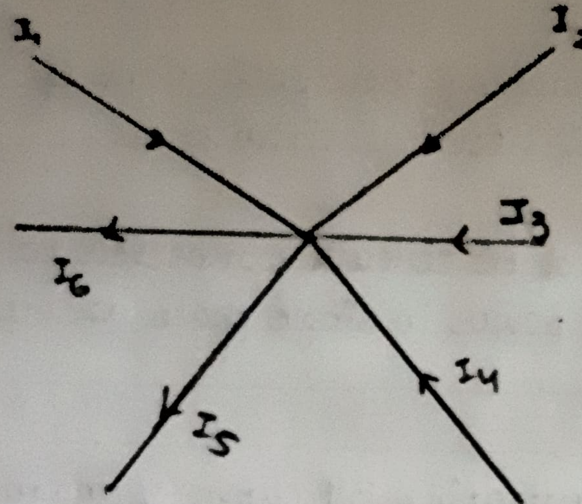
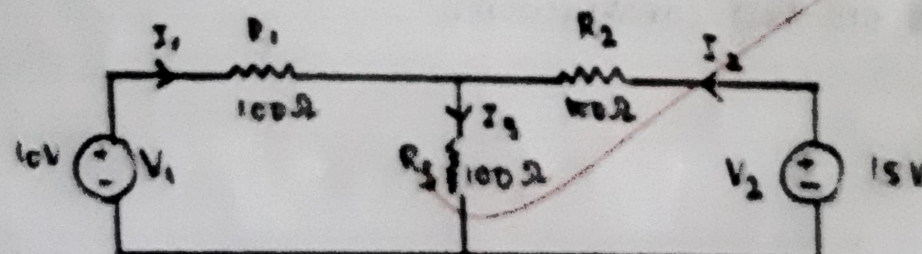


Fig 1.1 Illustration of KCL



Object: Verify Kirchoff's current Law.

Apparatus used: Ammeter, Resistances, dc supply, Connecting wire.

Theory/Principle: It states that the algebric sum of currents meeting at a junction of conductors is zero. In others words, the sum of currents flowing away from a junction is equal to the sum of current flowing towards the junction. Assuming the current entering into the junction as positive and currents leaving the junction as negative. The algebric sum of all the currents is zero.

$$I_1 + I_2 + I_3 + I_4 - I_5 - I_6 = 0$$

$$I_1 + I_2 + I_3 + I_4 = I_5 + I_6 \quad \text{[Acc. to KVL]}$$

Procedure: This experiment is performed in the following steps.

(i) Connect the different resistances are sources as per the circuit shown in Fig.
(ii) Switch on the supply.
(iii) Note down the readings of ammeter connected in all branches.
(iv) check that the sum of readings of ammeters. A1 and A2 equal to that of Ammeter A3 and equal the procedure.

Observation: Record the observations as per the table given below:

Table 1.1 Verification of KCL

SNo.	I_1 amp	I_2 amp	$I_3 = (I_1 + I_2)$
1.			
2.	19.3 mA	64.0 mA	83.3 mA

Teacher's Sign:

Calculation

Add the readings obtained from first and second ammeter and it will be equal to the reading of the third ammeter.

$$I_3 = I_1 + I_2.$$

$$\underset{mA}{83.3} = \underset{mA}{19.3} + \underset{mA}{64.0}$$

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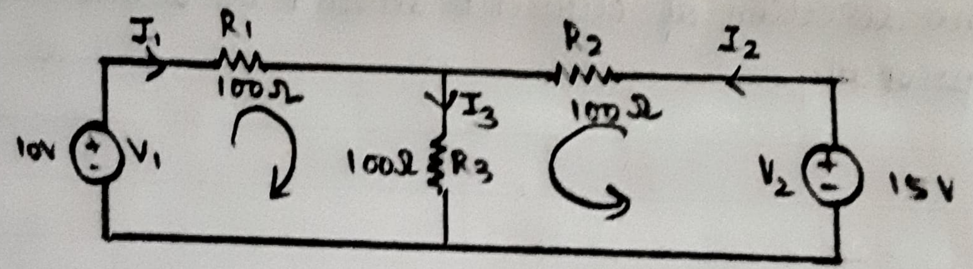
3.			

Results: KCL is verified. Because the current of third ammeter is equal to the sum of currents of first and second ammeter.

Precautions:
- All the connection should be tight.
- Before operating, check their zero reading of instruments.
- The direction of current should be connected properly.



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Date

Expt. No. 1(B) Page No. 4

Object: Verify Kirchoff voltage Law.

Apparatus used: Ammeter, Resistance, dc supply, connecting wire

Theory / Principle: Acc. to this law, "The algebric sum of voltage around a closed circuit or a loop is zero ie.

$$\sum_{j=1}^{k} v_j = 0$$

It can also be stated as "In any closed circuit, the algebric sum of the product of current and resistance in each of the conductor is equal to the algebraic sum of the emf of the battery. The voltage rise is to be taken as positive ie if we move from the -ve terminal to the +ve terminal.

Procedure: The experiment is to be performed in the following steps.

(i) connect the circuit as shown in Fig.
(ii) switch on the supply.
(iii) Note the readings of voltmeters across R_1, R_2, R_3.
(iv) Reading of voltage across R_1, R_3 should be equal to V_1.
(v) Switch off supply.

Observations: Record the observation as per the table 1.2 given below.

Table 1.2 Verification of KVL

S.No.	V across R_1	V across R_2	V across R_3	V_1 = V across R_1 + V across R_2 V_2 = V across R_2 + V across R_3
	1.7	6.7	8.1	V_1 = 9.8 V V_2 = 14.8 V

Teacher's Sign:

Calculation

Add the voltage V_1 and V_2 recorded from first and second voltmeter, and record the same in last column of this table. check that the voltage V_3 with the voltage (V_1+V_2) recorded in last column.

$V_1 = V_{R_1} + V_{R_2}$

$V_1 = 1.7 + 8.1$

$V_1 = 9.8V$

$V_2 = V_{R_2} + V_{R_3}$

$V_2 = 6.7 + 8.1$

$V_2 = 14.8V$

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Result: As the voltage V_1 and $V_{R1}+V_{R3}$ are equal and V_2 and $V_{R2}+V_{R3}$ the KVL is verified.

Precautions: (i) All connections should be tight.

(ii) Before connecting, the instrument check their zero reading.

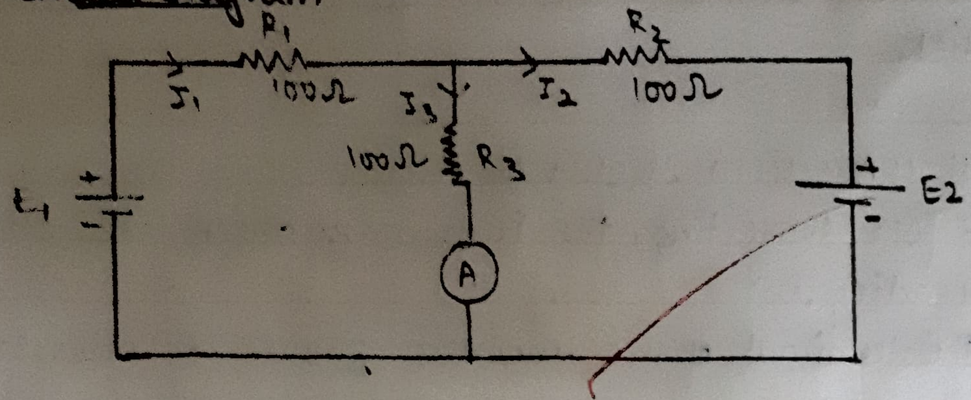
(iii) The terminal of the rheostats should be connected properly.

