EXPERIMENT - 1
VERIFICATION OF KVL AND KCL

AIM:

To verify Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL) in a Passive ResistiveNetwork .

APPARATUS:

S. No	Apparatus Name	Range	Type	Quantity
1	RPS	(0-30)V		1No.
2	Ammeter	20mA	Digital	3Nos
3	Voltmeter	30V	Digital	3Nos
4	Resistors			
5	Bread Board	-	-	01
6	Connecting Wires	-	-	As required

1.1 CIRCUIT DIAGRAMS:

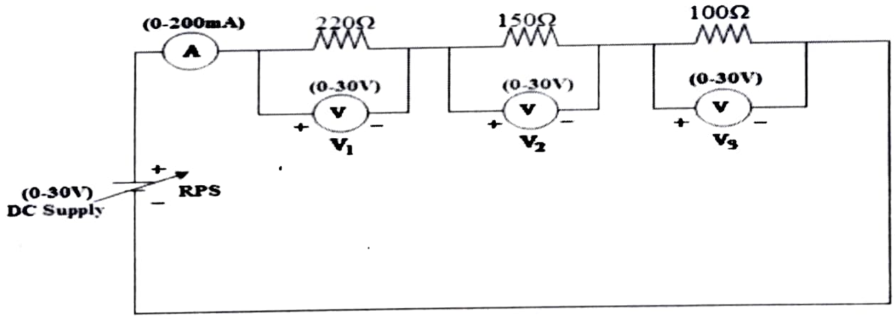


Figure – 1.1 Verification of KVL

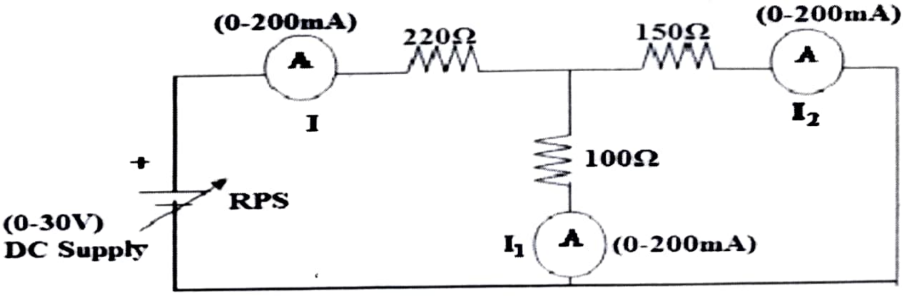


Figure – 1.2 Verification of KCL

PROCEDURE:

To Verify KVL

1. Connect the circuit diagram as shown in Figure 1.
2. Switch ON the supply to RPS.
3. Apply the voltage (say 5v) and note the voltmeter readings.
4. Gradually increase the supply voltage in steps.
5. Note the readings of voltmeters.
6. sum up the voltmeter readings (voltage drops) , that should be equal to applied voltage .
7. Thus KVL is Verified practically.

To Verify KCL

1. Connect the circuit diagram as shown in Figure 2.
2. Switch ON the supply to RPS.
3. Apply the voltage (say 5v) and note the Ammeter readings.
4. Gradually increase the supply voltage in steps.
5. Note the readings of Ammeters.
6. Sum up the Ammeter readings (I_1 and I_2) , that should be equal to total current (I).
7. Thus KCL is Verified practically

OBSERVATIONS:

For KVL

Applied Voltage V (volts)	V_1 (volts)		V_2 (volts)		V_3 (volts)		$V_1+V_2+V_3$ (volts)	
	Theoritical	Practical	Theoritical	Practical	Theoritical	Practical	Theoritical	Practical
10V	4.68V		3.19V		2.13V		10V	

For KCL

Applied Voltage V (volts)	I (A)		I_1 (A)		I_2 (A)		I_1+I_2 (A)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical
10V	35.7mA		21.43mA		14.28mA		35.7mA	

