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KAMMAVARI SANGHAM (R) - 1952

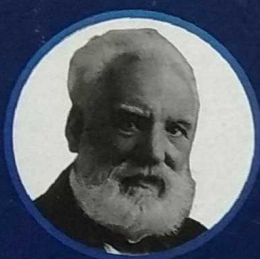
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K. S. INSTITUTE OF TECHNOLOGY

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#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru - 560109



GRAHAM BELL



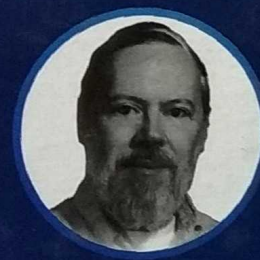
A P J ABDUL KALAM



MARIE CURIE



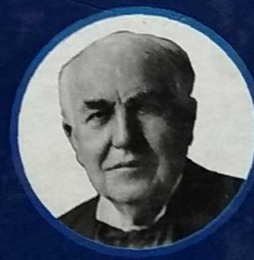
SRINIVASA RAMANUJAN



DENNIS RITCHIE



J R D TATA



THOMAS ALVA EDISON

"Tell me and I'll forget;
Show me and I may
remember; Involve me
and I'll understand"

PRACTICAL RECORD

NAME : K. JEEVITHA

SEM / BRANCH : ECE - 2nd Sem

SUBJECT & CODE : Basic Electrical Engg lab - 18EE103

USN :

1	K	S	2	O	E	C	O	4	2
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Laboratory Certificate

This is to certify that Mr./Ms. *K. JEEVITHA*
has satisfactorily completed the course of experiments in
... *Basic Electrical Engg laboratory, Code... 18ELBL 27* ...
prescribed by Visvesvaraya Technological University, Belagum for the
..... *II* Semester B.E *ECE* Branch
in this college during the academic year 20..20.. - 20..21..

Name of the Candidate : *K. JEEVITHA*

USN : *1/CS 20 ECO 42* Subject (with code) *BEE lab (18ELBL 27)*

Internal assessment marks awarded :

<i>24</i>	<i>13</i>	<i>37</i>
+		
<i>25</i>	<i>15</i>	<i>40</i>
=		

Signature of Staff Incharge

100

Signature of Head of
Department

Pms

Date : *8/9/21*

INSTRUCTIONS FOR MAINTAINING THE PRACTICAL RECORD

1. Record should be written neatly in black ball point pen on the right side page only, left side pages being reserved for diagrams and graphs in pencil.

2. Record should contain

- Number and name of Experiment
- The date
- Principle
- Procedure
- Observation calculation (to be entered on the left hand side pages in neat tabular forms wherever applicable)
- Results

CONTENTS AND EVALUATION

Sl.No.	Date of Conducting Experiment	Date of Submission	Page No.	Title of the Experiment	Assessment Marks			Signature Staff with Date
					Experiment 10 Marks	Record 5 Marks	Total	
01	23-8-21	27-8-21	1-5	Verification of KCL & KVL	10	4	14	21/8/21
02	27-8-21	1-9-21	6-9	2-way & 3-way control of lamps & verification of truth table	10	5	15	
03	27-8-21	1-9-21	10-14	Study of effect of open & short circuit	10	3	13	20/9/21
04	1-9-21	3-9-21	15-21	Measurement of power & power factor of different lamps	10	5	15	
05	1-9-21	3-9-21	22-25	Measurement of parameters of choke coil using 3-wattmeter method	10	15	25	23/9/21
06	7-9-21	7-9-21	26-27	Measurement of earth resistance	10	15	25	10/9/21
07	3-9-21	7-9-21	28-32	Measurement of 3 phase power by 2 wattmeter method	10	15	25	8/9/21
				5+4 = 9				
				avg → 24				

DATE 23-8-21
EXP. NO. 01

EXPT. TITLE: Verification of KCL & KVL

PAGE NO.

1

Verification of Kirchhoff's current law (KCL) & Kirchhoff's voltage law (KVL)

Aim:- To verify Kirchhoff's current law (KCL) & Kirchhoff's voltage law (KVL)

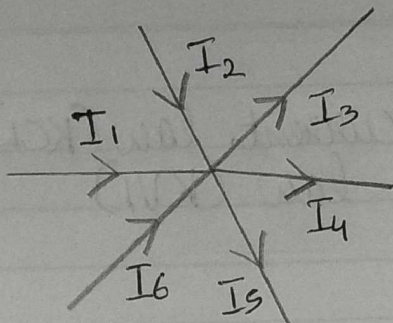
Apparatus required:-

- 1) DC ammeter (0-100mA) - 3 nos
- 2) DC voltmeter (0-100V) - 3 nos
- 3) Resistor (1k Ω) - 2 nos
- 4) DC power supply (0-30V) / 1A - 1 no
- 5) Connecting falls

Theory:- Kirchhoff's laws are basic analytical tools in order to obtain solutions of currents & voltages for any electric circuit when it is supplied from a direct-current / an alternating current.

1) Statement of Kirchhoff's current law

States that at any instant the algebraic sum of all currents meeting at a junction in a circuit is zero.



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

- 1. DC source (10V)
- 2. DC voltage source (10V)
- 3. Resistor (1k)
- 4. DC power supply
- 5. DC power supply
- 6. DC power supply

Thomson's theorem states that the sum of the squares of the currents in the branches of a network is a minimum when the network is in a steady state. This is a consequence of the conservation of energy.

The statement of Thomson's theorem is that the sum of the squares of the currents in the branches of a network is a minimum when the network is in a steady state.

Thomson's theorem states that the sum of the squares of the currents in the branches of a network is a minimum when the network is in a steady state. This is a consequence of the conservation of energy.

In other words, sum of currents flowing away from the junction is equal to the sum of currents flowing towards that junction.

$$\sum I_{\text{junction}} = 0$$

Considering the fig. as per KCL
 $I_1 + I_2 - I_3 - I_4 - I_5 + I_6 = 0 \rightarrow \textcircled{1}$

Direction of incoming currents to a node is taken as positive while outgoing currents is taken as negative. The reverse of this can also be taken, i.e. incoming current as negative or outgoing as positive.

Equation $\textcircled{1}$ can also be written as

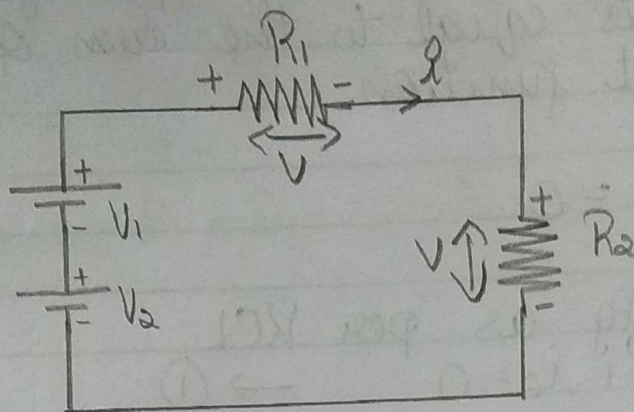
$$I_1 + I_2 + I_6 = I_3 + I_4 + I_5$$

Sum of incoming currents = sum of outgoing currents

ii) Statement of Kirchhoff's voltage law.

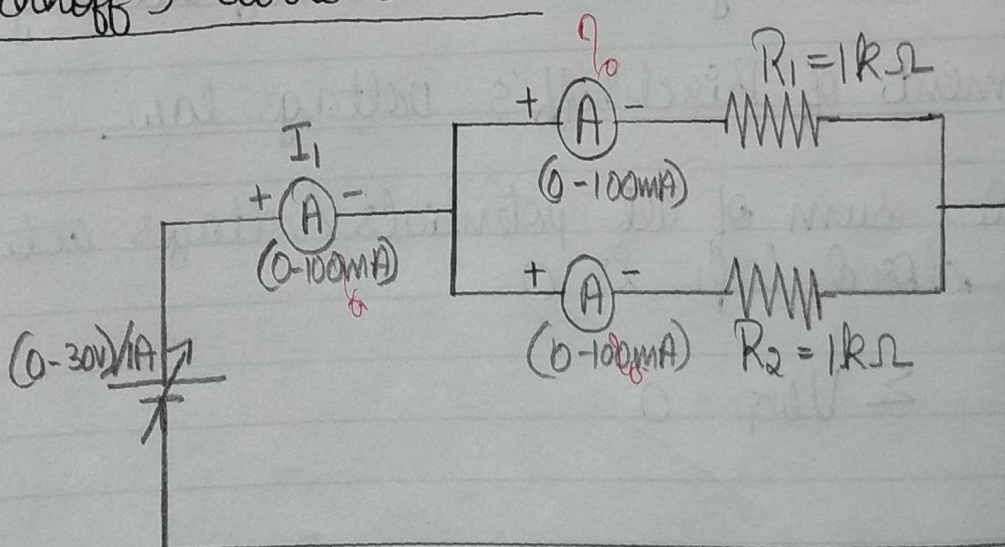
Algebraic sum of all potentials/voltages acting around closed loop is 0

$$\sum V_{\text{loop}} = 0$$



$$-V_1 + (-V_2) + IR_1 + IR_2 = 0$$

Kirchhoff's current law



It states that in a closed circuit, algebraic sum of all voltage drops. Voltage drop is encountered when current flows into an element (resistance/load) from higher-potential terminal toward lower potential terminal.