(iv) Any time, current of ammeter should not exceed the current rating of the rheostats.

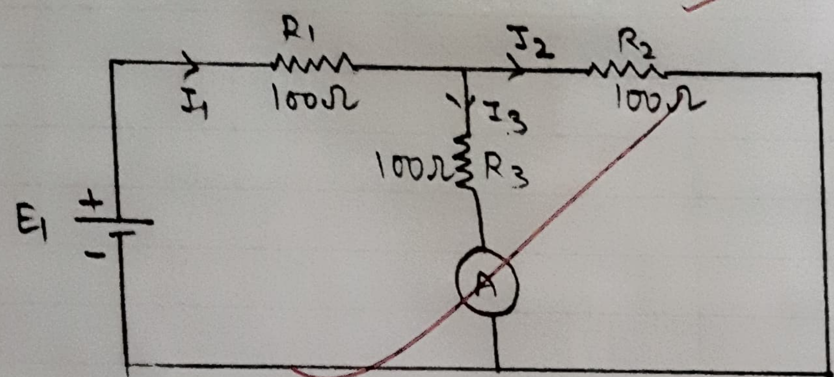
5/5

Teacher's Sign: 18/3/23

circuit Diagram



When Both source are active.



When E_1 source is active and E_2 is SC

Aim: verification of superposition principle.

Apparatus Required: Multimeter, Resistance 100Ω, Connecting wire, Bread Board (experiment KA), variable DC supply (0-30 volt).

Theory: A current in a particular branch due to many emf sources active in circuit can be obtained by the algebraic sum of the current which would flow due to one emf source and other emf source are replaced by their internal source if any. The superposition theorem can be made clear with the help of network.

Circuit Diagram: In this experiment there are two voltage sources E_1 and E_2. Now we have to calculate any current I_1, I_2 and I_3 with the help of superposition theorem. Now we will solve the circuit step by step.

Step 1: Remove emf source E_2 with zero resistance as it has no internal resistance. Now the given circuit can be redrawn as

As the case (-ve) to (+ve) so the current in R_1, R_2, R_3 is I_{1a}, I_{2a}, I_{3a}, then.

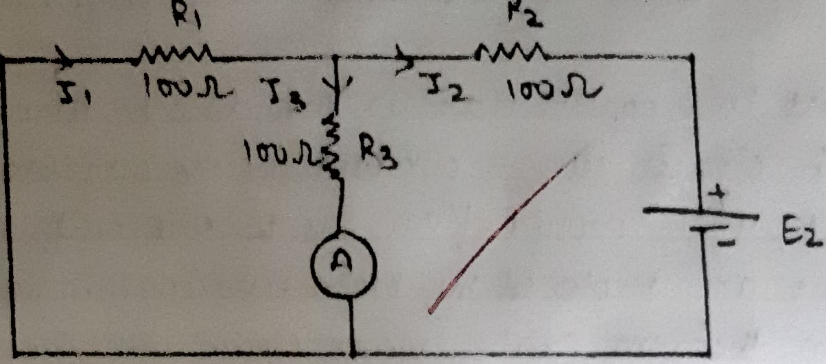
$$I_{1a} = \frac{E_1}{R_1 + \frac{R_2 R_3}{R_2 + R_3}} , \quad I_{3a} = I_{1a} \times \frac{R_2}{R_2 + R_3}$$

$E_1 = 10V$, $R_1 = 100\,\Omega$, $R_2 = 100\,\Omega$, $R_3 = 100\,\Omega$.

$$I_{1a} = \frac{10}{100 + \frac{10000}{200}} = 0.06A = 60\,mA.$$

$$I_{3a} = 0.06 \times \frac{100}{200} = 0.03A = 30\,mA$$

Teacher's Sign:



When E_2 source is active and E_1 is SC.

Result

$I_{3a} + I_{3b} \approx I_3$

$I_3 = 30 + 50$

$I_3 = 80$ mA.

SNO	current	Theoritical value	Practical Value	% error
1	I_3	80 mA	76.0 mA	4%
2	I_{3a}	30 mA	29 mA	3%
3	I_{3b}	50 mA	47.8 mA	4.4%

Step 2: Remove emf source E_1 with zero resistance as it has no internal resistance. Now the given circuit can be redrawn as.

Now say current in R_1, R_2, R_3 is I_{1b}, I_{2b}, I_{3b} then.

$$I_{2b} = \frac{E_2}{R_2 + \frac{R_1 R_3}{R_1 + R_3}} \quad , \quad I_{3b} = I_{2b} \times \frac{R_1}{R_1 + R_3}$$

$E_2 = 15V$, $R_1 = 100\Omega$, $R_2 = 100\Omega$, $R_3 = 100\Omega$

$$I_{2b} = \frac{15}{100 + \frac{10000}{200}} = 0.1A = 100 mA \quad , \quad I_{3b} = 0.1 \times \frac{100}{200}$$

$I_{3b} = 50 mA$.

Now acc. to superposition theorem
For $I_1 = I_{1a} - I_{1b}$ (as both current are opp direction)
For $I_2 = I_{2a} - I_{2b}$ (as both current are opp direction)
For $I_3 = I_{3a} - I_{3b}$ (as both current are same direction).
Hence, superposition theorem can be stated as " in a circuit of network of linear resistance having more than one EMF source, the current which flow in any branch, will be the sum of all the currents which would flow in that branch due to each emf source acting separately and all other emf source are replace with their internal resistance if any"

Result: $I_{3a} + I_{3b} \approx I_3$
superposition theorem is verified and % error b/w theoritical & practical values are calculated & tabulated in observation Table.

Precaution: All connection should be tight.
- Reading should be taken carefully.
- Do not touch the live wires.

Teacher's Sign: 5/5 [illegible]