1.2 **PRECAUTIONS:**

1.Check for proper connections before switching ON the supply

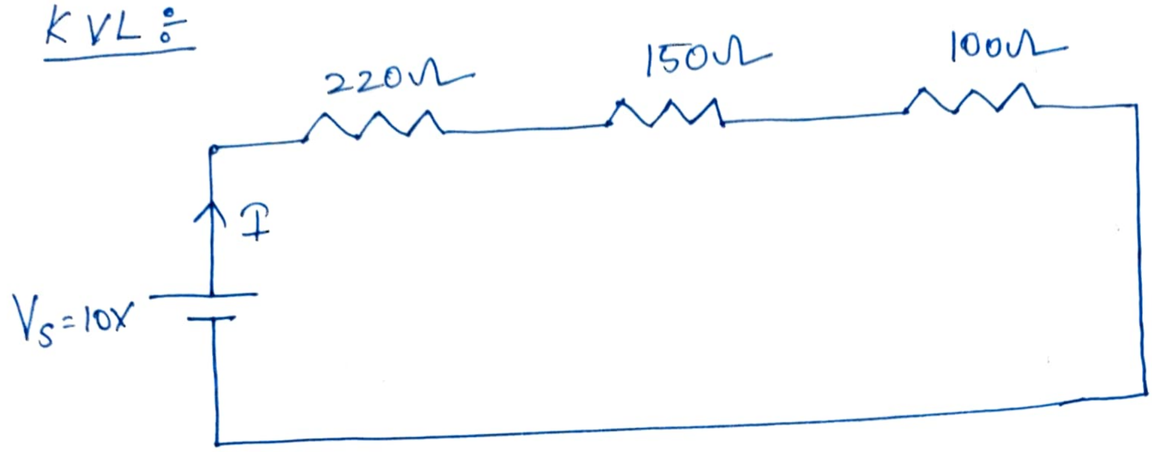
2.Make sure of proper color coding of resistors

3.The terminal of the resistance should be properly connected.

1.3 **RESULT:**

Theoritical calculations (KVL):

KVL:



Source voltage (V_S) = $I(220 + 150 + 100)$

Let $V_S = 10V$ (Consider)

$$I = \frac{V_S}{R} = \frac{10}{470} = 21.27mA$$

$\therefore V_1 = 220 \times 21.27mA = 4.68V$

$V_2 = 150 \times 21.27mA = 3.19V$

$V_3 = 100 \times 21.27mA = 2.13V$

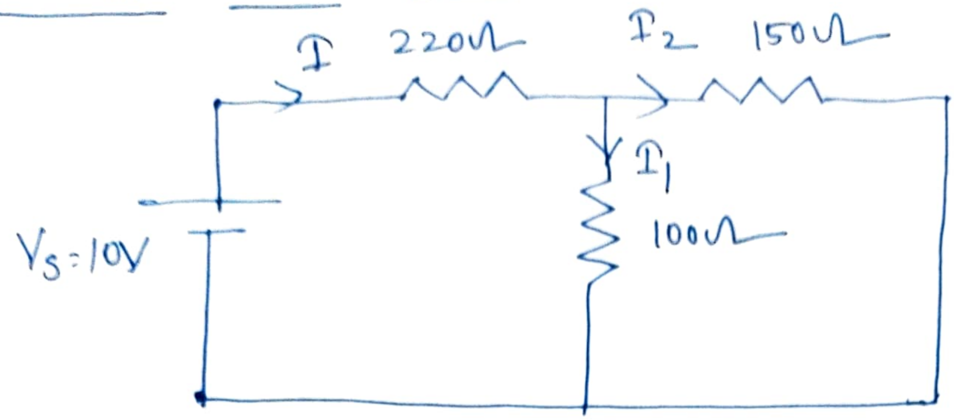
$\therefore V_S = V_1 + V_2 + V_3$

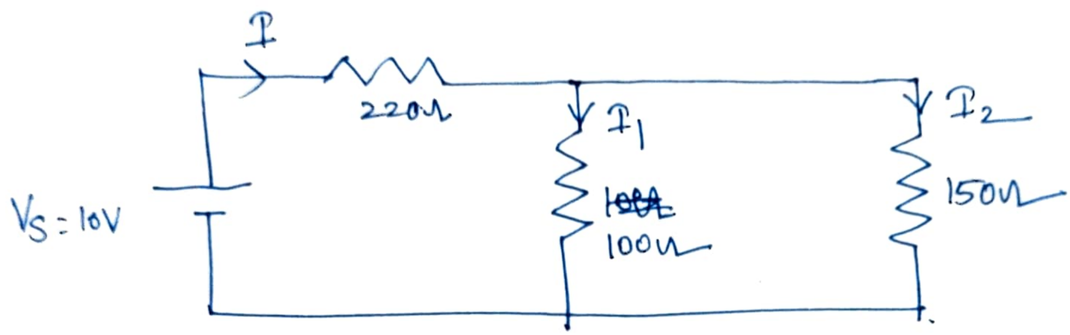
$= 4.68 + 3.19 + 2.13$

$= 10V$

$\therefore$ Hence KVL is verified.