The fig shows closed circuit also termed as mesh.
As per KVL

$$-V_1 + (-V_2) + IR_1 + IR_2 = 0 \rightarrow (2)$$

Here, the assumed current I causes positive voltage drop of voltage when flowing from positive to negative potential while negative potential drop while current flowing from negative to positive terminal potential.

$$I(R_1 + R_2) = V_1 + V_2$$

Or

$$I = \frac{V_1 + V_2}{(R_1 + R_2)}$$

Kirchhoff's current law (KCL)

Procedure :-

1) Make connections as given in circuit diagram.

Tabular column

SL No	I ₁ mA	I ₂ mA		I ₃ mA		I ₁ = I ₂ + I ₃ mA
		Theoretical	Practical	Theoretical	Practical	
1	5	2.5	2.4	2.5	2.5	4.9
2	10	5	4.9	5	5.1	10
3	15	7.5	7.3	7.5	7.5	14.8
4	20	10	9.9	10	10.1	20
5	25	12.5	12.3	12.5	12.6	24.9

Calculations

$$I_2 = 5 \left(\frac{1k\Omega}{1k\Omega + 1k\Omega} \right) = 2.5 \text{ mA}$$

$$I_2 = 10 \left(\frac{R_2}{R_1 + R_2} \right) = 5 \text{ mA}$$

$$I_2 = 15 \left(\frac{1k\Omega}{1k\Omega + 1k\Omega} \right) = 7.5 \text{ mA}$$

$$I_2 = 20 \left(\frac{1k\Omega}{1k\Omega + 1k\Omega} \right) = 10 \text{ mA}$$

$$I_2 = 25 \left(\frac{1k\Omega}{1k\Omega + 1k\Omega} \right) = 12.5 \text{ mA}$$

$$I_3 = I_1 - I_2 = 5 - 2.5 = 2.5 \text{ mA}$$

$$I_3 = 10 - 5 = 5 \text{ mA}$$

$$I_3 = 15 - 7.5 = 7.5 \text{ mA}$$

$$I_3 = 20 - 10 = 10 \text{ mA}$$

$$I_3 = 25 - 12.5 = 12.5 \text{ mA}$$

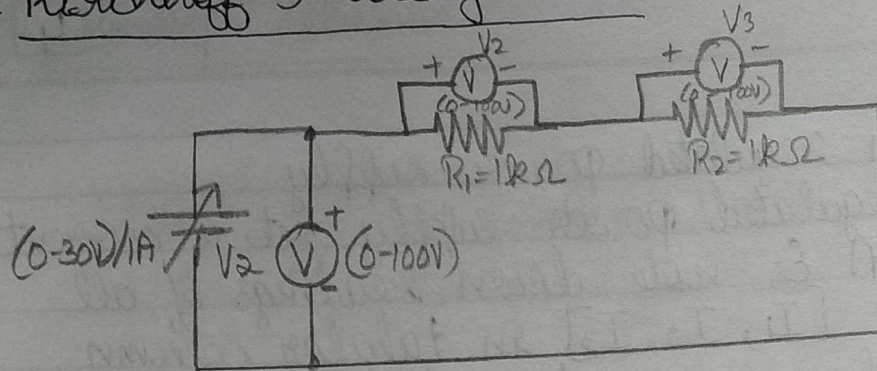
- 2) Switch on regulated power supply
- 3) Using regulated power supply set a current of 5mA & note down readings of all ammeters $[I_1, I_2, I_3]$ in tabular column
- 4) Repeat the same for different values of current by varying power supply in steps.

Kirchhoff's voltage law [KVL]

Procedure :-

- 1) Make the connections as given in the circuit diagram
- 2) Switch on regulated power supply.
- 3) Using regulated power supply apply a voltage of 5V & note down the readings of all voltmeters (V_1, V_2, V_3) in tabular column
- 4) Repeat the same for different voltages by varying power supply in steps

Kirchhoff's Voltage Law



Tabular column

Sl no	V ₁ (Volts)	V ₂ (Volts)		V ₃ (Volts)		V ₁ = V ₂ + V ₃ (Volts)
		Theoretical	Practical	Theoretical	Practical	
1	5	2.5	2.5	2.5	2.4	4.9
2	10	5	5.0	5	4.9	9.9
3	15	7.5	7.5	7.5	7.4	14.9
4	20	10	10.1	10	9.8	19.9
5	25	12.5	12.6	12.5	12.3	24.9

$$V_2 = \frac{V R_1}{R_1 + R_2}$$

$$V_3 = \frac{V R_2}{R_1 + R_2}$$

Calculations :-

$$V_2 = \frac{5 \times 1}{1+1} = 2.5V$$

$$V_2 = \frac{10 \times 1}{1+1} = 5V$$

$$V_2 = \frac{15 \times 1}{1+1} = 7.5V$$

$$V_2 = \frac{20 \times 1}{1+1} = 10V$$

$$V_2 = \frac{25 \times 1}{1+1} = 12.5V$$

$$V_3 = \frac{5 \times 1}{1+1} = 2.5V$$

$$V_3 = \frac{10 \times 1}{1+1} = 5V$$

$$V_3 = \frac{15 \times 1}{1+1} = 7.5V$$

$$V_3 = \frac{20 \times 1}{1+1} = 10V$$

$$V_3 = \frac{25 \times 1}{1+1} = 12.5V$$

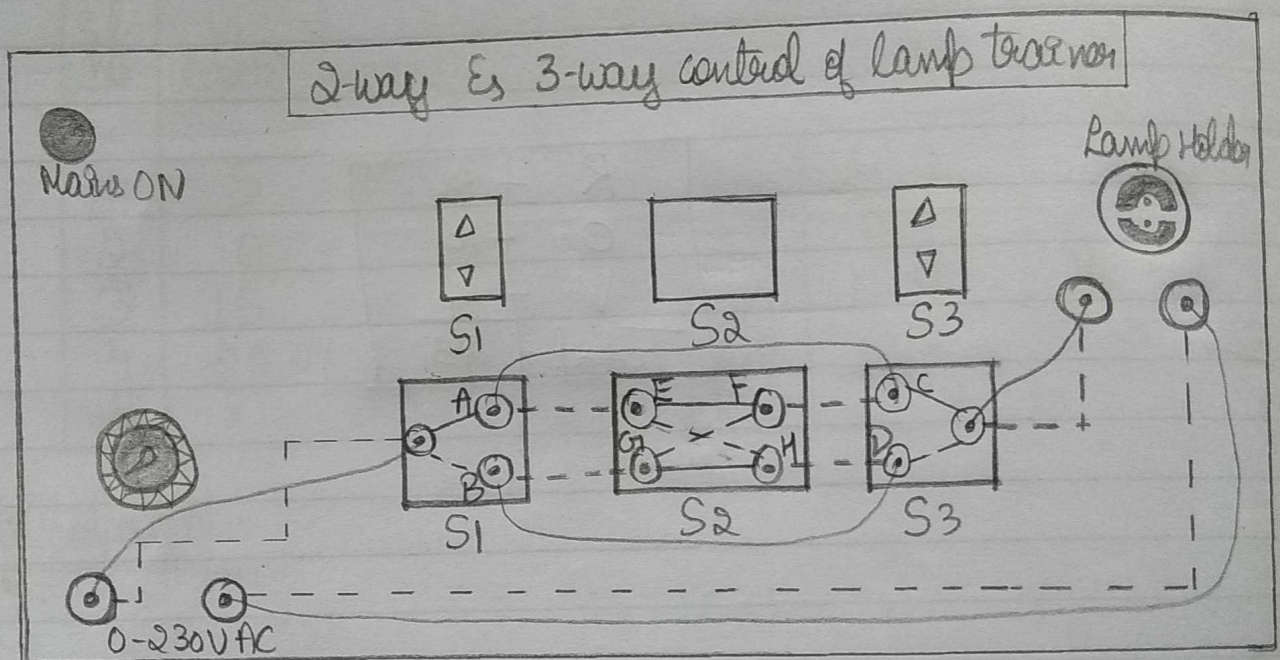
Result :-

Kirchhoff's voltage law [KVL] &
Kirchhoff's current law [KCL] for given
DC network were studied & verified.