Circuit Diagram

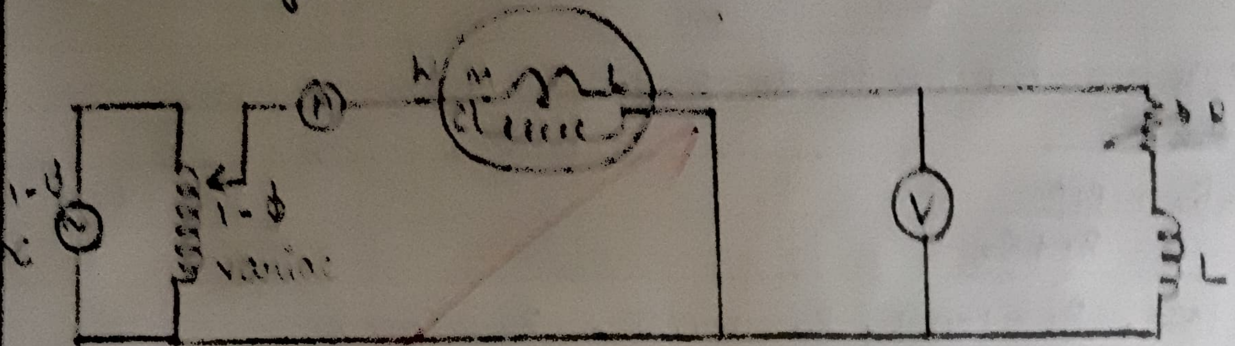


Fig 1

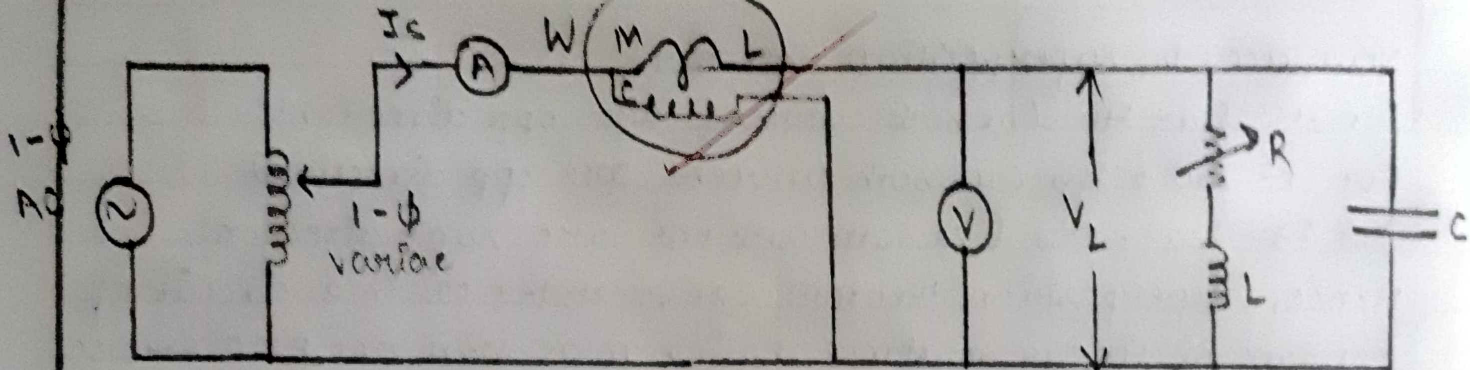


Fig 2

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Measurement of Power and Power factor.

Object: To measure the power and power factor in a single phase AC circuit and to study improvement of power factor by using capacitor.

Apparatus Required: 1. Experimental power
2. connecting leads.

Theory: power in a single phase AC circuit with inductive load is given by -

$P = VI\cos\phi$ —①

P = Power consumed by load in watts,
V = load voltage in volts,
I = Load current in Amps.
$\cos\phi$ = Power factor of load.
Power factor $= \cos\phi = \frac{P}{VI}$

Power factor of angle of load $\phi = \cos^{-1}\left(\frac{P}{VI}\right)$

For circuit given in fig 1.
Active Power $P = VI\cos\phi$ watts.
Reactive Power $Q = VI\sin\phi$ VAR.
Apparent Power $S = VI$ Volt Amps.
Apparent Power $S = \sqrt{P^2 + Q^2}$
Power factor $= \frac{P}{S}$

Because of inductive nature of load active as well as reactive power in such a circuit is supplied by source to the load. By adding capacitor in parallel with load as shown in fig 2, some

Observation Table

Table 1 without capacitor

S.No	V_L (volts)	P (watts)	I_S (amp)	$\cos\phi = (P/I_S V_L)$
1	200V	7.152 W	0.084 A	0.425
2	205V	7.652 W	0.088 A	0.424
3	210V	8.102 W	0.090 A	0.428

Table 2 with capacitor.

S.No.	V_L (volts)	P (watts)	I_S (Amp)	$\cos\phi = P/(I_S V_L)$
1	200V	6.701 W	0.065 A	0.515
2	205V	7.301 W	0.064 A	0.556
3	210V	7.901 W	0.077 A	0.488

$$\cos\phi = \frac{P}{I_S V_L}$$

$$\cos\phi_1 = \frac{7.152}{0.084 \times 200}$$

$$\cos\phi_1 = 0.425$$

$$\cos\phi_2 = \frac{7.652}{205 \times 0.088}$$

$$\cos\phi_2 = 0.424$$

$$\cos\phi_3 = \frac{8.102}{210 \times 0.090}$$

$$\cos\phi_3 = 0.428$$

$$\cos\phi_1 = \frac{6.701}{200 \times 0.065}$$

$$\cos\phi_1 = 0.551$$

$$\cos\phi_2 = \frac{7.301}{205 \times 0.064}$$

$$\cos\phi_2 = 0.556$$

$$\cos\phi_3 = \frac{7.901}{210 \times 0.077}$$

$$\cos\phi_3 = 0.488$$

of the reactive power is supplied by capacitor depending upon value of capacitance added in parallel with the load resulting in reduction of apparent power (S) supplied by source and hence power factor of the circuit.

$\cos\phi = \frac{P}{S}$ increases.

Resulting in improvement of power factor.

Result: value of power and power factor is determined at various loads.

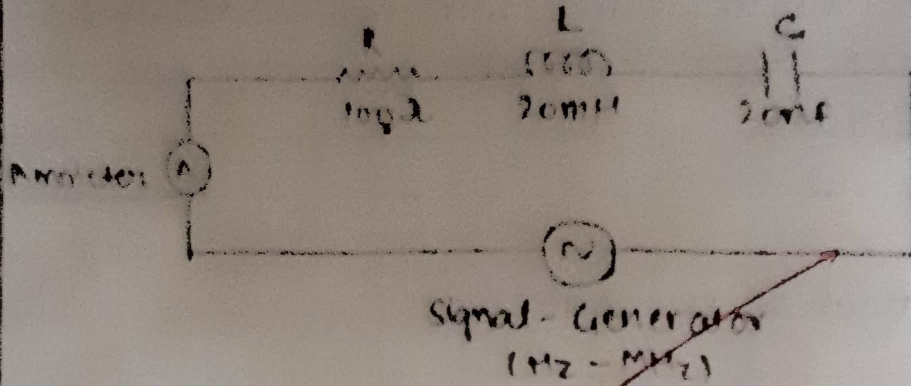
Precautions:

- Use proper connecting leads for making connections.
- Check the zero error in all the instruments.
- Handle the equipments carefully.
- Before switching ON the supply, the autotransformer knob must be on zero position.
- Don't touch live terminals & don't move apparatus after switching ON the supply.
- Take readings by removing the parallax.

5/6

Teacher's Sign: 8/6/23

Circuit Diagram



Objective: study of phenomenon of resonance in RLC series circuit and obtain resonant frequency.

Apparatus Required

S.No	Equipments	Type	Specification	quantity
1	Singe Phase AC Supply	AC	230 volts - 50 Hz	1 no.
2	Variable freq. Signal Generator	AC	1 Hz - MHz (0-10) V sine wave	1 no.
3.	AC ammeter	MI	(0-10) mA	1 no.
4.	Inductor		10, 20, 30 mH	1 no.
5.	capacitor		10, 20, 30 nf	1 no.
6.	Resistor		100 ohm	1 no.
7.	Connecting wires		PVC Insulated	As per ckt requirement

Theory: In a ckt, consisting of reactive components of opp. nature i.e. L & C, if we change the variable F, L or C there comes a situation when over all impedance (or admittance) of the circuit becomes purely resistive (or conductive G). such a condⁿ is called "RESONANCE".