Kirchoff's Current Law:





Equivalent Resistance $(R_{eq}) = 220 + \left(\frac{100 \times 150}{100 + 150}\right)$

$= 220 + 60$

$= 280\,\Omega$

Total current $(I) = \frac{V_S}{R_{eq}} = \frac{10}{280} = 35.7\,mA$

Voltage across 100Ω resistor = Voltage across 150Ω resistor $= 10 - (I * 220)$

$= 10 - (35.7 \times 10^{-3} \times 220)$

$= 2.143$ volts

current $(I_1) = \frac{2.143}{100} = 21.43\,mA$

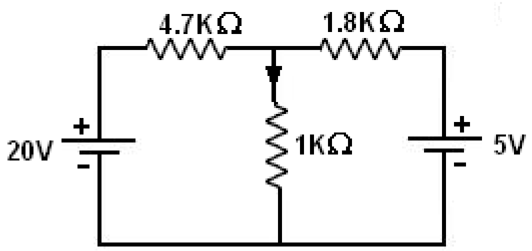
current $(I_2) = \frac{2.143}{150} = 14.28\,mA$

$\therefore I_1 + I_2 = (21.43 + 14.28)\,mA = 35.7\,mA = I.$

$\therefore$ Hence KCL is verified

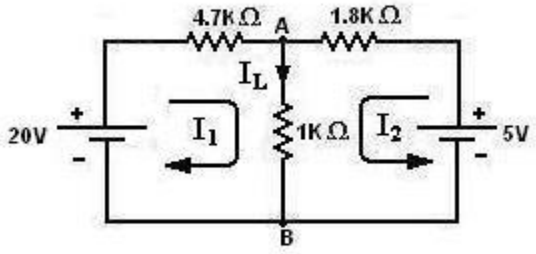
2. VERIFICATION OF SUPERPOSITION THEOREMS

Given circuit



Theoretical circuit diagrams:

When both the sources are acting:



Apply K.V.L. to loop 1

$20 = 4.7\text{ K } I_1 + 1\text{K } (I_1 + I_2)$

$20 = 5.7\text{ K}I_1 + 1\text{K } I_2$ .... (1)

Apply K.V.L. to loop 2

$5 = 1.8\text{ K}I_2 + 1\text{K } [I_1 + I_2]$

$5 = 2.8\text{ K}I_2 + 1\text{K } I_1$ .... (2)

$$\begin{bmatrix} 5700 & 1000 \\ 1000 & 2800 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 20 \\ 5 \end{bmatrix}$$

$$I_1 = \frac{\Delta_1}{\Delta} = 3.41\text{ mA.}$$

$$I_2 = \frac{\Delta_2}{\Delta} = 0.57\text{ mA.}$$

$I_L = I_1 + I_2 = 3.41 + 0.57 = 3.98$ mA.

Practical circuit diagrams:

When both the sources are acting:

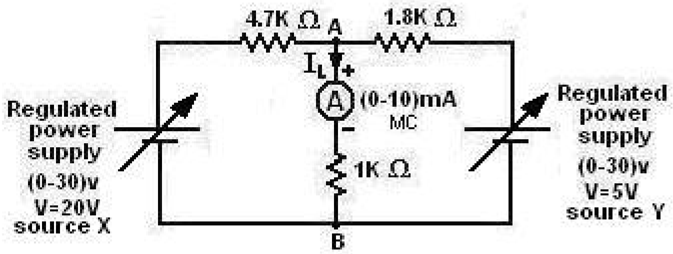


Fig (4.1)

Tabular Column:

S.No	Applied Voltage		Current I_L (mA)
	V_1 (Volts)	V_2 (Volts)	

2. VERIFICATION OF SUPERPOSITION THEOREMS

AIM: To verify superposition theorem for the given circuit.

STATEMENT:

Super position theorem

In any linear, bilateral, multi source network the response in any element is equal to the algebraic sum of the responses obtained by each source acting separately while all other sources are set equal to zero.

APPARATUS:

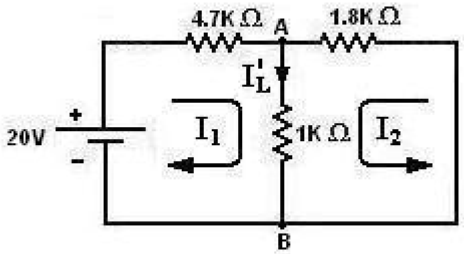
S. No	Name of the apparatus	Range	Type	Quantity
1	Dual channel regulated power supply	(0 – 30V)	-	1No
2	Ammeter	(0 – 10) mA	MC	1No
3	Resistors	4.7 KΩ 1.8 KΩ 1 KΩ 470Ω 2.2 KΩ	Carbon Composition	1No 1No 1No
4	Bread board	-	-	1No
5	Connecting wires	-	-	Required number

PRECAUTIONS:

1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings with out parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.