21/8/21

R	+ 9
O	- 10
V	- 4
Total	- 23

Connection diagram



DATE 27-8-21

EXP. NO. 02

EXPT. TITLE: 2-way & 3-way control of lamps & verification of truth table

PAGE NO. 6

Two way and three way control of Lamps and verification of truth table

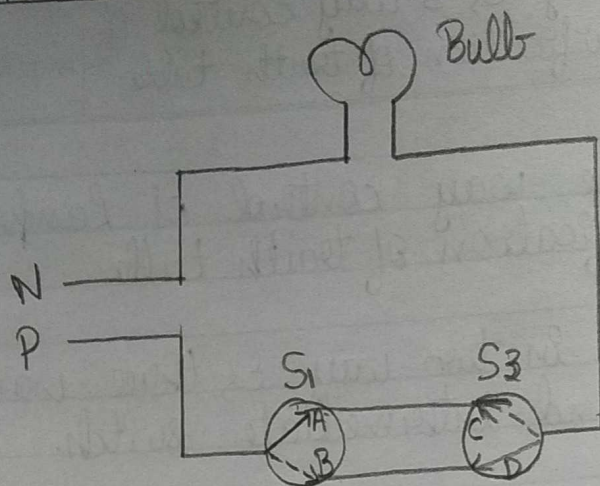
Aim:- To control lamps in two-way & three-way using two-way and intermediate switch.

Apparatus:-

- 1) Two way switch - 2 nos
- 2) Intermediate switch - 1 no
- 3) Lamp - 1 no
- 4) Connecting wires

Two-way control

Theory:- 2 way switching means having 2 or more switches in different locations to control 1 lamp. They are wired so that operation of either switch will control the light. This arrangement is often found in stairways, with 1 switch upstairs & 1 downstairs. When we turn ON/OFF the switch at any end the light present state changes to opposite state, if light presents in ON condition then it becomes OFF, if light present in OFF condition then it becomes ON. It is also used in long hallways with switch at either end.



Truth Table

Sl No	SW1	SW2	LAMP
1	A	C	ON
2	A	D	OFF
3	B	C	OFF
4	B	D	ON

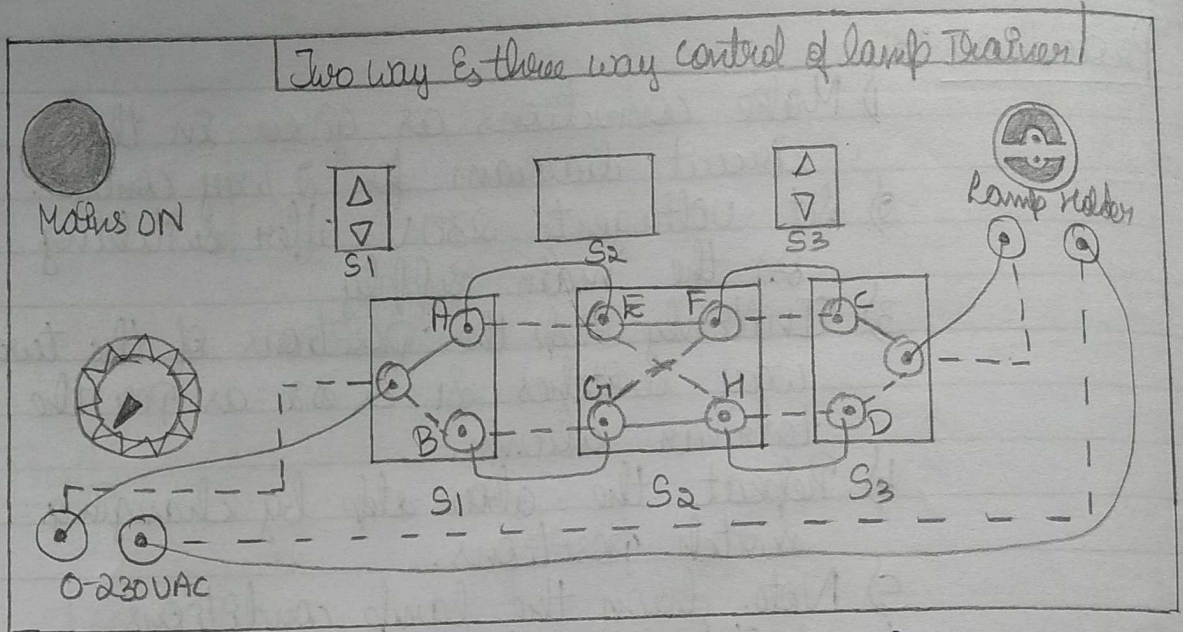
Procedure :-

- 1) Make connections as given in the circuit diagram for 2 way control.
- 2) Set voltage to 230V after switching on the main supply.
- 3) Initially keep the positions of the two way switches S_1 & S_2 as per the tabular column.
- 4) Repeat the above step by changing switch positions.
- 5) Note down the lamp conditions.
- 6) Switch off the supply.

Three-way control

Theory :- A light / lights can be controlled by more than 1 switch. The usual practice in home construction is to use 3-way switches. A lamp can be controlled from 3 different locations. The circuit needs an intermediate switch along with two number 2-way switches. Intermediate has 2 states namely straight & cross connection.

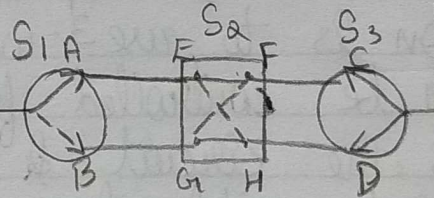
Connection diagram



Bulb

N

P



Application of three-way control is corridor lighting, stair case lighting, bedroom lighting, etc.

Procedure :-

- 1) Make connections as given in the circuit diagram for 3 way control
- 2) Set voltage to 230V after switching on main supply.
- 3) Initially keep positions of two way switches S_1 , intermediate S_2 as per tabular column.
- 4) Repeat the above step by changing switch positions.
- 5) Note down lamp condition.
- 6) Switch off supply

Truth table

sl no	sw1	sw2	sw3	Lamp
1	A	straight Connection EFGH	C	ON
2	A		D	OFF
3	B		C	OFF
4	B		D	ON
5	A	Cross Connection EHGF	C	OFF
6	A		D	ON
7	B		C	ON
8	B		D	OFF

DATE

EXPT. TITLE :

EXP. NO.

PAGE NO.

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Result :-

Two-way control & three-way control of a lamp are studied & truth tables are verified.

Q
01/01/21

R.	10
O	10
V	4
Total.	24

DATE 27-8-21
EXP. NO. 3

EXPT. TITLE: study effect of open & short circuit

PAGE NO. 10

study effect of open & short circuit

Aim:-

To study & verify effect of open & short circuit in simple DC circuits.

Apparatus:-

- 1) Voltmeter (0-100V) - 2 nos
- 2) Ammeter (0-100mA) - 1 no
- 3) DC power supply (0-30V) - 1 no
- 4) Resistors (1K Ω) - 3 nos
- 5) Connecting wires

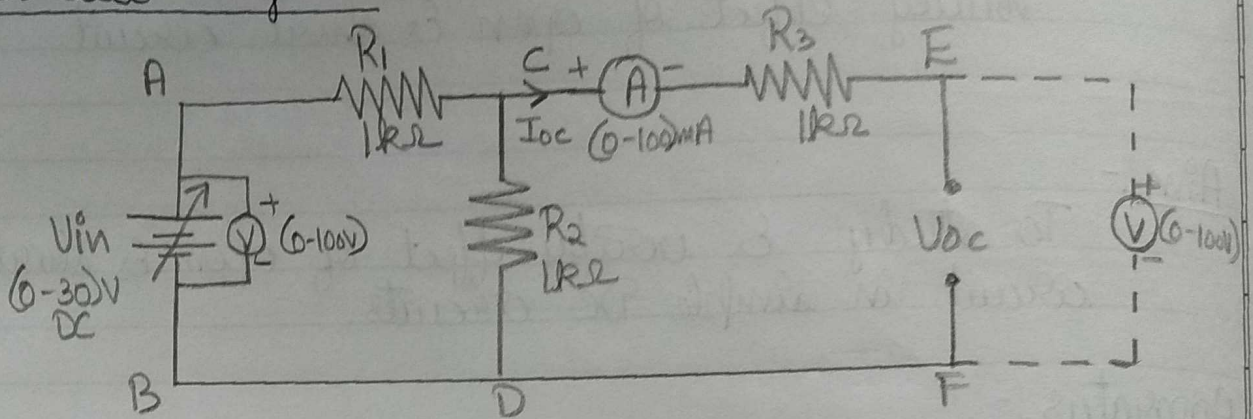
Theory:-

Learning Objectives

- i) To realize effect of open & short circuit tests in an electric circuit.
- ii) To realize existence of voltage in open circuit.
- iii) To realize effect of current in short circuit.

An electric ~~current~~ circuit in which normal path of current has been interrupted either by disconnection of 1 part of its conducting pathway from another / any

Circuit diagram



Tabular column

SL No	Practical			Theoretical
	V_{in} Volts	V_{oc} Volts	I_{oc} mA	V_{oc} Volts
1	5	2.5	0	2.5
2	10	5.1	0	5
3	15	7.5	0	7.5
4	20	10.1	0	10
5	25	12.7	0	12.5

Interruption in the circuit such as open switch or a break in the wiring referred as open circuit. Open circuit means there will be no flow of current but availability of voltage is present.

An open circuit is a very high resistance path between 2 points of a circuit element. An open circuit results in 0 current flow, but high voltage across terminals. A short circuit results in extreme large current flow in a circuit & may cause power source & other devices to be damaged.