Apply KVL, we get.

$$V = V_R + V_L + V_C$$

$$V = IR + j(IX_L - IX_C)$$

$$V = IZ$$

where,
$$Z = R + j(X_L - X_C)$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

& the magnitude of current, $I = V/Z$

Now, at Resonance, we have, $X_L = X_C$.

$$2\pi f_r L = \frac{1}{2\pi f_r C}$$

Teacher's Sign:

SNo	Freq. (in KHz)	Current (mA)	Freq. corresponding to max current	$F_r = \frac{1}{2\pi\sqrt{LC}}$
1	3	0.9		
2	5	2.7		
3	7	9.8		
4	7.8	13.0	7.8 KHz	7.96 KHz
5	9	7.8		
6	11	3.2		
7	13	1.5		

Calculations

Calculate Resonant frequency ~~and~~ $f_r = \frac{1}{2\pi\sqrt{LC}}$ theoretically.

$$F_r = \frac{1}{2\times3.14\sqrt{20\times10^{-3}\times20\times10^{-9}}}$$

$$F_r = \frac{1}{2\times3.14\times20\times10^{-6}}$$

$$F_r = \frac{10^{6}}{2\times3.14\times20}$$

$$F_r = \frac{10^{5}}{2\times3.14\times2}$$

$$F_r = \frac{10^{5}}{12.56}$$

$$F_r = 7961.78\ Hz$$

$$F_r = \frac{7961.78\ Hz}{1000}$$

$$F_r = 7.96\ KHz.$$

Shiva

Date

Expt. No.

since, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

Now, $Z = R$ as $(X_L = X_C)$

Therefore, $I = \frac{V}{R}$

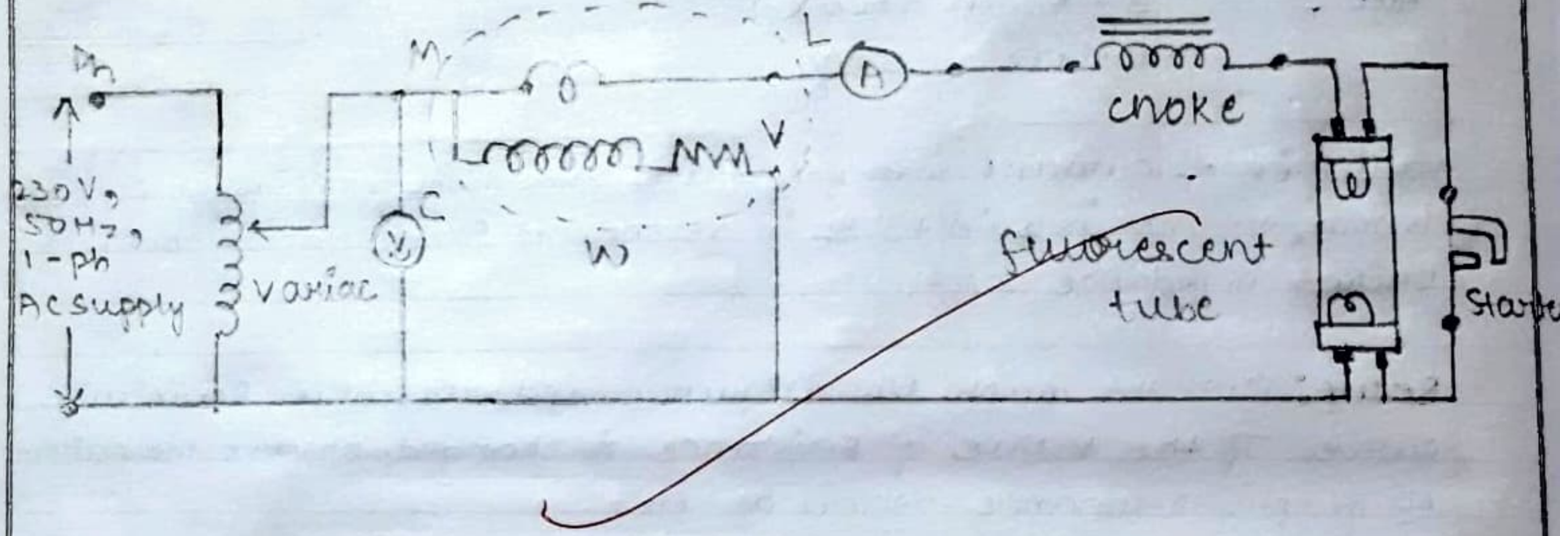
variation of current wrt freq. are shown in graph. when current is max, the ckt is said to be in resonance. Power factor becomes unity & impedance $Z = R$.

Result: Plot the graph b/w frequency and current ie Resonance curve. If the value of Resistance is changed. observe the nature of graph. Resonance occurs at Hz.

Precautions: All connections should be tight.
All steps should be followed carefully.
Readings and calculation should be taken carefully.
Don't touch the live terminals.

Teacher's Sign:

Circuit Diagram



Aim: connection and measurement of power consumption of a fluorescent lamp.

Apparatus Required

S.No	Item Description	specification	Type	Quantity
1.	Ammeter	0-2 A	MI	1
2	voltmeter	0-300V	MI	1
3.	wattmeter	230V, 5/10 A	DM	1
4.	choke	40W, 230V	Iron core	1
5.	starter	230V, 50 Hz	Glow	1
6.	Fluorescent Tube	40W, 230V, 50Hz	–	1
7.	variac	1-PH, 0-300V, 5A	–	1
8.	connecting wire.	3/20S WG	PVC	LS

Theory: Fluorescent lamp constitute a glass tube whose inside is coated with fluorescent powder. when the two filament of the lamp are maintained at potential diff. sufficient enough t produce electric discharge through the gap, then electron are emitted from one electrode and move towards the other electrodes. In the mean time, these electrons collide with the fluorescent coating and emit cool light. These rays strike fluorescent phosphorus coating on the interior surface of the bulb. Unfortunately a fluorescent lamp can't just work as is case of incandescent lamp.

Procedure:

- Do the connection as per the ckt diagram.
- keep the variac in the zero position and switch on the power supply.
- Increase the variac voltage slowly until the fluorescent tube

calculation

SNo	Voltmeter(V)	Ammeter(A)	Wattmeter(W)	Power factor
1	190 V	0.226A	29.25 W	0.68
2	200 V	0.252A	32.20 W	0.63
3	215 V	0.300A	38.36W	0.59

$$\cos\phi = \frac{W}{VI}$$

$$\cos\phi_1 = \frac{29.25}{190 \times 0.226}$$

$$= \frac{29.25}{42.94} = 0.68$$

$$\cos\phi_2 = \frac{32.20}{200 \times 0.252}$$

$$= \frac{32.20}{50.40} = 0.63$$

$$\cos\phi_3 = \frac{38.36}{215 \times 0.300}$$

$$= \frac{38.36}{64.50} = 0.59$$

$$\text{Mean power factor} = \frac{0.68 + 0.63 + 0.59}{3}$$

$$= \frac{1.9}{3}$$

$$= 0.633$$

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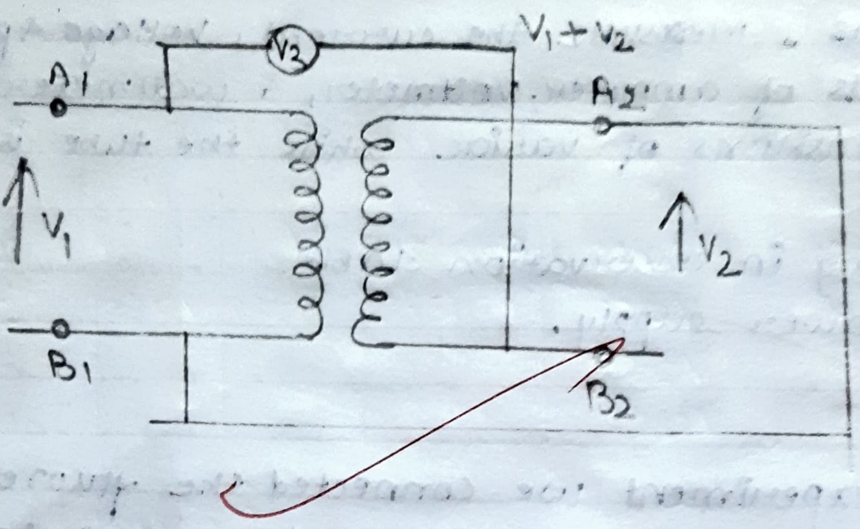
flickers and glows. Measure the current, Voltage & power.