Theoretical circuit diagrams:

When 20V source is acting;



Apply K.V.L. to loop 1

$20 = 4.7\,KI_1 + 1K\,[I_1 + I_2]$

$20 = 5.7K\,I_1 + 1KI_2$ ……….. (1)

Apply K.V.L. to loop 2

$0 = 1.8K\,I_2 + 1K\,[I_1 + I_2]$

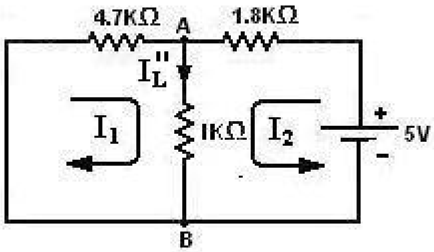
$0 = 2.8K\,I_2 + 1K\,I_1$ ……… (2)

$$\begin{bmatrix} 5700 & 1000 \\ 1000 & 2800 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 20 \\ 0 \end{bmatrix}$$

$$I_1 = \frac{\Delta_1}{\Delta} = \mathbf{3.74mA}\ ; I_2 = \frac{\Delta_2}{\Delta} = -1.34\mathbf{mA}\ .$$

$I_L^{1} = I_1 + I_2 = 3.74 - 1.34 = 2.4mA.$

When 5V source is acting;



Apply K.V.L. to loop 1

$0 = 4.7\,KI_1 + 1K\,[I_1 + I_2]$

$0 = 5.7K\,I_1 + 1KI_2$……….. (1)

Apply K.V.L. to loop 2

$5 = 1.8K\,I_2 + 1K[I_1 + I_2]$

$5 = 2.8K\,I_2 + 1K\,I_1$ ……… (2)

$$\begin{bmatrix} 5700 & 1000 \\ 1000 & 2800 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \end{bmatrix}$$

$$I_1 = \frac{\Delta_1}{\Delta} = -0.334\mathbf{mA}\ ; I_2 = \frac{\Delta_2}{\Delta} = 1.91\mathbf{mA}\ .$$

$I_L^{11} = I_1 + I_2 = -0.334 + 1.91 = 1.58mA.$

Verify $I_L = I_L^{1} + I_L^{11}$

PROCEDURE:

Practical circuit diagrams:

When 20V source is acting;

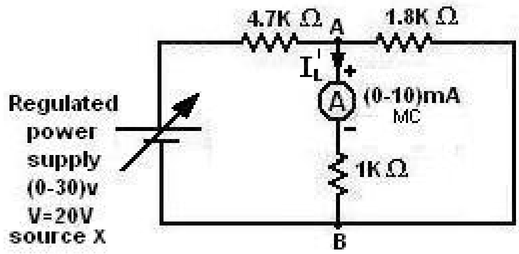


Fig (4.2)

Tabular Column:

S. No	Applied voltage (V_1) Volt	Current I_L (mA)

When 5V source is acting

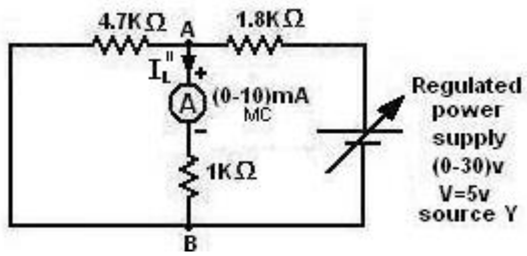


Fig (4.3)

S. No	Applied voltage (V_2) Volt	Current I_L (mA)

Verify $I_L^{*} = I_L^{1} + I_L^{11}$

Super position theorem

1. Connect the circuit as per the fig(4.1).
2. Adjust the output voltage of sources X and Y to 20V and 5V respectively(RPS output).
3. Note down the response (current, I_L) through the branch of interest (AB) (ammeter reading).
4. Now set the 5V source (Y) to 0V.
5. Note down the current through the branch AB (I_L^{l}) (ammeter reading).
6. Now set the 20V source (X) to 0V and source Y to 5V.
7. Note down the response (current, I_L^{ll}) through the branch AB (ammeter reading).
8. Disconnect the circuit

RESULT:

1. Since $I_L = I_L^{1} + I_L^{11}$ superposition theorem is verified on the given circuit and practical values are compared with theoretical values.

S.No	Load current	Theoretical Values	Practical Values
1	When Both sources are acting, I_L		
2	When only source X is acting, I_L^{1}		
3	When only source Y is acting, I_L^{11}		

CONCLUSION:

1. The given circuit is linear, since the response is algebraic sum of the individual responses.
2. Superposition theorem is not valid for power responses.