A short circuit is simply a very low resistance connection between 2 conductors supplying electric power to any circuit. This results in excessive current flow in power source & may even cause the power source to be damaged.

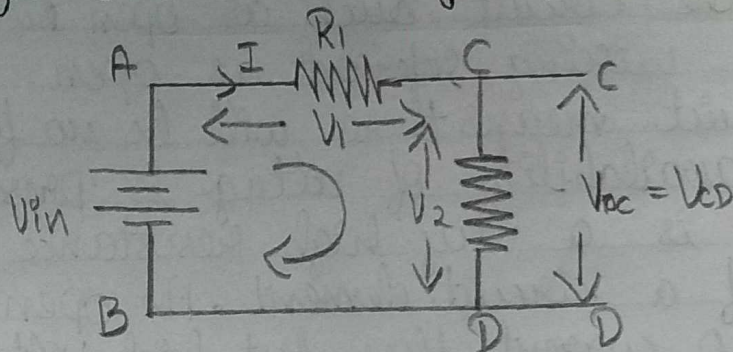
Open Circuit test

Procedure :-

- i) Make connections as per the circuit diag.
- ii) Apply DC power supply voltages & note readings of voltage & current.
- iii) Calculate V_{oc} & I_{sc} theoretically
- iv) Now increase supply voltages in steps &

Calculations

Equivalent circuit for open circuit



Apply KVL to loop ACDBA

$$V_1 - IR_1 - IR_2 = 0$$

$$V - I(R_1 + R_2) = 0$$

$$I = \frac{V}{R_1 + R_2}$$

$$V_{oc} = \frac{V}{R_1 + R_2} \times R_2$$

$$= \frac{5}{1k + 1k} \times 1k = 2.5V$$

$$= \frac{10}{1k + 1k} \times 1k = 5V$$

$$= \frac{15}{1k + 1k} \times 1k = 7.5V$$

$$= \frac{20}{1k + 1k} \times 1k = 10V$$

$$= \frac{25}{1k + 1k} \times 1k = 12.5V$$

$$V_{cd} = IR_2$$

$$V_{cd} = \frac{V}{R_1 + R_2} \times R_2$$

$$\text{But, } V_{cd} = V_{oc}$$

$$\therefore V_{oc} = \frac{V}{R_1 + R_2} \times R_2$$

$$I_{oc} = 0A$$

DATE

EXPT. TITLE :

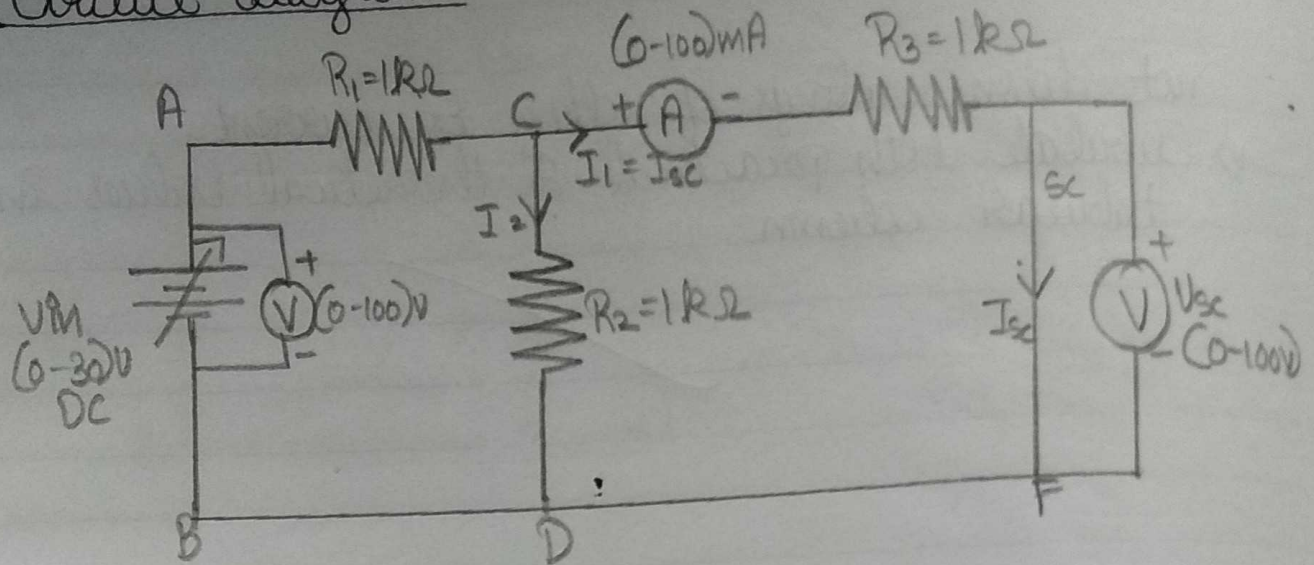
EXP. NO.

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not down readings of voltage & current.
v) Tabulate both practical & theoretical values in tabular column.

Circuit diagram



Tabular column

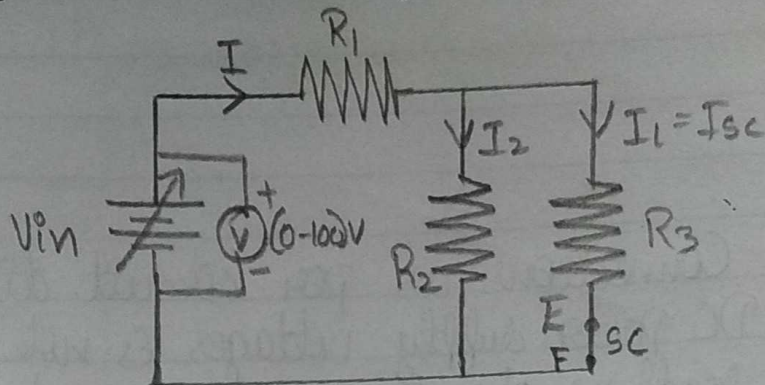
SL No	Practical			Theoretical
	V_m Volts	V_{sc} Volts	I_{sc} mA	I_{sc} mA
1	5	0	1.7	1.66
2	10	0	3.4	3.33
3	15	0	5.1	5
4	20	0	6.8	6.65
5	25	0	8.5	8.33

Short circuitProcedure :-

- 1) Make Connections as per circuit diagram
- 2) Apply DC power supply voltages E_s note down readings of voltage E_s current.
- 3) Calculate V_{sc} & I_{sc} theoretically
- 4) Now increase supply voltage in steps E_s note down readings of voltage E_s current.
- 5) Tabulate both practical & theoretical values in tabular column.

Calculations

Equivalent circuit for short circuit



$$R_p = \frac{1 \times 1}{1+1} = 0.5$$

$$R_{eff} = 1 + 0.5 = 1.5$$

$$I_{sc} = \frac{I R_2}{R_2 + R_3}$$

$$= \frac{3.3 \times 1}{1+1} = 1.66 \text{ mA}$$

$$= \frac{6.6 \times 1}{1+1} = 3.33 \text{ mA}$$

$$= \frac{10 \times 1}{1+1} = 5 \text{ mA}$$

$$= \frac{13.3 \times 1}{1+1} = 6.65 \text{ mA}$$

$$= \frac{16.6 \times 1}{1+1} = 8.33 \text{ mA}$$

Here, R_2 & R_3 are in parallel

$$R_p = \frac{R_2 R_3}{R_2 + R_3}$$

$$R_{eff} = R_1 + R_p$$

$$R_{eff} = R_1 + \frac{R_2 R_3}{R_2 + R_3}$$

$$I = \frac{V}{R_{eff}}$$

Apply current division rule

$$I_{sc} = \frac{I R_2}{R_2 + R_3} \text{ A}$$

$$V_{sc} = 0 \text{ V}$$

DATE

EXPT. TITLE :

PAGE NO.

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EXP. NO.

Result :-

Open circuit & short circuit effect have been studied & tabulated.

01/09/21

R	10
O	10
V	4
Total -	24

DATE 1-9-21

EXP. NO. 4

EXPT. TITLE: Measurement of power & Power factor of different lamps

PAGE NO.

15

Measurement of Power & power factor of different lamps

Aim:-

To measure power & power factor of incandescent lamp, fluorescent lamp, CFL & LED lamps

Apparatus:-

- 1) Incandescent lamp (60W) - 1 no.
- 2) Fluorescent lamp (40W) - 1 no.
- 3) CFL (14W) - 1 no.
- 4) LED lamp (15W) - 1 no.
- 5) Multi function meter - 1 no.
- 6) Connecting wires

Theory:-

Apparent Power :- The product of RMS values of voltage & current is called as apparent power & is measured in volt amperes (VA) / kilo volt amperes (KVA)

$$S = VI$$

Unit VA / KVA

AC circuits :-

Energy storage elements such as inductance & capacitance results in periodic reversals of direction of energy flow which are alternating in nature.