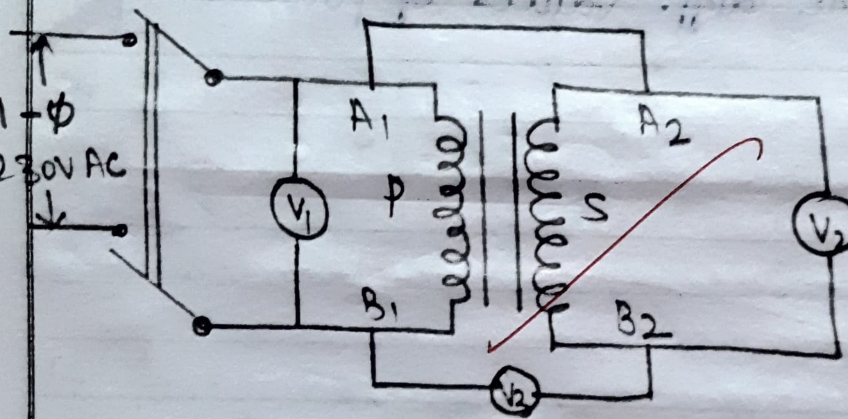
- Take another 4 sets of ammeter, voltmeter, & wattmeter reading at diff. positions of variac while the tube is glowing.
- Record the reading in observation table.
- Switch off the power supply.

conclusion

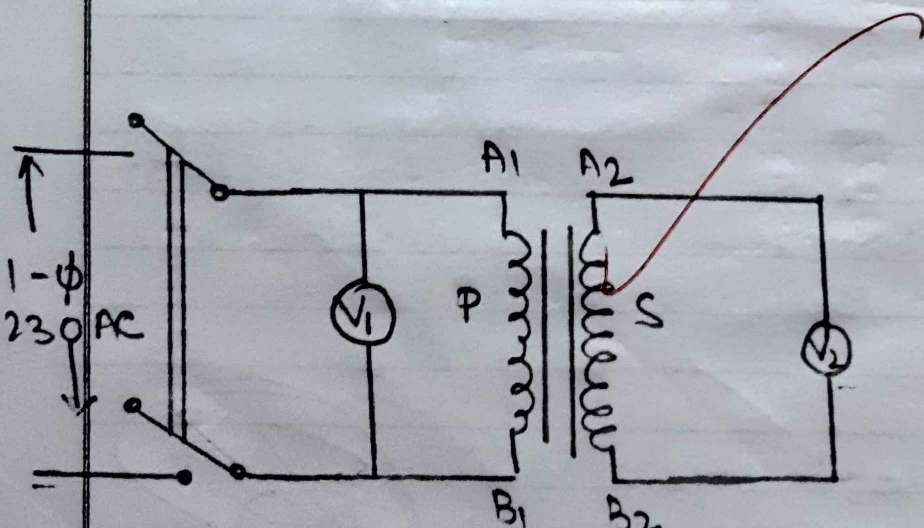
From the above experiment we connected the fluorescent lamp and measured the diff. values of power and power factors.



V2
V1 + V2
A1
A2
V1
V2
B1
B2



1-φ
230V AC
A1
A2
V1
P
S
V2
B1
B2
V2



A1
A2
1-φ
230 AC
V1
P
S
V2
B1
B2

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Date 1/June/23

Expt. No. 6 Page No. 14

Objective: Determination of (i) voltage ratio (ii) polarity and (iii) efficiency by load test of a single phase transformer.

Apparatus Required: Single phase transformer
Auto transformer (for variable supply)
Voltmeter moving iron type (0-75/300V)
Ammeter moving iron type (0-1/5 Amp)
Wattmeter (0-15/75 watt)
Connecting wires
Lamp load.

Theory:

(i) **Polarity test:** Each of the terminal of primary as well as sec. winding of a transformer is alternately positive and negative wrt each other. It is essential to know the relative polarities at any instant of the primary & sec. terminal for making correct connections.

(i) When two single phase transformer are to be connected in parallel to share the total load on the system.

(ii) For connecting three single phase transformer to form a 3 phase bank with proper connections of primary & sec. winding.

(ii) **Voltage Ratio:** The induced emf per phase in the primary & sec. winding of a transformer is given by-

Induced emf in primary, $E_1 = 4.44 f \phi N_1$

Induced emf in sec., $E_1 = 4.44 f \phi N_2$

Hence, the voltage ratio, $\frac{E_2}{E_1} = \frac{V_2}{V_1} = \frac{N_2}{N_1}$

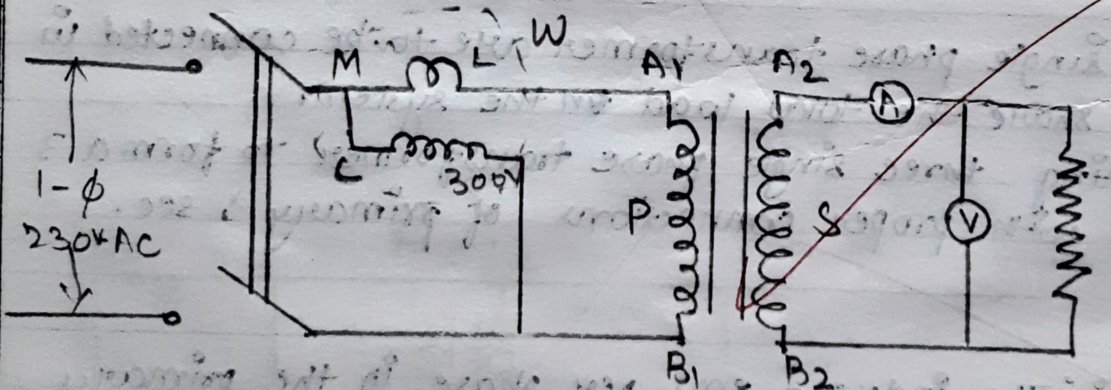
Teacher's Sign:

Observation Table

SNo	Polarity test			Voltage Ratio test		
	V_1	V_2	V_3	V_1	V_2	V_2/V_1
1	220V	220V	445(add)	220V	220	1
2	220V	220V	0 (sub)	220V	63	3.49
3				220V	110	2
4				220V	193	1.13