3.Measurement of Resistance using Wheatstone Bridge

Aim:

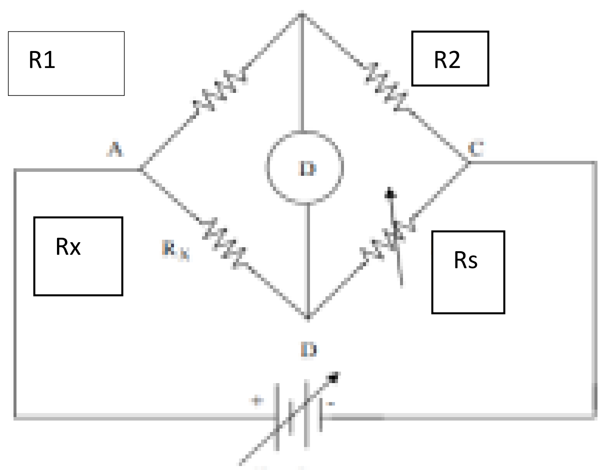
1. To know the principle of operation of the basic Wheatstone bridge.
2. To measure the unknown value of resistance of a resistor by using Wheatstone bridge.

Apparatus Required:

1. Regulated Power Supply(RPS)(0-30V)
2. Galvanometer
3. Resistors
4. Decade Resitance Box
5. Multimeter
6. Connecting wires

Introduction:

The DC bridges are used to measure the resistance while the ac bridges are used to measure the impedances consisting capacitances and inductances. The two types of DC bridges are:1) Wheatstone Bridge 2) Kelvin Double Bridge .

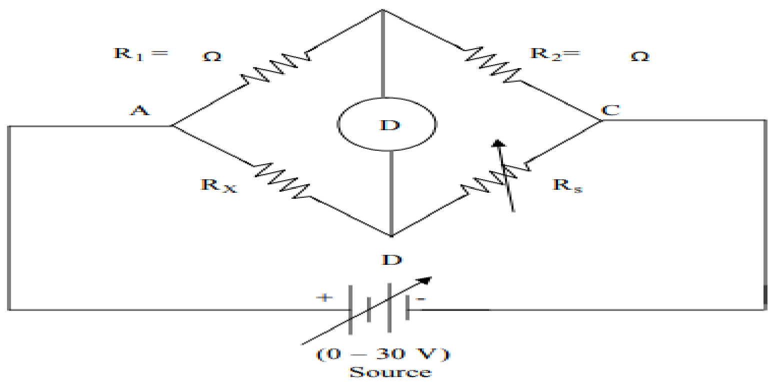


The Wheatstone bridge consists of four resistance arms together with a source of e.m.f and a null detector. The galvanometer is used as a null detector. The arms consisting of the resistances R1 & R2 are called Ratio arms. The arm consisting of the resistor R_X is the unknown resistance value to be measured. The battery is connected between A and C while galvanometer is connected between B and D. The bridge is balanced by varying the resistance Rs. Under balanced condition,

$$R_1 * R_S = R2 * Rx$$

Unknown Resistance $R_x = (R_1 * R_s / R_2)$.

Circuit Diagram:



Wheatstone Bridge

Procedure:

1. From the available standard resistances, select a suitable value for the arms R1 & R2.
2. Select the suitable value for the resistance as R_S.
3. Make the connections as per the circuit diagram.
4. Switch on the supply.
5. Adjust the value of DRB for null deflection in the galvanometer detector.
6. Increase the DC supply voltage continuously in steps and for each setting, obtain null deflection.

Tabular Column :

S.No.	Supply Voltage (V)	Rs (Ω)	Unknown Resistance Rx = (Rs * R1)/ R2 (Ω)

Precautions:

1. All the readings are to be noted without Parallax errors.
2. Avoid loose connections.

Result: Unknown Resistance has been measured by using Wheatstones Bridge.

