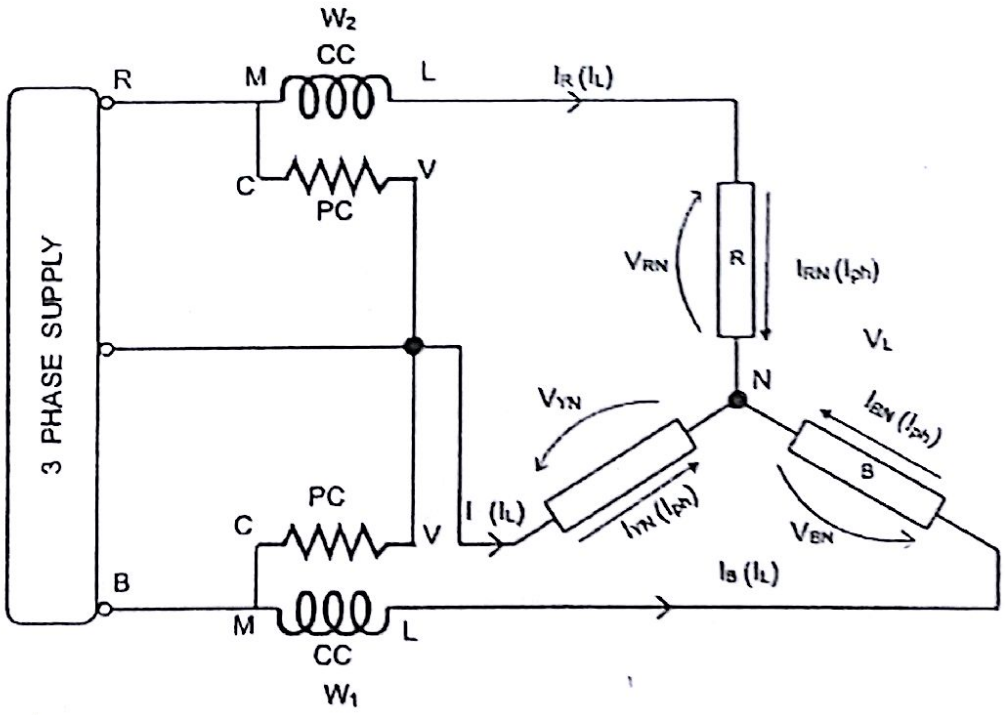
$= V_L I_L\, 2 \cos 30 \cos\Phi$

$= V_L I_L\, 2 \times \sqrt{3}/2 \cos\Phi$

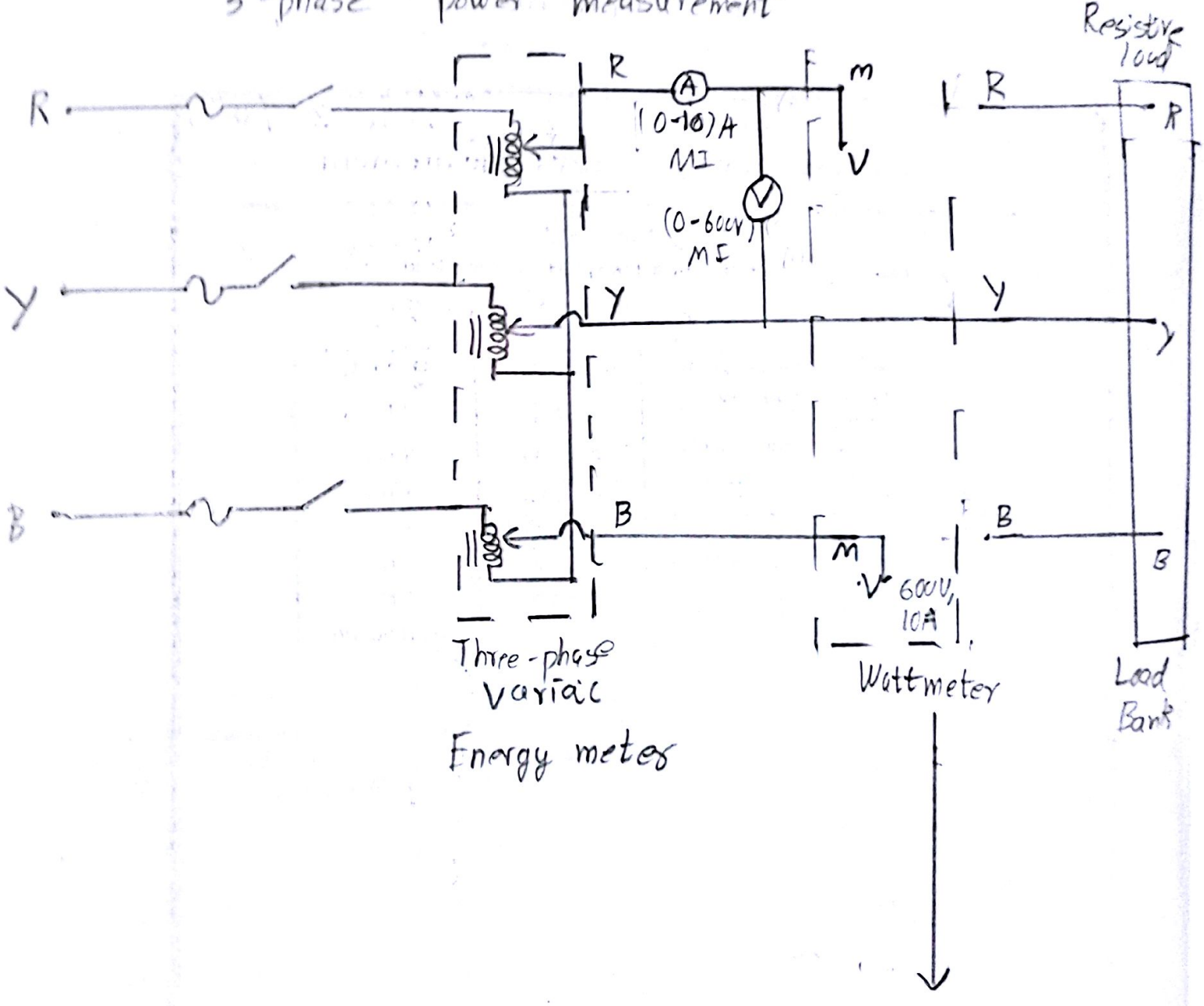
$W = \sqrt{3}\, V_L I_L \cos\Phi$ watts

This shows that two wattmeter is sufficient to measure total power in a 3 phase star system

Circuit Diagram



3-phase power measurement



Observation

Type of Load (W)	W1 (KW)	W2 (KW)	I1 Amps	I2 Amps	Vph Volts	W1+W2 KW	P KW	Energy

Result

Thus the power and energy where measured for a 3 phase supply connected to a 3 phase star connected resistive load.