Active Power :-

This is actual power consumed in an AC circuit which is obtained by multiplying apparent power by the power factor. It is expressed in watts or kilo watts.

$$\text{Real Power } P = VI \cos \phi$$

Where,

P = Power in watts

I = Current through load in A

V = Voltage across load in Volts

ϕ = Power factor of load

$P = \text{Volts} \times \text{amps} \times \text{p.f.}$

Units - Watts (W) or kilo watts (kW)

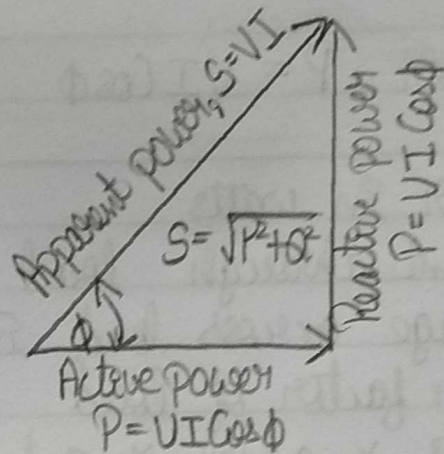
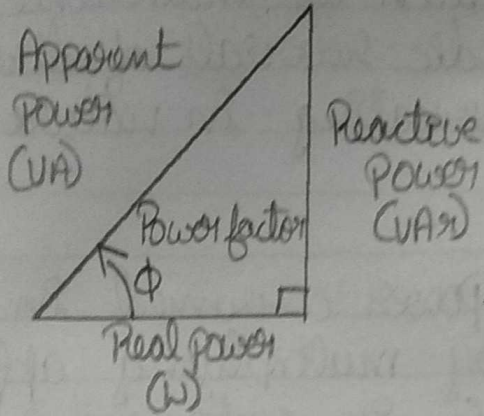
$$P = VI \cos \phi$$

But, $\cos \phi = \frac{R}{Z}$ & $V = IZ$

$$P = (IZ)(I) \left(\frac{R}{Z} \right)$$

$$P = I^2 R \text{ Watts}$$

Power triangle



Reactive Power

It is the power developed in reactance of circuit. It is given by,
 $Q = VI \sin \phi$ & is measured in VAR
 Units - Reactive volt ampere.
 Power triangle is shown in figure.

From power triangle,

$$S^2 = P^2 + Q^2$$

$$(KVA)^2 = (KW)^2 + (KVAR)^2$$

$$P.F = \cos \phi = \frac{KW}{KVA} = \frac{P}{S}$$

$$\cos \phi = \frac{RVI \cos \phi}{RVI}$$

Power factor & its significance :

Power factor can be defined as,

1) Cosine of angle between voltage & current.

$$2) \cos \phi = \frac{R}{Z} = \frac{\text{Resistance}}{\text{Impedance}} = \frac{R}{\sqrt{R^2 + X^2}}$$

$$3) \cos \phi = \frac{P}{S} = \frac{\text{Real Power}}{\text{Apparent power}} = \frac{VI \cos \phi}{VI} = \frac{KW}{KVA}$$

Note :-

- 1) If current lags voltage, power factor is lagging (Inductive load)
If current leads voltage, power factor is leading (Capacitive load)
If current is in phase with voltage, power factor is unity (Resistive load)
- 2) For heaters & incandescent lamps power factor is unity.
For motors & tube light the power factor is lagging.
For capacitors & condensers power factor is leading.
- 3) The magnitude of power factor varies from 0 to 1.

Fluorescent Lamp :-

This circuit consists of a choke, a starter, a fluorescent tube & a frame. Length of commonly used fluorescent tube is 120cm & 60cm, its power rating is 28W at 230V. The tube is filled with argon & drop of mercury. When supply is switched on, current heats filaments & initiates emission of electrons. After $1/2$ seconds, the starter

circuit opens & makes the choke to induce a momentary high voltage surge across 2 filaments.

Ionization takes place through argon & produces bright light. Typical luminous efficacy of fluorescent lighting systems is 50-100 lumens per watt.

Incandescent Lamp :-

It is an electric light with a wire filament heated to such high temperature that it glows with visible light. The filament is protected from oxidation. These bulbs are manufactured in a wide range of sizes, lights output & voltage ratings. They require no external regulating equipment, low manufacturing costs. It is widely used in household & commercial lighting, table lamps, car headlamps & flashlights.

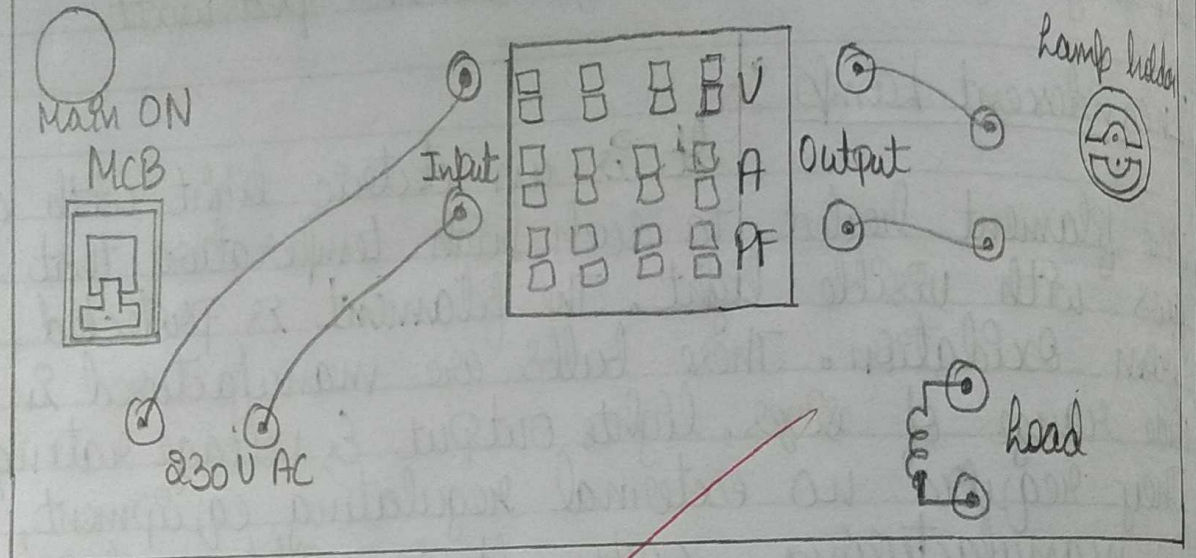
These bulbs have been replaced in many applications by other types of electric light.

LED lamp :-

LED light bulb is electric light for use in light fixtures that produces light using light-emitting diode. These have lifespan & electrical efficiency which are several times greater than incandescent lamps & are more efficient.

Connection diagram

Measurement of Current, Power & power factor of lamps



CFL lamp:-

It is designed to replace incandescent light bulb; some types fit into light fixtures designed for incandescent bulbs. The lamps use a tube which is curved / folded to fit into space of an incandescent bulb & compact electronic ballast in base of lamp.

Procedure:-

- 1) Connect circuit as shown with incandescent bulb in holder.
- 2) Switch on A.C supply, close switch & observe voltage, current, power & power factor values in multifunction meter.
- 3) Repeat same for fluorescent lamp, CFL bulb & LED bulb.
- 4) Now compare power factor.

Tabular column

SL No.	Lamp Type	V	I	Power factor Cos ϕ		Power Watts	
				Theoretical	Practical	Rated	Practical
1	Incandescent	240	0.267	1	1	60	64
2	Fluorescent	241	0.359	0.520	0.526	40	45
3	CFL	241	0.064	0.972	0.945	14	15
4	LED	242	0.058	0.997	0.982	15	14

Calculations

$$\cos \phi = \frac{P_{\text{practical}}}{VI}$$

$$1) \cos \phi = \frac{64}{240(0.267)} = 1$$

$$2) \cos \phi = \frac{45}{241(0.359)} = 0.520$$

$$3) \cos \phi = \frac{15}{241(0.064)} = 0.972$$

$$4) \cos \phi = \frac{14}{242(0.058)} = 0.997$$

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Result :-

Power & power factor of Incandescent lamp, fluorescent lamp, CFL lamp & LED lamp is tabulated.

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3/9/2015

R	10
O	10
V	4
Total	24

DATE 1-9-21
EXP. NO. 5

EXPT. TITLE: Measurement of Parameters of choke coil using 3-voltmeter method

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Measurement of Parameters of a choke coil using 3-voltmeter method

Aim :- To measure parameters of a choke coil by 3 voltmeter method.