4. OPEN CIRCUIT CHARACTERISTICS OF D.C SHUNT GENERATOR

Aim: To obtain the no load or open circuit characteristics of a DC shunt generator and to determine the critical field resistance and critical speed

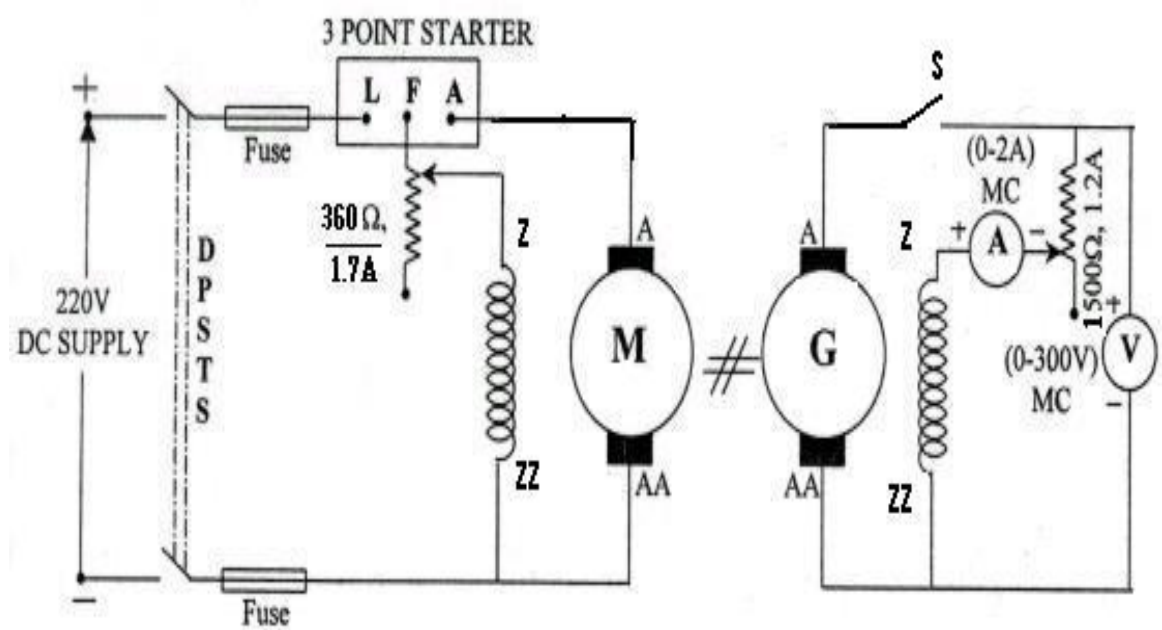
Name Plate Details

S.NO	Characteristic	D.C Motor	D.C Generator
1	Voltage	220 V	220 V
2	Current	20 A	11 A
3	Speed	1500 RPM	1500 RPM
4	H.P	5HP	3 KW
5	Field current	1 A	1 A

Apparatus Required

S.NO	Description	Type	Range	Quantity
1	Volt meter	MC	0-2A	1
2	Ammeter	MC	0-300V	1
3	Tacho meter	Digital	0-3000 rpm	1
4	Rheostat	Wire wound	360/1.7A, 1500Ω/1.2A	1

Circuit Diagram:



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PROCEDURE:

1) The connections are made as per circuit diagram.
2) The motor field regulator is kept at the minimum resistance (minimum speed) position. In this position, the starting torque of the motor is maximum and the speed finally attained is minimum and the generator field regulator is kept at maximum position.
3) To start the motor DPST switch is closed and the starter handle is moved from “off” position to “on” position slowly.
4) After the motor is started the speed is adjusted to rated speed using motor field regulator.
5) The switch S is kept open initially and for zero field current in the generator, emf is induced, which is the “Residual Voltage”.
6) Now, the switch is closed and by increasing the field current of the generator in steps corresponding induced emf as read by voltmeter is noted.
7) A graph is drawn taking the induced emf along the Y-axis and field current along X-axis. This graph is actually the B-H curve or magnetization characteristics of the generator. Since the induced emf is proportional to the flux density B and the magnetizing force H is proportional to the field current.

Tabular Column

Residual Voltage = 20V

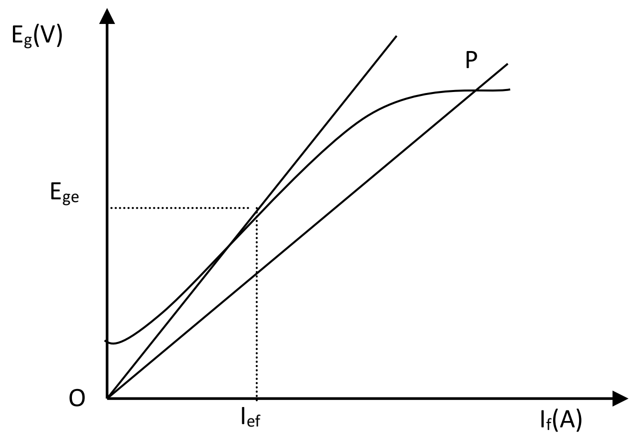
S.NO	**FIELD CURRENT** **$I_{f(amps)}$**	**GENERATED E.M.F$_{(volts)}$**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

Precautions:

1) Keep the field rheostat of motor at minimum position initially and generator field rheostat at maximum position.
2) During the experiment the generator field current is varied in one direction only to avoid hysteresis effect
3) Starter handle is moved slowly.
4) The meter reading are taken avoiding parallax error

Model Graph

Draw the graph between generated voltage at no load and field current. By taking generated voltage E_g in volts on Y axis and field current I_f in amps on X-axis.



