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EXPERIMENT - 10

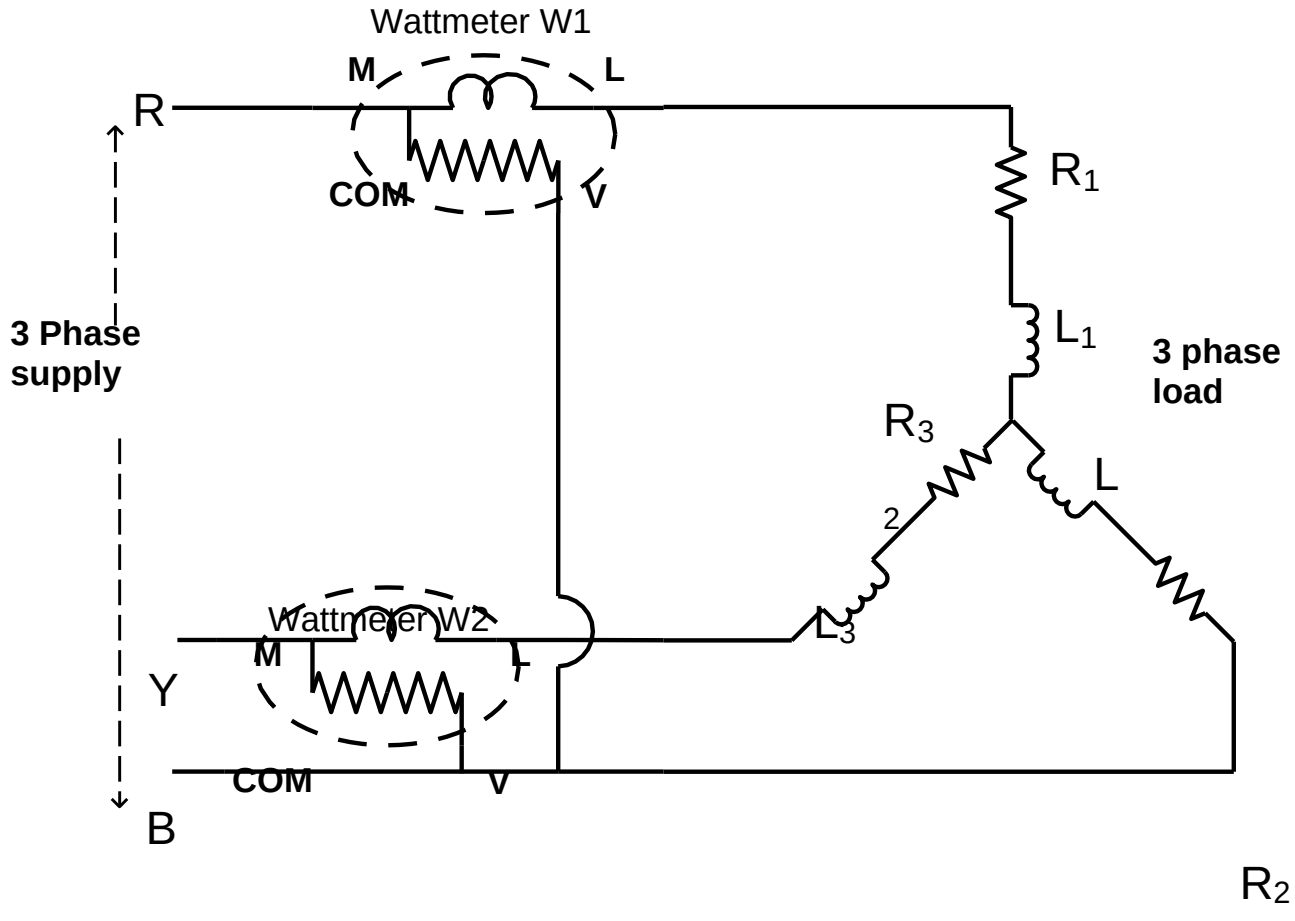
EXPERIMENT: MEASUREMENT OF POWER IN THREE PHASE BALANCED LOAD.

Objective: To determine**:**

(1) Relationship between phase and line voltage and current

(2) Power and power factor by two wattmeter method.

Equipment: **(1) AC** Voltmeter **(2)** Three phase balanced R-L Load **(3)** C-M Board **(4)** AC Ammeter **(5)** Three Phase Variable Transformer **(6)** Two AC Wattmeters **(7)** Connecting wires



Connection diagram for Two Wattmeter Method of Power Measurement

Fig. Circuit diagram for measurement of power in a three phase load using two wattmeter method.

Theory: Power measurement : The active power per phase in three phase circuit is given by $P_P = V_P I_P \cos\theta$ Where θ is the phase angle between phase voltage and phase current. V_P is phase voltage and $I_P$is phase current. Total power in three phase circuit is given by $P=3\ V_P\ I_P \cos\theta$.

For star connections, $V_p = (V_L/\sqrt{3})$ and $I_P=I_L$. $P =3(V_L/\sqrt{3})(I_L)\cos\theta= \sqrt{3}\ V_L I_L \cos\theta$.

For delta connections $V_P= V_L$ and$I_P=(I_L\sqrt{3})$. $P = 3\ V_L(I_L/\sqrt{3})\cos\theta=\sqrt{3}\ V_L I_L \cos\theta\ I_L$

is the line current and V_L is the line voltage.

Power and power factor in a three phase balanced circuit is measured by one wattmeter or two wattmeter or three wattmeter method. Three wattmeter methods is used to measure power in unbalanced circuit. For wattmeter W_1, the current through current coil is Ia and voltage across potential coil is (Va-Vb). For watt meter W_2, the current through current coil is Ic and voltage across potential coil is (Vc-Vb).

Total instantaneous power of load = $VaIa+V_bI_b+VcIc$.

Now,considering the three phase balanced load:-

Sum of all the three phase currents is zero,i.e $I_a+I_b+I_c=0$ for balanced circuit,

So total instantaneous power $P=(V_a-V_b)Ia+(Vc-V_b)Ic$

P=Instantaneous reading of W_1 +Instantaneous reading of W_2

Using phasor diagram, $W_1 =\sqrt{3}(V_L)(I_L)\cos(30°+\theta)$ and $W_2 = \sqrt{3}V_L I_L \cos(30°-\theta)$

Such that power in 3 phase circuit will be $W=W_1+W_2=\sqrt{3}\ (V)(I)\cos\theta$, Where θ is the phase angle of load.

Hence,power=$P=W=W_1+W_2.=\sqrt{3}\ (V)(I)\cos\theta$. ThePower factor can be calculated

as: $\cos\theta=\cos[\tan^{-1}\{\sqrt{3}\ (W_2-W_1)\ /\ (W_1+W_2)\}]$.

Procedure:

- Connect the experimental set up as shown in the circuit diagram.
- Switch on the appropriate input supply and measure the following;
- **(a)** Voltage across each phase **(b)** Voltage drop across R and L. **(c)** Current in each phase by using the current measurement board and ampere meter.
- Take the both wattmeter readings simultaneously.
- Record readings of all the instruments in the observations in table.

Observation

Type of circuit	Voltage				Current		V_L/V_P	I_L/I_P	Watt-meter reading		Total Power	Power factor
	V_P	V_L	V_R	V_{XL}	I_P	I_L			W_1	W_2	W_1+W_2	$\cos\phi$
Star	59V	108 V	23 V	50V	206 A	206 A	1.83	1	16 W	208 W	224 W	0.58

CALCULATIONS:

Experiment - 10 (Calculation part)

Phase voltage = 59 V
line voltage = 107 V

$V_R = 23V$, $V_{XC} = 50V$.

$I_{ph} = 2.06A$, $I_C = 2.06A$

∵ [Because star connection $I_{ph} = I_C = 2.06A$]

Multiplying factor = $\frac{125 \times 2.5 \times 1}{156.25} = 2.$

Wattmeter connected between two phases

$W_1 = 8 \times$ multiplying factor
$W_1 = 8 \times 2 = 16 W$

Illy,
$W_2 = 104 \times 2 = 208 W.$

Total Power (P) = $W_1 + W_2$
= $16 + 208 = 224 W.$
$P. = 224 W$

Calculate Power factor ($\cos\phi$) (verification)

Case I) Total Power (P) = $\sqrt{3}\, V_L\, I_L \cos\phi$

$$\cos\phi = \frac{224}{107 \times 2.06 \times \sqrt{3}}$$

$$\boxed{\cos\phi = 0.58} \quad \text{—(1)}$$

$$\boxed{\phi = 54.12^\circ}$$

Case II)

$$\cos\phi = \cos\left[\tan^{-1}\left\{\frac{\sqrt{3}(W_1 - W_2)}{(W_1 + W_2)}\right\}\right]$$

$$\cos\phi = \cos\left[\tan^{-1}\left\{\frac{\sqrt{3}(-192)}{(224)}\right\}\right]$$

On solving this,

$$\boxed{\cos\phi = 0.5586} \quad \text{—(2)}$$

$$\boxed{\phi = 56.036^\circ}$$

Result: Hence, we get $\cos\phi \simeq 0.55$ from both formulas. ∴ We verified the power factor $\cos\phi$.

Teacher's Signature : _____

Precautions:

- Always keep measuring instruments in horizontal position. i.e. table mode.
- Select appropriate range of the instruments. i.e. the range of the instruments should always be more than the existing value of current or voltage in the circuit.

- Don’t touch the resistance even after switching off the supply as it might have been heated up.

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