Load test

SNo	W_1	V_2	I_2	$V_2 I_2$	η%
1	125x4	218	2.25	490.5	98%

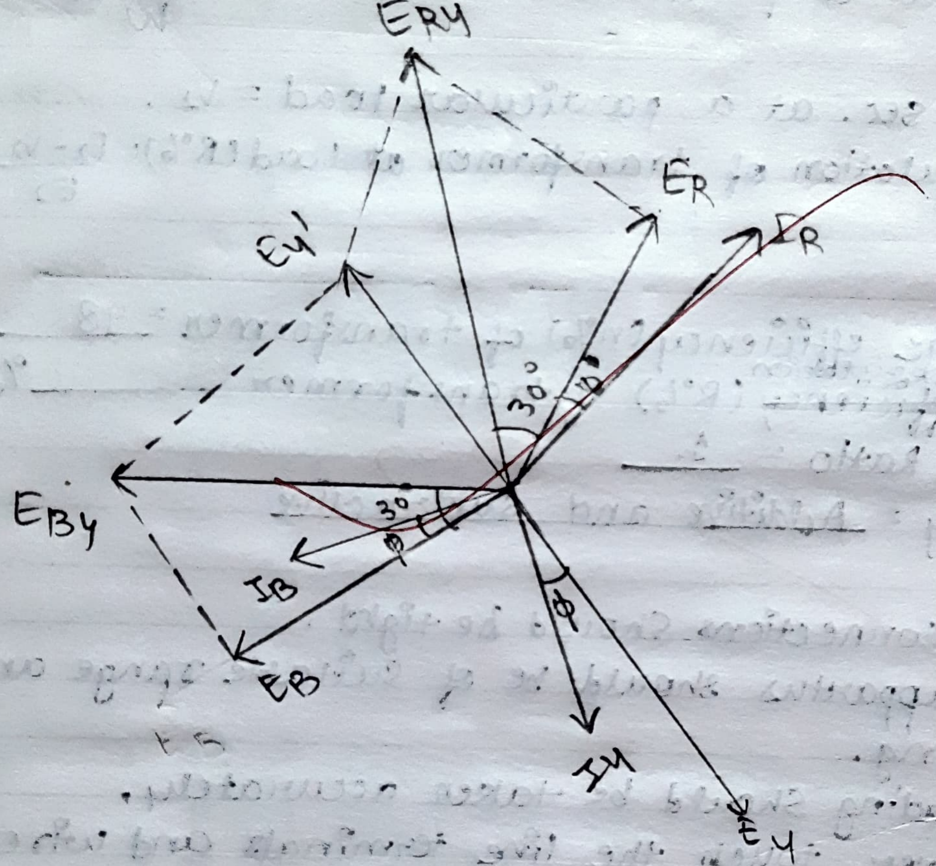


Load test: Performance of the transformer can be determined as follows from the observations of load test.
Power input to the transformer = W_1
Power output of transformer = V_1
Thus efficiency at a particular load, $(\eta\%) = \frac{VI}{W} \times 100$

Terminals V across sec. at a particular load = V_2.
Thus Voltage regulation of transformer at load $(R\%) = \frac{E_2 - V_2}{E_2} \times 100$

Result: (i) Percentage efficiency $(\eta\%)$ of transformer = 98 %
(ii) Voltage ~~efficiency~~ regulation $(R\%)$ of transformer = ____ %
(iii) Voltage Ratio = 1
(iv) Polarity = Additive and subtractive

Precautions: (i) All connections should be tight.
(ii) All apparatus should be of suitable range and rating.
(iii) Reading should be taken accurately.
(iv) Never touch the live terminals and wires.



ERY
ER
ER
EY'
EBY
30°
30°
φ
φ
φ
IB
EB
IY
EY

Objective: Measurement of power in 3-ϕ circuit by two wattmeter method and determination of its power factor.

Apparatus Required: Dynamometer type wattmeter (0-600W)
Triple pole iron clad switch (TPIC).
3-ϕ balanced load.
Moving iron voltmeter (0-600V)
Moving iron ammeter (0-10A)
connecting wires.

Theory: For connecting power in a 3-ϕ ckt, two wattmeter method is usually employed. Two diameter method is quite convenient for measuring power in the star or delta connected balanced or unbalanced load of 3-ϕ, 3 wire system. one ~~th~~ thing should also be kept in mind that the direcⁿ of voltage through the ckt ~~the~~ should same as that taken for current when rotating the readings of wattmeter.

Phasor diagram for the balanced star connected 3-ϕ load.

$W_1 = VI_a \cos(30° + \phi)$

$W_2 = VI_B \cos(30° - \phi)$

$W_1 + W_2 = VI_a \cos(30° + \phi) + VI_c \cos(30° - \phi)$

But $I_B = I_Y = I_B = I$

$W_1 + W_2 = VI[\cos(30° + \phi) + \cos(30° - \phi)]$

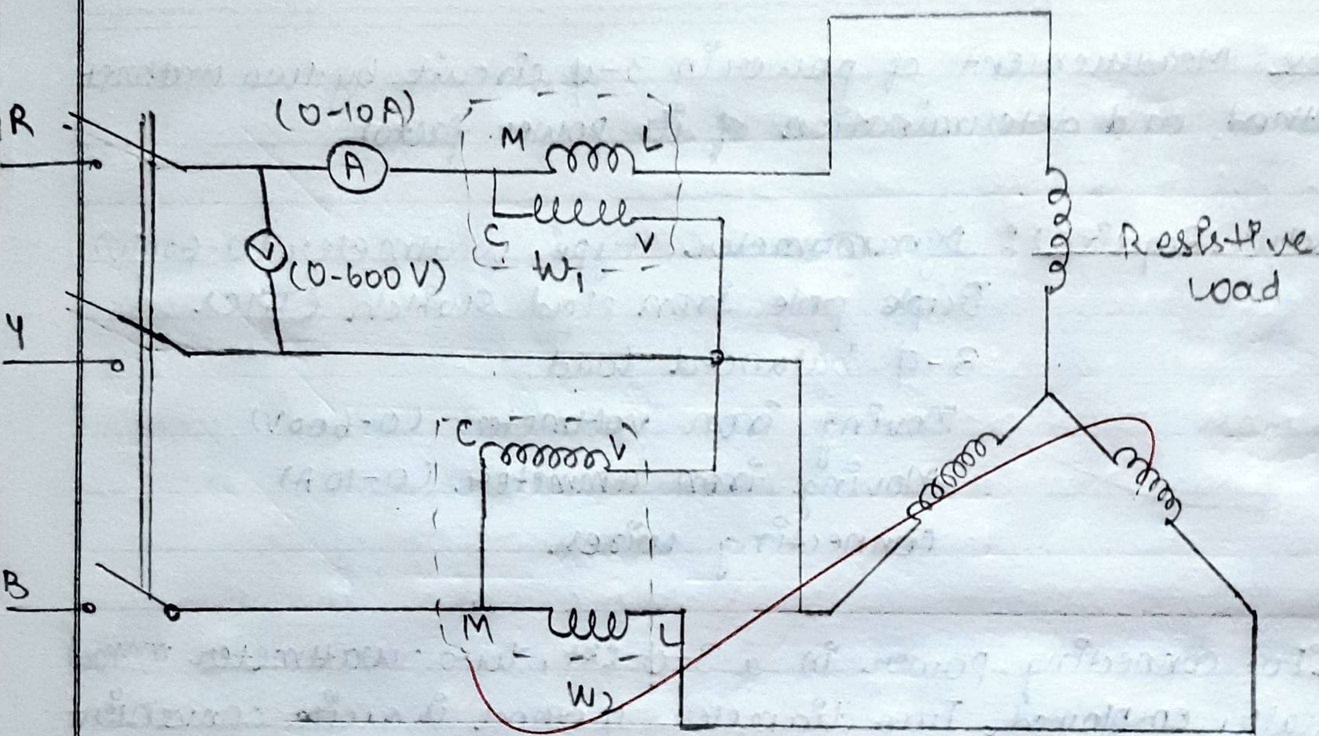
$W_1 + W_2 = \sqrt{3} V_1 \cos\phi$

$W_1 - W_2 = V_1 \sin\phi \; V_L I_L.$

$\tan\phi = \sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)$

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

Teacher's Sign: ____________



S.No.	voltage(V)	current(IL)	Power(W1)	Power(W2)	Total Power(PT)	Pf (cosϕ)
1	380V	2.4A	100×8	90×8	1520	0.99
2	380V	3.3A	130×8	100×8	1840	0.97

$$\frac{3360}{2}$$

$\boxed{1680}$ $\boxed{0.98}$

The total power is given as the sum of two wattmeter reading W_1 & W_2.