To Find Critical Field Resistance:

1) Draw the shunt field resistance line
2) Draw tangent to the OCC
3) The slope of this tangent gives the R_{fc}

Critical field resistance, Rc=Ege/ I_{Fe} =

Result:-

The magnetizing or open circuit characteristics of a DC shunt generator are plotted From graph,

Critical field resistance =
Critical speed =

.

5.Measurement of power and power factor using Single-Phase Wattmeter

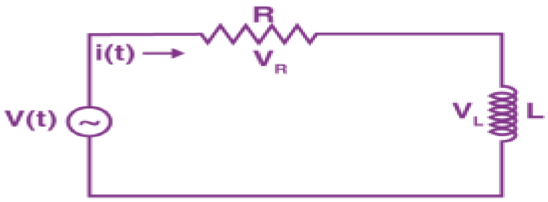
Aim: To measure power and Power Factor using Single-Phase Wattmeter

Apparatus Required :

Sl. No.	Name	Specification	Quantity
1	Single-phase auto transformer	5KVA, (0-270)V	1 Nos.
2	Voltmeter	(0-250)V, MI	1 Nos.
3	Watt-meter	(0-1500)W,	1 Nos.
4	Ammeter	(0-5)A, MI	1 Nos.
5	Rheostat	(0-80)Ω, 5A	1 Nos.
6	Inductor		1 Nos.
7	Connecting Wires	PVC Insulated Copper	As per required

Theory:

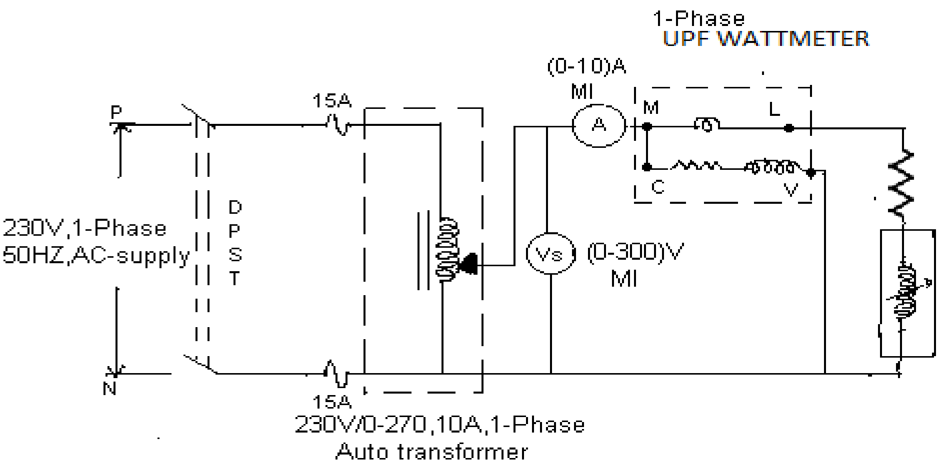
In R-L series AC circuit a resistor of resistance R ohm, and Inductor of inductance L henry are connected across single phase ac supply of V volts as shown in below figure



Power consumed by the Inductive load is given by P=V*I*Cosϕ watts.

Power Factor (pf) = {P/(V*I)}where, P is active power in watt, V is supplied voltage in volts, I is current flowing through the circuit elements in Amp.thus, by using above formula the power consumed by the load and power factor can be determined.A single Phase Wattmeter can be used for the measurement of the Power.

Circuit Diagram:



Procedure:

1. Connect all the instruments as per circuit diagram given above.
2. Before switch on the main power supply make sure that single-phase auto transformer knobe is at zero position.
3. Now slowly increase the supply voltage to the circuit after giving supply to the single-phase auto-transformer.
4. Take all the corresponding readings of the connected instruments in the circuit as per observation table.
5. Now calculate power factor Cosϕ .
6. Increase the load in steps and calculate power factor for each load.
7. Tabulate all the readings.

Precautions:

1. All the readings are to be noted without Parallax errors.
2. Avoid loose connections.
3. Don't switch on power supply without concerning teacher.
4. Single phase autotransformer must be kept at minimum potential point before switch on the experiment.