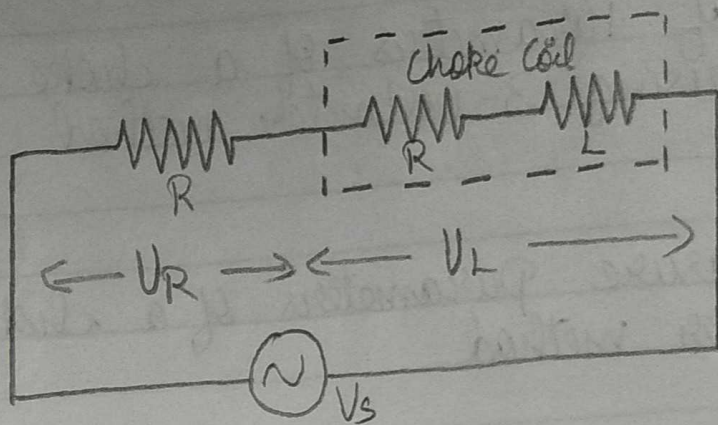
Apparatus :-

SL No.	Apparatus	Range	Type	Quantity
1	Choke coil	230V, 0.39A	Copper wound	1 No
2	Voltmeter	0-300V	Digital	3 Nos
3	Ammeter	0-1000 mA	Digital	1 No
4	1 Phase auto transformer	0-270V, 2A		1 No
5	Resistance	145.2 Ω 2.8A		1 No

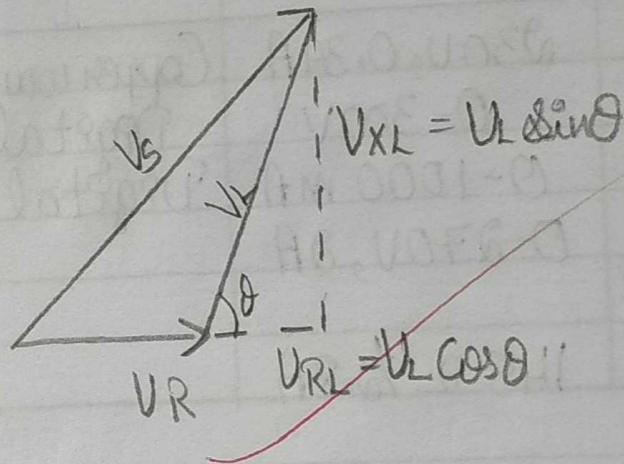
Theory :-

Choke coil parameters we are going to measure in this 3-voltmeter method are- the inductance & resistance as all choke coils have inherent resistance in addition to their inductance. A given choke coil is usually represented by pure inductance (L) in series with equivalent resistance. This takes into effect the iron losses in the core.

Circuit diag



Phasor diag



of choke coil is the inherent resistance of choke coil. 3- Voltmeter method is the best method to measure these 2 parameters. This equivalent resistance accounts for copper losses in choke coil & the Iron losses in iron coil core.

From fig.

Voltmeter reading across resistance = IR

Voltmeter reading across choke coil = $I(\sqrt{R^2 + \omega^2 L^2})$

$$V_s^2 = V_L^2 + V_R^2 + 2V_L V_R \cos \theta$$

$$\cos \theta = \frac{V_s^2 - V_L^2 - V_R^2}{2V_L V_R}$$

$$\text{Also, } I = \frac{V_R}{R} \quad \text{Es } Z = \frac{V_L}{I}$$

Now, coil resistance $R = Z \cos \theta$

Coil reactance $X_L = Z \sin \theta$

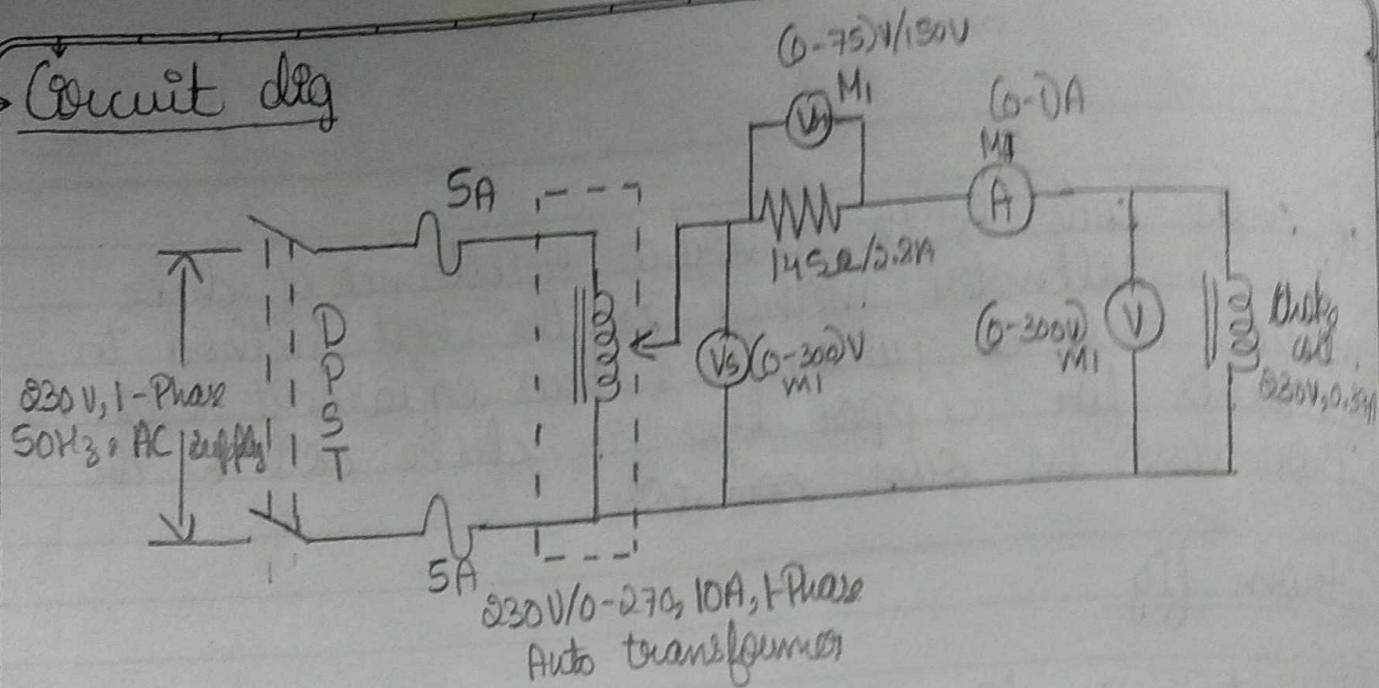
$$Q\text{-factor} = \frac{X_L}{R}$$

Power absorbed by choke coil (P) = $V_L I \cos \theta$

Hence,

$$R = \frac{V_L \cos \theta}{I}$$

Circuit diag



Tabular column

SL No	V_S Volts	V_R Volts	V_L Volts	I mA	Power factor of coil ($\cos \phi$) $\frac{V_S^2 - V_R^2 - V_L^2}{2V_R V_L}$	Resistance (ohms) $R = \frac{V_L \cos \phi}{I}$	Inductive reactance (ohms) $X_L = \frac{V_L \sin \phi}{I}$	Inductance (Henry) $L = \frac{X_L}{2\pi f}$
1	150	119	65	117	0.2659	147	535	1.0702
2	170	134	74	132	0.2757	154	538	1.0712
3	190	150	82	148	0.2795	155	531	1.0690
4	210	166	91	163	0.2735	152	536	1.0706
5	230	182	100	179	0.2685	150	538	1.0712

$$R_{avg} = 152 \Omega$$

$$L_{avg} = 1.0704 H$$

$$X_L = Z \sin \theta = \frac{V_L \sin \theta}{I}$$

And $L = X_L / 2\pi f$

Procedure :-

- 1) Make connections as shown
- 2) Initially keep transformer in minimum position.
- 3) Close supply DPST Switch
- 4) Vary autotransformer E_s apply some voltage across circuit say, 150V E_s note readings of all meters.
- 5) Vary applied voltage in steps by varying auto transformer E_s note down readings of all meters
- 6) Calculate resistance & inductance of choke coil as given in tabular column.

Calculations :-

$$\text{Power factor } \cos \theta = \frac{V_s^2 - V_R^2 - V_L^2}{2V_R V_L}$$

$$\text{Resistance } R = \frac{V_L \cos \theta}{I} \text{ Ohms}$$

$$\text{Inductive reactance of coil } X_L = \frac{V_L \sin \theta}{I} \Omega$$

$$\text{Inductance } L = \frac{X_L}{2\pi f} \text{ H}$$

$$f = 50 \text{ Hz}$$

$$\text{Power factor, } \cos \theta = \frac{V_s^2 - V_R^2 - V_L^2}{2V_R V_L}$$

$$1) \cos \theta = \frac{(150)^2 - (119)^2 - (65)^2}{2(119)(65)} = 0.2659$$

$$4) \cos \theta = \frac{(210)^2 - (166)^2 - (91)^2}{2(166)(91)} = 0.2735$$

$$2) \cos \theta = \frac{(170)^2 - (134)^2 - (74)^2}{2(134)(74)} = 0.2757$$

$$5) \cos \theta = \frac{(230)^2 - (182)^2 - (100)^2}{2(182)(100)} = 0.2685$$

$$3) \cos \theta = \frac{(190)^2 - (150)^2 - (82)^2}{2(150)(82)} = 0.2795$$

$$\text{Resistance, } R = \frac{V_L \cos \theta}{I}$$

$$1) R = \frac{65(0.2659)}{117 \times 10^{-3}} = 147 \Omega$$

$$4) R = \frac{91 \times 0.2735}{163 \times 10^{-3}} = 152 \Omega$$

$$2) R = \frac{74(0.2757)}{132 \times 10^{-3}} = 154 \Omega$$

$$5) R = \frac{100 \times 0.2685}{179 \times 10^{-3}} = 150 \Omega$$

$$3) R = \frac{82 \times 0.2795}{148 \times 10^{-3}} = 155 \Omega$$

Result:-

The parameters i.e., resistance & inductance of a given choke coil are calculated by 3-voltmeter method & their values are found to be $R_{avg} = 152 \Omega$ & $L_{avg} = 1.7044 \text{ mH}$

~~Sub the~~
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R -	10
O	10
V	5
Total	25

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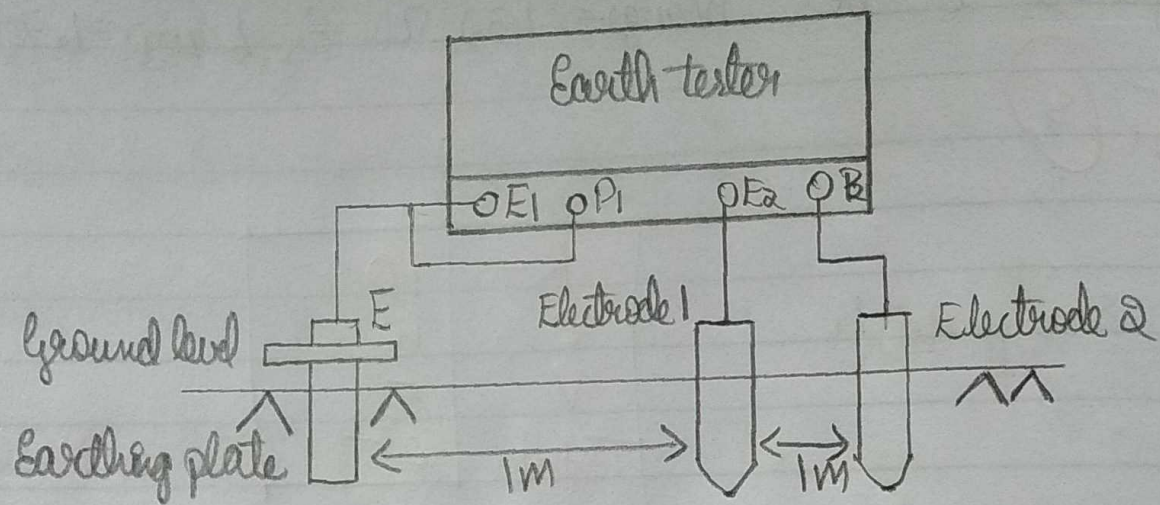
Result:-

The parameters i.e., resistance & inductance of a given choke coil are calculated by 3-voltmeter method & their values are found to be $R_{avg} = 152 \Omega$ & $L_{avg} = 1.7044H$

~~Sub the~~
3/9/21 (5)

R -	10
O	10
V	5
Total.	25

Circuit diag



DATE 7-9-21
EXP. NO. 6

EXPT. TITLE: Measurement of Earth Resistance

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Measurement of Earth Resistance

Aim:-

To measure earth resistance of an installation with the help of Digital earth resistance Tester (Megger)

Apparatus:-

- 1) Digital earth resistance Tester - 1 no
- 2) Spikes (Electrodes) - 3 no
- 3) Connecting wires

Theory:-

All electrical installations & appliances should be earthed properly for ensuring human safety. A separate wire, known as earth wire, runs along supply line & is ultimately connected to ground through earth electrode. The total resistance of earthing system should be small so that in the event of any fault, the fault current is sufficiently high to blow off the fuse.

The earth resistance is resistance offered by soil & electrode to the flow of earth leakage current which will flow in case of earth fault only. The earth tester is a special type of ohmmeter which sends ac through earth & dc through measuring instruments as shown in dig.

Tabular column

S. no.	Different position of electrode	Earth resistance (R_e) in Ohm	Mean of R_e
1	Trial 1	3.21	2.606
2	Trial 2	2.28	
3	Trial 3	2.33	

The working principle of earth tester is identical to that of megger. There are 2 moving coil viz. potential E_s current coil which are deflected in magnetic field of permanent magnet. Hand driven generator supply power to these coils. It has got 4 terminals P_1, E_1, P_2, E_2 . P_1, E_1 are shorted to form a common point which is connected to earth electrode under test. The E_2, P_2 are connected to auxiliary electrodes 1 & 2. Value of earth resistance is indicated directly on scale when test button is pressed. Normal value of earth resistance should be between 1 to 2Ω .

Procedure :-

- 1) Connect earth resistance tester to all electrodes
- 2) Short E_1, P_1 . Connect E_2 to 1st & P_2 to 2nd electrode.
- 3) Switch ON earth tester
- 4) Adjust resistance range button between 10Ω to 1000Ω . E_s set to 10Ω
- 5) Change position of electrode 1 & 2 by 1m & observe earth resistance by pressing test button.
- 6) Take mean of observations of earth resistance

Result :- Earth resistance of given installation is measured with digital earth resistance tester & its mean value is found to be 2.606 Ohm

Per
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R	10
O	10
V	5
Total.	25

DATE 3-9-21
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EXPT. TITLE: Measurement of 3 phase power by 2 wattmeter method

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Measurement of 3 Phase Power By 2-Wattmeter Method

Aim :-

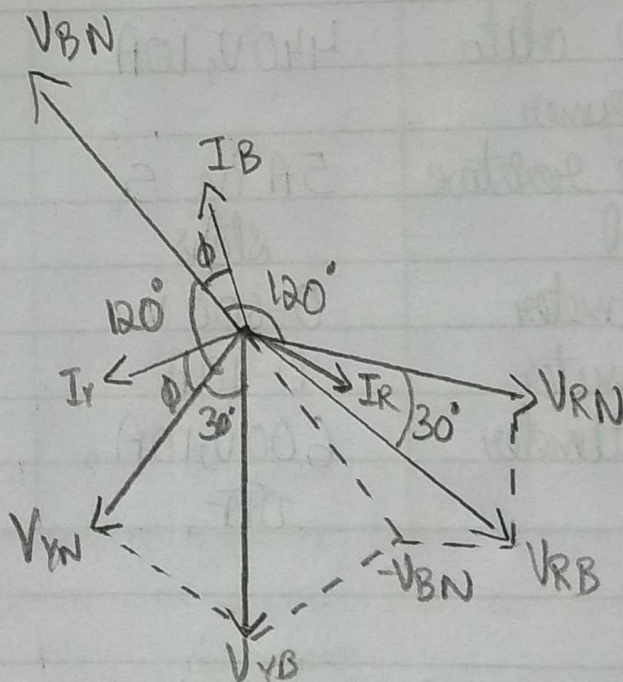
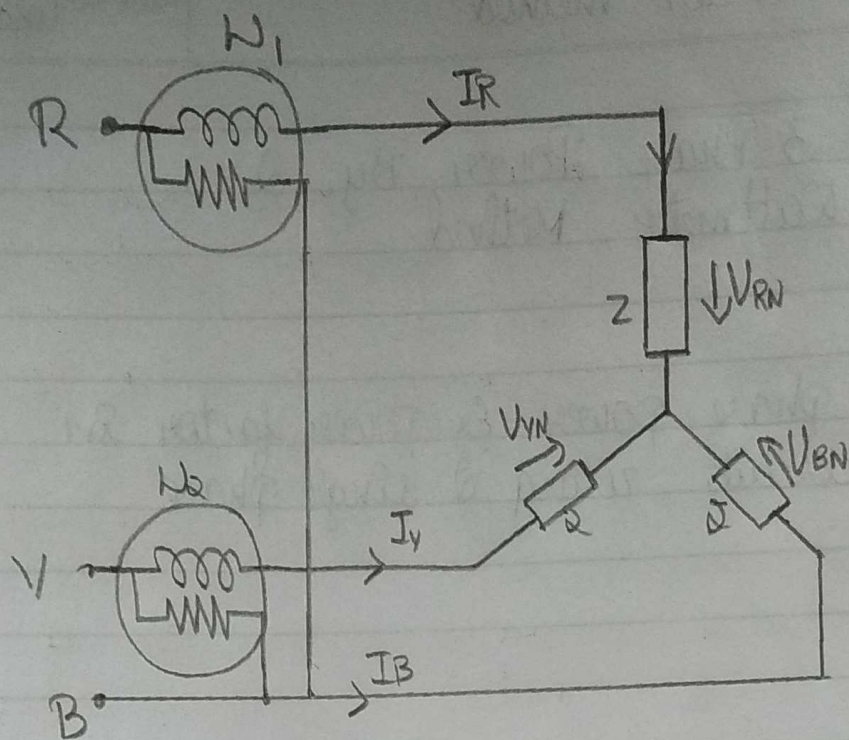
To measure 3 phase power & power factor in balanced 3 phase circuit using 2 single phase wattmeters.

Apparatus :-

S. No.	Apparatus	Range	Quantity
1	3 phase auto transformer	440V, 10A	1 No.
2	3 phase resistive load	5A in 5 steps	1 No.
3	AC voltmeter	0-600 V	1 Nos
4	AC Ammeter	0-10A	1 Nos
5	AC wattmeter	600V, 10A, 10PF	2 Nos

Theory :-

Power in an AC circuit is measured with help of Wattmeter. A wattmeter is an instrument which consists of 2 coils called Current coil & Potential coil.



The current coil having low resistance is connected in series with load so that it carries load current. The potential coil having resistance is connected across load & carries current proportional to the potential difference.

The 2 wattmeter method is explained, taking example of balanced load. In this, we can prove that power measured by 2 wattmeters i.e. sum of 2 wattmeter readings is equal to $\sqrt{3} V_L I_L \cos \phi$ which is the actual power consumed in 3 phase balanced load.

From fig

The 3 phase voltages V_{RN} , V_{YN} & V_{BN} are displaced by an angle of 120° electrical as shown in phasor diag. The phase current lags behind their phase voltages by angle ϕ .

The current flowing through the coil of wattmeter W_1 is

$$W_1 = IR$$

Potential difference across pressure / potential coil of wattmeter, W_1 will be

$$W_1 = V_{RB} = V_{RN} - V_{BN}$$

To obtain value of V_{RB} , reverse the phasor V_{BN} & add it to phasor V_{RN} as shown in phasor diag. Phase difference between V_{RB} & IR is $(30^\circ - \phi)$

∴ Power measured by W_1 is

$$W_1 = V_{RB} IR \cos (30^\circ - \phi)$$

Current through current coil of wattmeter, W_2 is

$$W_2 = I_Y$$

Potential difference across Wattmeter, W_2 is

$$W_2 = V_{YB} = V_{RN} - V_{BN}$$

The phase difference V_{YB} & I_Y is $(30^\circ + \phi)$

∴ Power measured by wattmeter, W_2 is given by equation

$$W_2 = V_{YB} I_Y \cos(30^\circ + \phi)$$

Since, load is in balanced condition, hence

$$I_R = I_Y = I_B = I_L \quad \text{Es}$$

$$V_{RY} = V_{YB} = V_{BR} = V_L$$

∴ Wattmeter readings will be

$$W_1 = V_L I_L \cos(30^\circ - \phi) \quad \text{Es}$$

$$W_2 = V_L I_L \cos(30^\circ + \phi)$$

Now, sum of 2 wattmeter readings will be

$$W_1 + W_2 = V_L I_L \cos(30^\circ - \phi) + V_L I_L \cos(30^\circ + \phi)$$

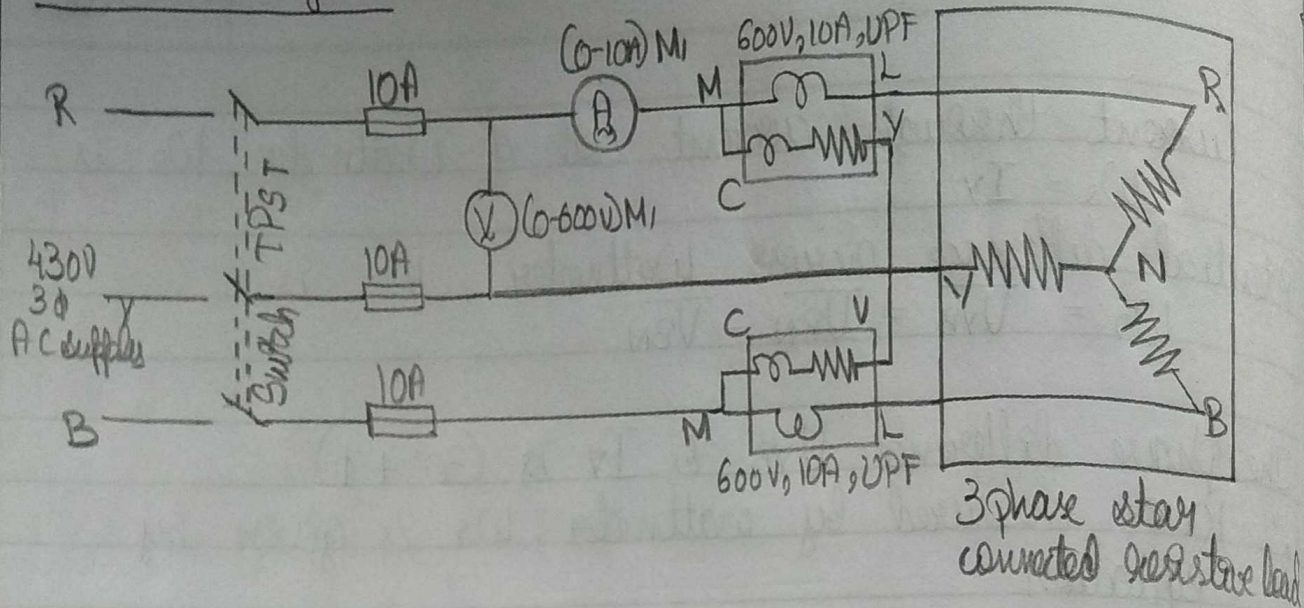
$$W_1 + W_2 = V_L I_L [\cos(30^\circ - \phi) + \cos(30^\circ + \phi)] \quad \text{Or}$$

$$W_1 + W_2 = V_L I_L [\cos 30^\circ \cos \phi + \sin 30^\circ \sin \phi + \cos 30^\circ \cos \phi - \sin 30^\circ \sin \phi] \quad \text{Or}$$

$$W_1 + W_2 = V_L I_L (2 \cos 30^\circ \cos \phi) \quad \text{Or}$$

$$W_1 + W_2 = V_L I_L \left(2 \frac{\sqrt{3}}{2} \cos \phi \right)$$

Circuit diagram



Tabular column

Sl No	VL Volts	IL Amps	W1 Watt	W2 Watt	Power in watts		Power factor $\cos \phi = \frac{W}{\sqrt{3} V_L I_L}$
					Practical $W = W_1 + W_2$	Theoretical $W = \sqrt{3} V_L I_L \cos \phi$	
1	410	0.96	354.4	351.7	705.8	681.66	0.9999
2	408	1.97	705.7	696.7	1402.4	1392.01	0.9999
3	406	2.97	1059	1034	2093	2087.91	0.9997
4	404	3.97	1394	1340	2764	2777.44	0.9998
5	402	4.96	1734	1706	3440	3452.2	0.9999

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

$$W_1 + W_2 = P \rightarrow \text{①}$$

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

Above equation ① gives power absorbed by 3 phase balance load.

Thus, sum of readings of 2 wattmeters is equal to power absorbed in 3 phase balanced load.

Procedure :-

- 1) Make connections as shown in diagram.
- 2) Ensure that autotransformer knob to be at minimum position.
- 3) Switch on 3-phase supply.
- 4) Slowly vary autotransformer knob & apply rated voltage.
- 5) Apply load in steps for different load currents & note all meter readings.
- 6) Repeat above step for different load currents.
- 7) Switch off load & bring autotransformer to 0 position & switch off supply.

Calculations

Total power $P = (W_1 + W_2)$ Watts

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

$$1) \cos \phi = \cos \left[\tan^{-1} \left(\sqrt{3} \frac{(354.4 - 351.7)}{(354.4 + 351.7)} \right) \right] = 0.9999$$

$$2) \cos \phi = \cos \left[\tan^{-1} \left(\sqrt{3} \frac{(705.7 - 696.7)}{705.7 + 705.7} \right) \right] = 0.9999$$

$$3) \cos \phi = \cos \left[\tan^{-1} \left(\sqrt{3} \frac{(1059 - 1034)}{1059 + 1034} \right) \right] = 0.9997$$

$$4) \cos \phi = \cos \left[\tan^{-1} \left(\sqrt{3} \frac{(1394 - 1370)}{1394 + 1370} \right) \right] = 0.9998$$

$$5) \cos \phi = \cos \left[\tan^{-1} \left(\sqrt{3} \frac{(1734 - 1706)}{1734 + 1706} \right) \right] = 0.9999$$

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Result :-

Three phase power & power factor of given 3 ϕ star connected Resistive load was measured using 3 wattmeter method.

$\frac{100}{81.91\%}$

R	10
O	10
V	5
Total	25



"To give real service, you must add something which cannot be bought or measured with money"

Sir Mokshagundam Visvesvaraya popularly known as Sir MV (15 September 1860 - 14 April 1962) was a notable Indian engineer, scholar, statesman and the Diwan of Mysore during 1912 to 1918. He was a recipient of Indian Republic's highest honour, the Bharat Ratna, in 1955. He was knighted as a Knight Commander of the Indian Empire (KCIE) by King George V for his contributions to the public good. Every year, 15 September is celebrated as Engineer's Day in India in his memory. He is held in high regard as a pre eminent engineer of India. He was the chief designer of the flood protection system for the city of Hyderabad in Andhra Pradesh, as well as the chief engineer responsible for the construction of the Krishna Raja Sagar dam in Mandya District.



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