Total power of load $P_T = W_1 + W_2$

And power factor of load, $\cos\phi = \cos\left[\tan^{-1}\sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)\right]$

Procedure:

$W_1 \to W_2 =$

connect the ckt as per ckt diagram.

Vary the Inductive load

Note down all the readings carefully,

If one wattmeter reads -ve or gives reverse reading, the reading of the wattmeter is taken by reversing the current coil terminal.

Result:

Total power (P_T) = 1680 W

Power factor $(\cos\phi)$ = 0.98

Precautions:

All connections should be tight.

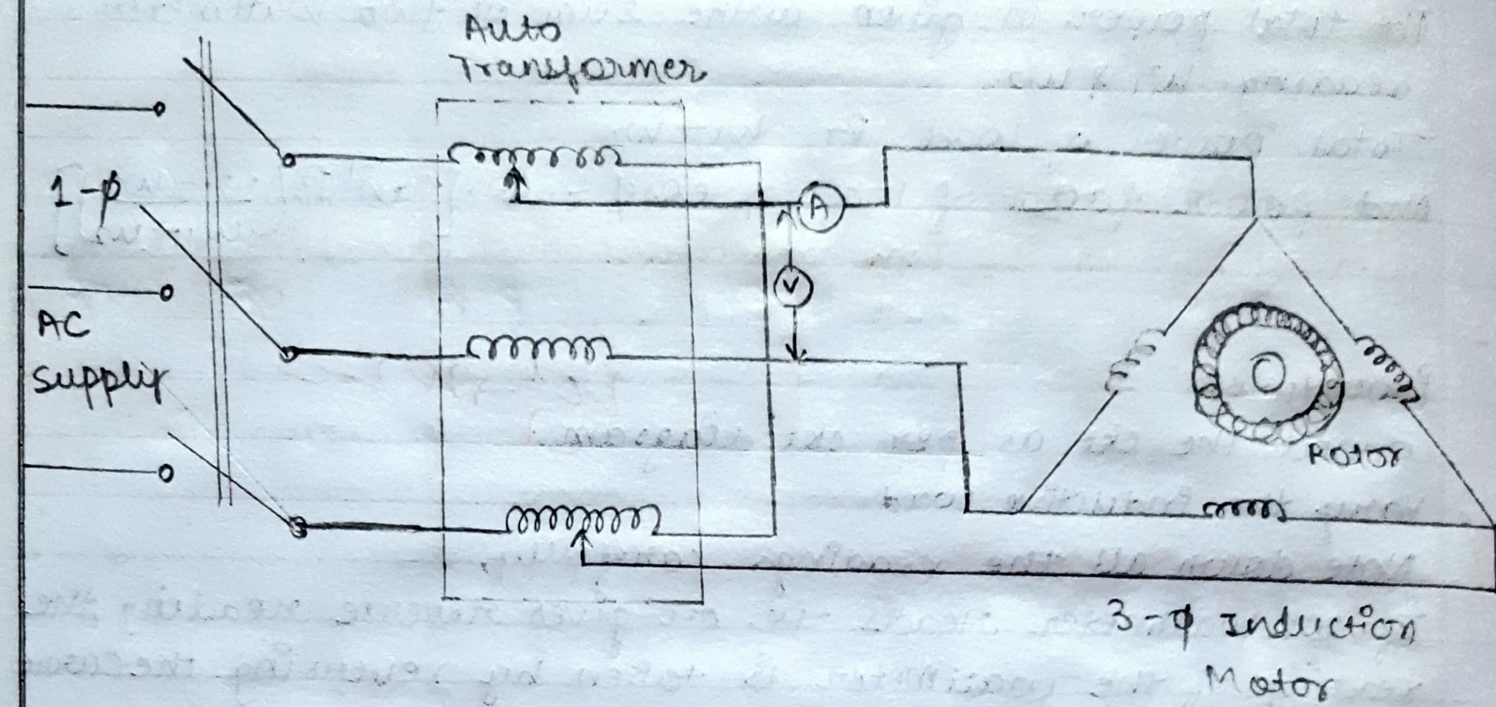
All apparatus should be suitable range and rating.

Reading should be taken accurately.

Never touch the live terminals and wires.

75

13/06/23


Auto Transformer
1-ϕ AC supply
A
V
Rotor
3-ϕ Induction Motor

Date

Expt. No. 8 Page No. 18

Objective: To study running and speed reversal of a 3-ϕ induction motor and record speed in both direction.

Apparatus Required

SNo.	Name of Equipment	Type	Specification/Range/Rating	Qty.
1.	Star Delta Starter	Manual	3-ϕ, 10 A, 600V	1
2.	Tachnometer	Digital	0-10000rpm	1
3.	3-ϕ induction motor.	Induction	3.7KW/5HP, 451 V, 1440rpm	1
4.	Ammeter	MI	5/10 amp	1
5.	Voltmeter	MI	0-600V	1

Theory: When the startor or primary winding of a 3-ϕ induction motor is connected to a 3-ϕ AC supply, a rotating MF is established which rotates at synchronous speed. The direc^n of evolution of this field will depend upon the phase sequence of the primary current & therefore, will depend upon the order of connection of the primary terminals to the supply.

$N_S = 120f/P$ RPM.

For clockwise direction

When phase direction is R-Y-B then acc. the theory startor flux rolates in R-Y-B-R direc^n, so rotor also moves in clockwise direc^n.

For anticlockwise direction

When phase direc^n is B-Y-R or Y-R-B or R-B-Y which is done by interchanging any two leads of 3-ϕ AC supply to AC induction motor.

Teacher's Sign:

Observation table

Clockwise Direction			Anticlockwise Direction		
V(volt)	I(Amp)	speed (rpm).	V(volt)	I(Amp)	speed (rpm)
370	3	1498	370	3	1498

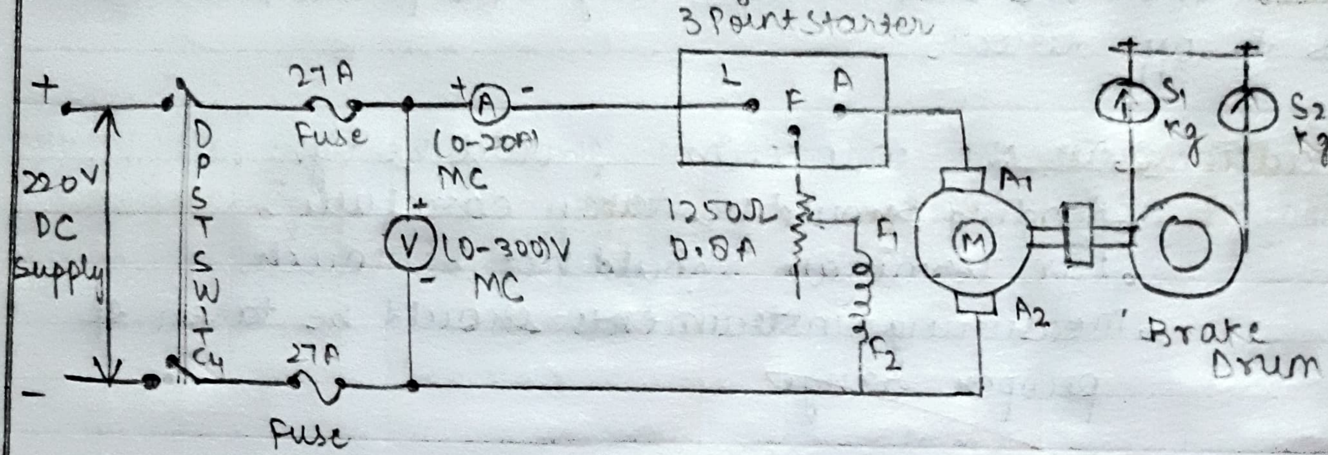
Date

Expt. No.