Tabular Column:

Sl. No.	V (in volts.)	I (in Amp.)	Wattmeter Reading P (in watts.)	Cosϕ= {P/(V*I)}

Result: Power and Power Factor has been Measured by using Single-Phase Wattmeter.

6.Calculation of Electrical Energy for Domestic Premises

Aim:

To calculate Electrical Energy in Domestic Premises

Apparatus:

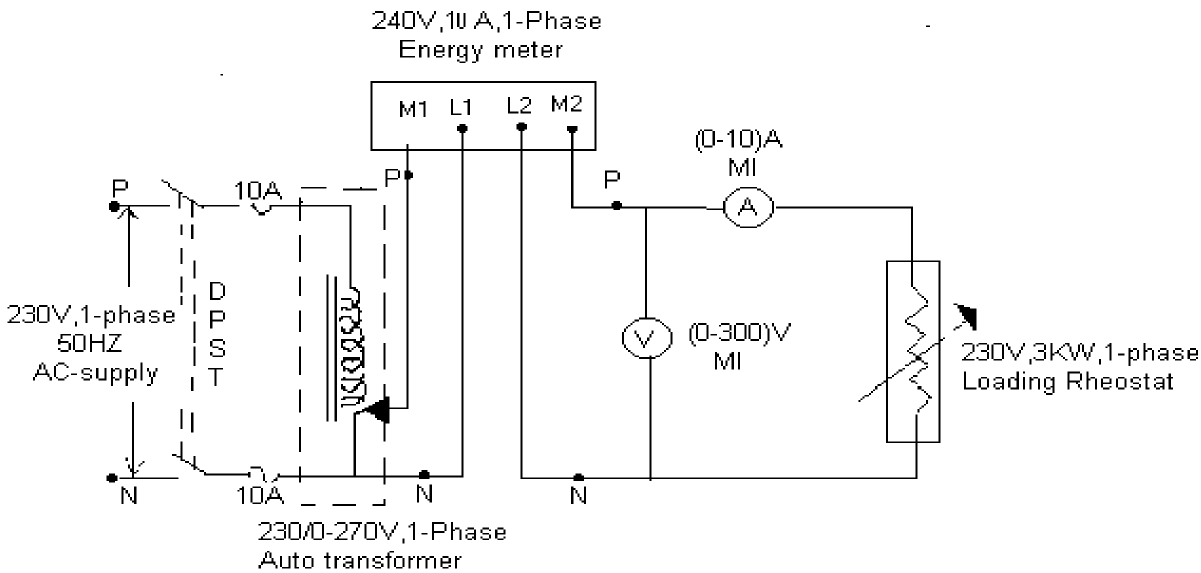
Sl.No	Apparatus	Range	Type	Quantity
1.	Voltmeter	0-300V	MI	1No.
2.	Ammeter	0-10A	MI	1No.
3.	Loading rheostat	3KW	-	1No.
4.	Energy meter	15A,240V	Analog	1No.
5.	Stop clock		Analog	1No.
6.	1-ϕ Auto Transformer	230V/ 0-270V,10A		1No.

Theory:

The energy meter is used for the measurement of Electrical energy. In energy meter, there are two fluxes produced by currents, flowing in the series and shunt windings. These alternating fluxes produce emfs in the metallic disc. These emfs inturn circulate eddy currents in the disc. Thus there are two fluxes and two eddy currents and therefore two torques are produced. Total torque is the sum of the torques. The speed of rotation of the disc is proportional to power.

Energy consumed=Number of pulses/Meter Constant

Circuit Diagram



Procedure

1. Connect the circuit as per the circuit diagram
2. Apply rated voltage i.e., 230V to the energy meter by varying auto transformer.
3. Switch on the load & vary the load in steps.
4. For each step note down the time taken for 5 revolutions of the disc using stop clock..
5. Note down the ammeter and voltmeter readings for each step.
6. Repeat the procedure until 10A of load current is reached.
7. Calculate the actual energy consumed by the loads.

Tabular Column

Meter Constant K= Rev/Hr

S.NO	Current in amps I_L(A)	Voltage in volts V(V)	No. of pulses	Time taken for 5 pulses(T)		Actual Energy= $VI_LT/1000$ (KWh)
				Secs	Hrs	

Sample calculations:

Voltage =

Current =

Time for 5 pulses =

Energy measured (actual) = $V*I_L*T*10^{-3}$=

Precautions:

1. Initially the autotransformer should be kept in minimum position.
2. Initially load resistance should be kept in minimum position.
3. Time taken for 5 pulses must be determined accurately.

Result:

Electrical Energy has been calculated for Resistive Loads using Single phase energy meter

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