Result: when we interchange any two phases, the motor runs in opp. direcⁿ.

Precautions:
- All the connections should be tight.
- Reading should be taken carefully.
- Live terminals should not be touch.
- Measuring instruments should be taken of proper range.

Teacher's Sign:



Fuse rating

125% of rated current

$$\frac{125 \times 21}{100} = 26.25A$$

Name Plate Details

Rated voltage = 220V

Rated current = 21A

Rated Power = 3.5KW

Rated speed = 1500 RPM

Objective: Determination of efficiency of a dc shunt motor by load test.

Apparatus Required

SNo	Apparatus	Range	Type	Quantity
1	Ammeter	0-20 A	MC	1
2.	voltmeter	0-300 V	MC	1
3	Rheostat	125Ω, 0.8 A	wire wound	1
4.	Tachuometer	0-1500rpm	Digital	1
5	connecting wires	2.5 sqmm	copper	few.

Theory: When no load is connected to the shaft of a dc motor it develops only that much torque which overcomes the rotational losses and iron losses and it is necessary to know ~~rotes~~ how does the motor react to the app. of a shaft load.

$$E_a = \left(\frac{PZ}{60\,A}\right)\phi N = K_E \phi N \quad -①$$

where K_E is a constant & $2\pi N t = E_a I_a$ = output power -②

from ① & ②

$$t = \frac{E_a I_a}{2\pi N}$$

value of E_a from ①

$$t = \left(\frac{PZ}{120\pi A}\right)\phi I_a = K_T \phi I_a \quad -③$$

where, $K_T = \frac{PZ}{120\pi A}$.

terminal voltage is given by

$$V = E_a + I_a R_a$$

Date

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$$I_a = \frac{V - E_a}{R_a} = \frac{V - K_E \phi N}{R_a} \quad \text{—(4)}$$

when no load is connected to the shaft of a dc motor, it develops only that much torque which overcomes the rotational losses and let us consider that the motor is running when no shaft is connected than the developed torque is just sufficient to overcome the frictional losses. All the three curves are drawn through a common joint representing the rated torque and speed. for dc shunt motor eq(4) canbe written as.

$$N = \frac{V - I_a R_a}{K_E \phi} \quad \text{—(5)}$$

Now, suppose that the load torque is reduced. the armature current becomes corresponding smaller. This makes the numerator of eq(5) larger.

Result: When we interchange any two phases, the motor runs with opp. direcn.

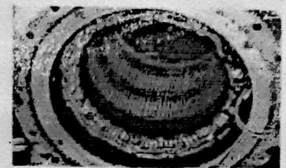
Precautions: All the connections should be tight.
Reading should be taken carefully.
live terminals should not be touch.
Measuring instruments should be taken of proper range.

Teacher's Sign: 31/01/25

SYNCHRONOUS MACHINE

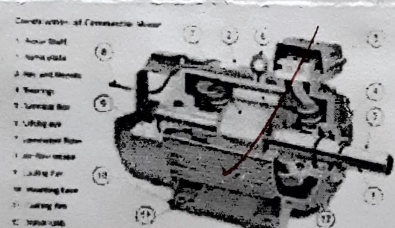
Synchronous Machines are of two type

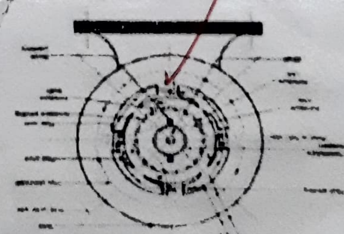
- Salient-pole synchronous machine
- Cylindrical or round-rotor synchronous machine



Stator

Salient Pole Rotor





DC Machines

The two major parts required for construction.
(a) Stator that houses the field winding.
(b) Rotor Rotating part that rotates in MF.

other parts are Yoke, Poles, Field winding, Armature winding, commutator & Brushes.

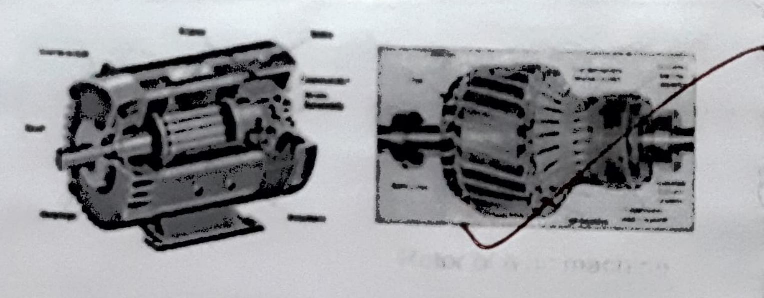
Yoke: Its main function is to from a protective covering over the inner sophisticated parts of the motor and carrier the flux produced by the poles. Madeup of cast iron or steel.

Poles: The magnetic poles are structures fitted onto the inner wall of the yoke with screws. the construction of magnetic poles basically comprises of two parts namely, the pole core the pole shoe ~~core~~ stacked together under hydraulic pressure & then attached to the yoke.

Field winding: Made with field coils wound over the slots of the pole shoe. The field windings basically form an electromagnet, that produced field flux.

Armature: The armature core are provided with slots to which the armature windings made with several turns of copper wire distributed uniformly over the entire periphery of the core.

Commutator: It is a cylindrical structure made up of copper segments stacked together, but insulated from each other by mica.



THREE PHASE INDUCTION MOTOR

Shiva

Brushes: Made with carbon or graphite structures, making sliding contact over the rotating commutator.

3-ϕ Induction motor

It consists of two parts.

1. Stator: It is the stationary part of the motor.
2. Rotor: It is the rotating part of the motor.

Stator has three main parts.

Stator winding: Has a three phase winding

Stator core: Built up of high grade silicon steel.

Outer frame: It is the outer body of the motor.

There are two types of rotor which are employed in 3-ϕ induction motor.

Phase wound / slip ring rotor

Squirrel cage rotor.

The rotor winding is permanently short ckted and it is not possible to add any external resistance. Cu or Al bar conductors are placed in these sides and short ckted at each end by Cu or Al rings called short ckting rings.

The rotor is wound for the same no. of poles as that of stator.

Consists of a laminated core having semiclosed slots at the outer periphery and carries a 3-ϕ insulated winding. It is also called Slip Ring Rotor

Synchronous Machine

Two types
Salient Pole Synchronous Machine.
Cylindrical or round rotor Synchronous Machine.

Teacher's Sign: