

BE8261
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BASIC
ELECTRICAL, ELECTRONICS
AND
INSTRUMENTATION ENGINEERING
LABORATORY MANUAL

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**SSM INSTITUTE OF ENGINEERING AND TECHNOLOGY
DINDUGUL-PALANI HIGHWAY, SINTHALAGUNDU POST
DINDUGUL – 624002**



DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

LABORATORY MANUAL

**BE8261 BASIC ELECTRICAL , ELECTRONICS AND INSTRUMENTATION
ENGINEERING LABORATORY MANUAL**

NAME :
CLASS :
SEMESTER :
ROLL NUMBER :
REGISTER NUMBER :

SYLLABUS

**BE 8261 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION
ENGINEERING LABORATORY**

LIST OF EXPERIMENTS

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1. Load test on separately excited DC generator
2. Load test on Single phase Transformer
3. Load test on Induction motor
4. Verification of Circuit Laws
5. Verification of Circuit Theorems
6. Measurement of three phase power
7. Load test on DC shunt motor.
8. Diode based application circuits
9. Transistor based application circuits
10. Study of CRO and measurement of AC signals
11. Characteristics of LVDT
12. Calibration of Rotometer
13. RTD and Thermistor

LIST OF EXPERIMENTS

FIRST CYCLE:

1. Load test on DC Shunt motor
2. Load test on single phase Induction Motor
3. Load test on single phase transformer
4. Load test on separately excited DC shunt generator
5. Measurement of three phase power
6. RTD
7. Thermistor

SECOND CYCLE:

8. Verification of Circuit Laws-Ohm's law
9. Verification of Circuit Laws-Kirchoff's law
10. Verification of Circuit Theorems-Super position theorem
11. Verification of Circuit Theorems-Thevenin's theorem
12. Verification of Circuit Theorems- Norton's theorem
13. Verification of Circuit Theorems- Maximum power transfer theorem
14. Study of CRO and measurement of AC signals.
15. Diode based application circuits

ALLOTMENT OF MARKS

Internal assessment	: 20 marks
Practical assessment	: 80 marks
TOTAL	: 100 MARKS

SPLIT UP OF INTERNAL MARKS

Observation	: 5 marks
Record note	: 10 marks
Model exam	: 5 marks
TOTAL	: 20 Marks

UNIVERSITY EXAMINATION

The Exam will be conducted for 100 marks. Then the marks will be converted to 80 marks.

SPLIT UP OF PRACTICAL EXAMINATION MARKS

Aim & procedure	: 10 marks
Circuit diagram	: 25 marks
Circuit connection	: 15 marks
Tabulation	: 15 marks
Calculation	: 15 marks
Graph& Result	: 10 marks
Viva	: 10 marks
TOTAL	: 100 marks

INDEX

S. No.	Date	Title of Experiment	Page No.	Marks	Signature
1		Load test on DC Shunt motor	7		
2		Load test on single phase Induction Motor			
3		Load test on single phase transformer			
4		Load test on separately excited DC shunt generator			
5		Measurement of three phase power			
6		RTD			
7		Thermistor			
8		Verification of Circuit Laws Ohm's law			
9		Verification of Circuit Laws Kirchoff's law			
10		Verification of Circuit Theorems- Super position theorem			
11		Verification of Circuit Theorems- Thevenin's theorem			
12		Verification of Circuit Theorems- Norton's theorem			
13		Verification of Circuit Theorems- Maximum power transfer theorem			
14		Study of CRO and measurement of AC signals			
15		Diode based application circuits			
		Viva questions			

Ex.No.1**LOAD TEST ON DC SHUNT MOTOR****AIM:**

To conduct load test on DC shunt motor to find the efficiency and to draw the performance characteristics curves.

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-20A)	MC	1
2	Voltmeter	(0-300V)	MC	1
3	Rheostat	175Ω/1.5A	Wire Wound	1
4	Tachometer		Digital	1
5	Connecting Wires		Copper	Few

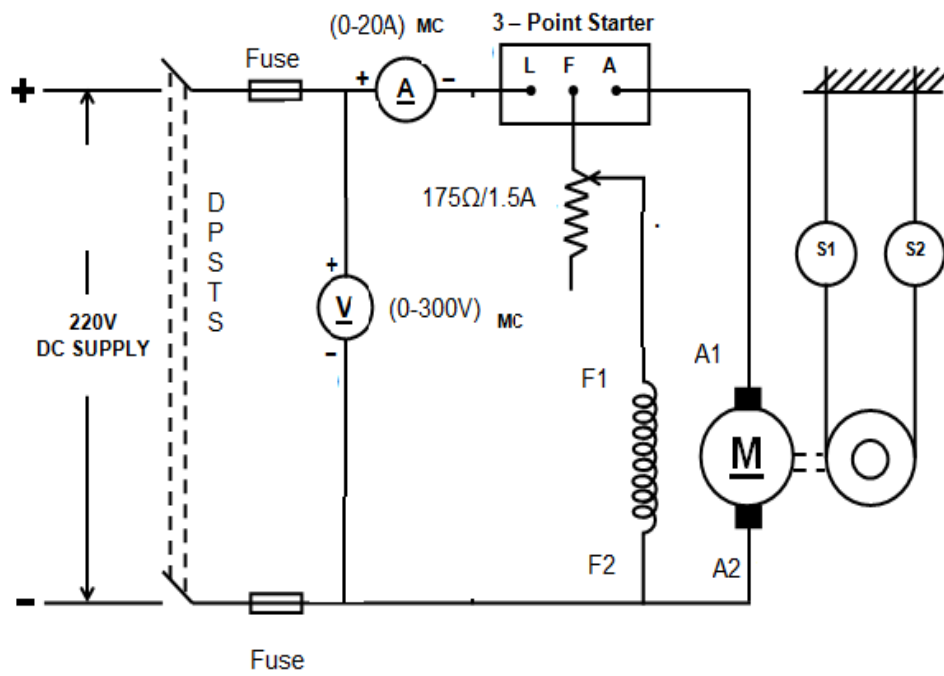
PRECAUTIONS:

1. DC shunt motor should be started and stopped under no load condition.
2. Field rheostat should be kept in the minimum position.
3. Brake drum should be cooled with water when it is under load.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking the no load condition, and minimum field rheostat position, DPST switch is closed and starter resistance is gradually removed.
3. The motor is brought to its rated speed by adjusting the field rheostat.
4. Ammeter, Voltmeter readings, speed and spring balance readings are noted under no load condition.
5. The load is then added to the motor gradually and for each load, voltmeter, ammeter, spring balance readings and speed of the motor are noted.
6. The motor is then brought to no load condition and field rheostat to minimum position, then DPST switch is opened.

CIRCUIT DIAGRAM



FUSE RATNG:
125% of rated current

Name plate details

Power	Voltage	Current	speed	Excitation

OBSERVATIONS:

S. No.	Voltage V (Volts)	Current I (Amps)	Spring Balance Reading		(S ₁ ~ S ₂) Kg	Speed N (rpm)	Torque T (Nm)	Output Power P _o (Watts)	Input Power P _i (Watts)	Efficiency η%
			S ₁ (Kg)	S ₂ (Kg)						

Circumference of the Brake drum = cm

FORMULAE:

Radius of brake drum R = $\frac{\text{Circumference}}{100 \times 2\pi}$ m

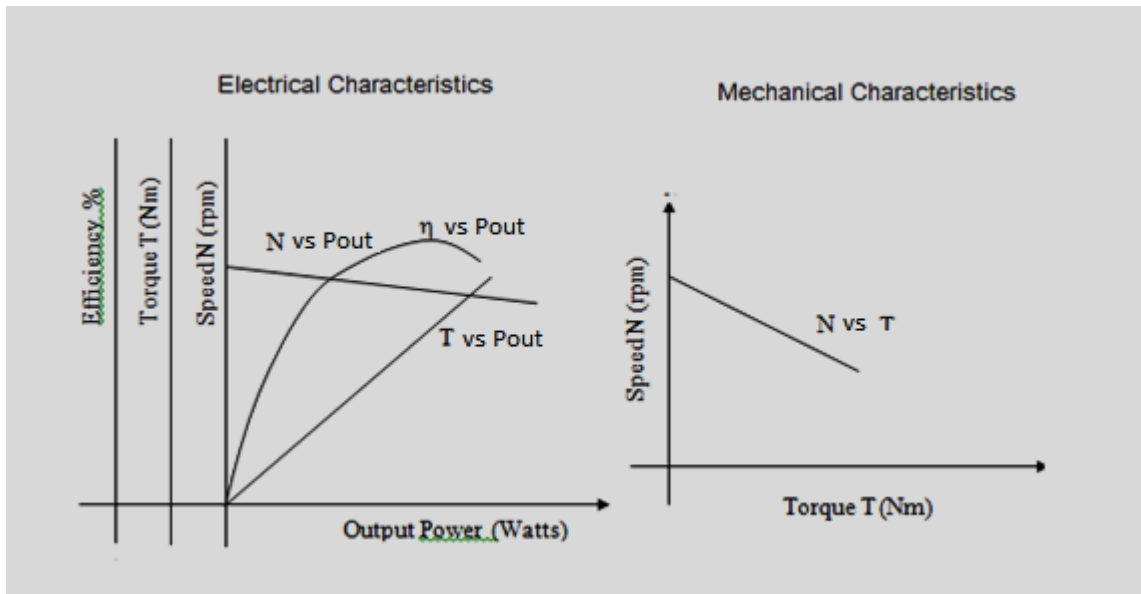
Torque T = (S₁~ S₂) x R x 9.81 Nm

Input Power $P_i = VI$ Watts

$$\text{Output Power } P_o = \frac{2\pi NT}{60} \text{ Watts}$$

$$\text{Efficiency } \eta \% = \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$$

MODEL GRAPHS:



RESULT:

Thus load test on DC shunt motor was conducted and its efficiency was determined, also its performance characteristics curves were drawn

Ex.No.2**Load test on single phase induction motor****AIM:**

To conduct load test on single phase induction to find the efficiency and to draw the performance characteristics curves.

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-10A)	MI	1
2	Voltmeter	(0-300)V	MC	1
3	Wattmeter	300V,10A	UPF	1
4	Single phase auto transformer	(0-270V)		1
5	Tachometer		Digital	1
6	Connecting Wires		Copper	Few

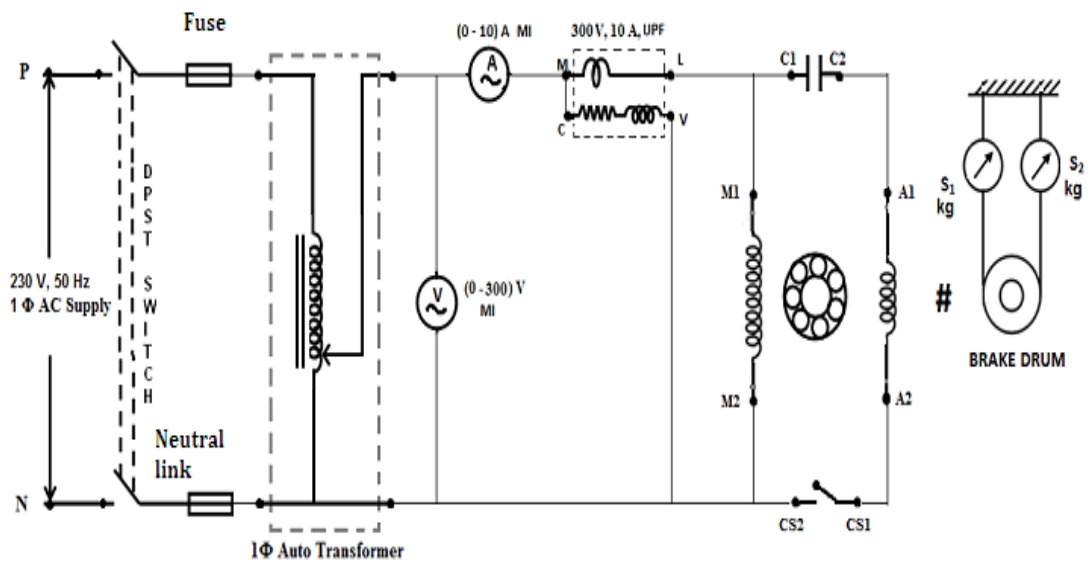
PRECAUTIONS:

1. The motor should be started without any load.
2. The supply should not be switched OFF before the motor is unloaded.
3. While running on load, the brake drum is cooled by pouring cold water.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking the no load condition, and minimum auto transformer position, DPST switch is closed.
3. The motor is brought to its rated speed by adjusting the auto transformer.
4. Ammeter, Voltmeter & wattmeter readings, speed and spring balance readings are noted under no load condition.
5. The load is then added to the motor gradually and for each load, voltmeter, ammeter, wattmeter, spring balance readings and speed of the motor are noted.
6. The motor is then brought to no load condition and auto transformer is to minimum position, then DPST switch is opened.

CIRCUIT DIAGRAM



- M1,M2-Main winding
- A1,A2-Auxiliary winding
- C1,C2-Capacitor
- Cs1,Cs2-Centrifugal switch

Fuse rating:

125% of rated current

Name plate details

Power	Voltage	Current	speed

OBSERVATIONS:

S. No.	Line Voltage (V _L) in Volts	Load current (I _L) in Amps	Spring balance Readings (Kg)			Speed (N) in RPM	Wattmeter readings		Input power (P _{in}) in Watts	Torque (T) in N-m	Output power (P _o) in Watts	Power factor	% Slip (S)	% Efficiency (η)
			S ₁	S ₂	S ₁ ~ S ₂		W	WxMF						

Circumference of the Brake drum = cm

$$\text{Radius of break drum } R = \frac{\text{Circumference}}{100 \times 2\pi} \text{ m}$$

FORMULAE:

Torque T = (S₁ - S₂) * 9.81 * R N-m.

The output power of the motor is given by

P_o = $\frac{2 * 3.14 * N * T}{60}$ Watts

Where N is the speed of the motor in RPM.

The power input to the motor $P_{in} = \dots$ watts

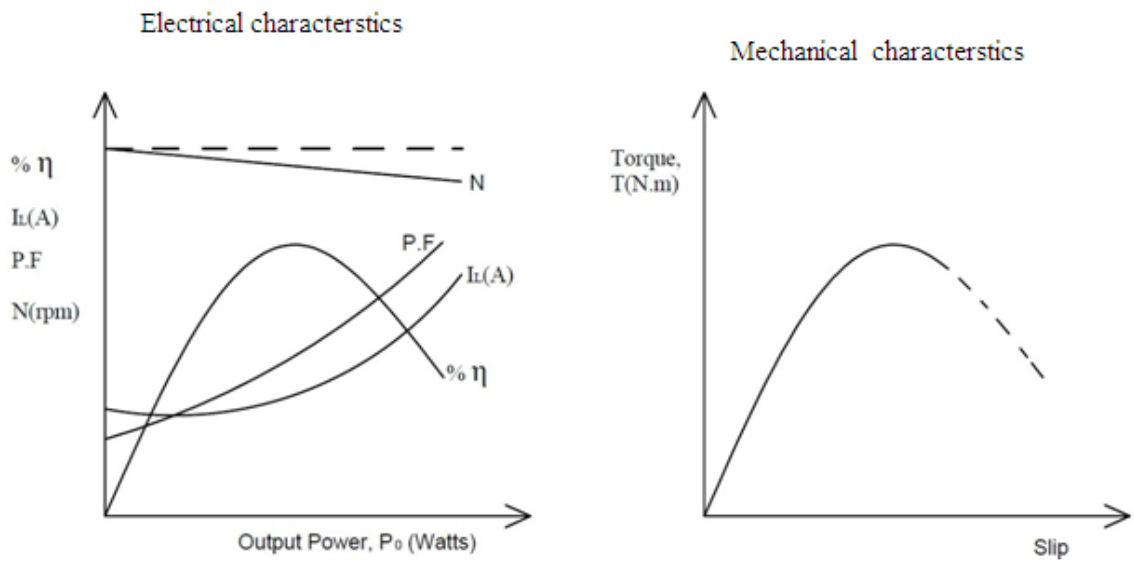
Efficiency $\eta = (P_o/P_{in}) \times 100$

$\cos \phi = P_{in} / (V_L \cdot I_L)$

Slip = $(N_s - N) / N_s \times 100$

$N_s = 1500 \text{ RPM}$

MODEL GRAPH



RESULT:

Thus the load test on single phase induction Motor was conducted and the performance characteristics were drawn.

Ex.No.3 LOAD TEST ON A SINGLE PHASE TRANSFORMER

AIM:

To conduct load test on single phase transformer to find efficiency and percentage regulation.

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-5A)	MI	1
		(0-10A)	MI	1
2	Voltmeter	(0-300V)	MI	1
		(0-150V)	MI	1
3	Wattmeter	300V,5A	UPF	1
		150V,10A	UPF	1
4	Auto Transformer	1KVA (0-270V)	-	1
5	Resistive Load	5KW/230V 1Ø	-	1
6	Connecting Wires		Copper	Few

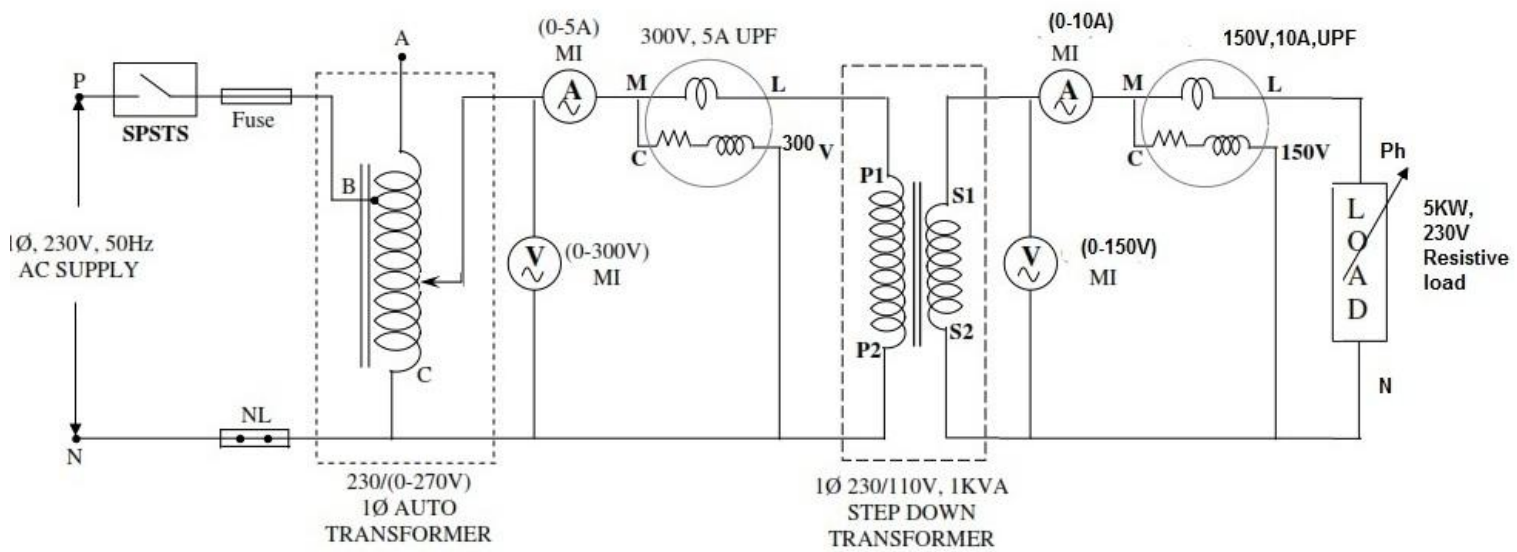
PRECAUTIONS:

1. Auto Transformer should be in minimum position.
2. The AC supply is given and removed from the transformer under no load condition.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking the no load condition, minimum position of auto transformer and DPST switch is closed.
3. Ammeter, Voltmeter and Wattmeter readings on both primary side and secondary side are noted.
4. The load is increased and for each load, Voltmeter, Ammeter and Wattmeter readings on both primary and secondary sides are noted.
5. Again no load condition is obtained and DPST switch is opened.

CIRCUIT DIAGRAM



FUSE RATING : 125% OF RATED CURRENT

NAME PLATE DETAILS:

	PRIMARY	SECONDARY
POWER		
VOLTAGE		
CURRENT		

OBSERVATIONS:

S.No.	Primary			Secondary			Input Power W ₁ x MF	Output Power W ₂ x MF	Efficiency η %	% Regulation
	V ₁ (Volts)	I ₁ (Amps)	W ₁ (Watts)	V ₂ (Volts)	I ₂ (Amps)	W ₂ (Watts)				

FORMULAE:

Output Power = W₂ x Multiplication factor

Input Power = W₁ x Multiplication factor

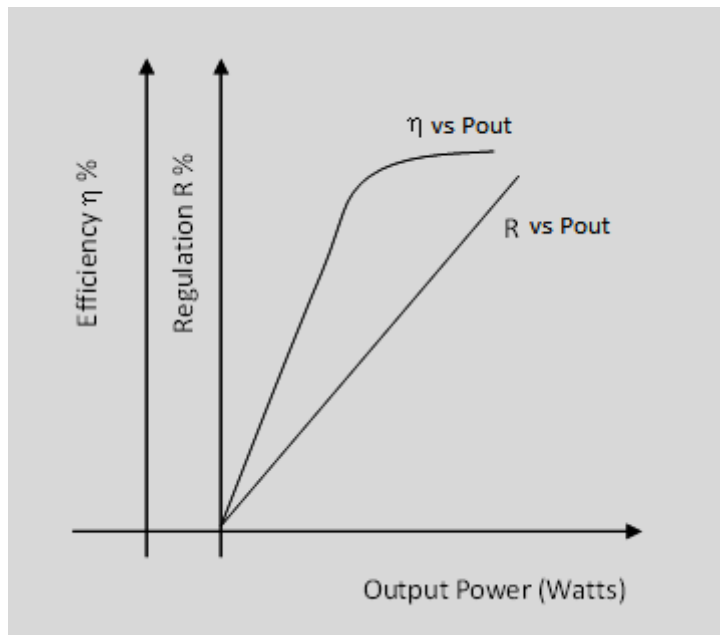
$$\text{Efficiency } \eta \% = \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$$

$$\text{Regulation R \%} = \frac{V_{NL} - V_{FL}}{V_{NL}} \times 100\%$$

where V_{NL}- secondary no load voltage =115V

V_{FL}- secondary voltage at full load

MODEL GRAPHS:



RESULT:

Thus the load test on single phase transformer was conducted and performance characteristics curves were drawn

Ex No. 4 LOAD TEST ON SEPARATELY EXCITED DC SHUNT GENERATOR**AIM:**

To conduct load test on separately excited DC shunt generator and obtain the load characteristics.

APPARATUS REQUIRED:

S. No	EQUIPMENT	TYPE	RANGE	QUANTITY
1	Ammeter	MC	(0-2A)	1
2	Ammeter	MC	(0-20A)	1
3	Voltmeter	MC	(0-300V)	1
4	Rheostat	Wire wound	175Ω/1.5A	2
5	Loading Rheostat	Resistive	5KW,230V	1
6	Tachometer	Digital	-	1
7	Connecting wires	-	-	As required

PRECAUTIONS:

At the time of starting,

1. The motor field rheostat should be kept at minimum resistance position.
2. The generator field rheostat should be kept at maximum resistance position.

FORMULAE USED:

$$E_g = V + I_a R_a \text{ (Volts)} \quad \& \quad I_a = I_L + I_f \text{ (Amps)}$$

where E_g =Generated emf in Volts, V =Terminal Voltage in Volts

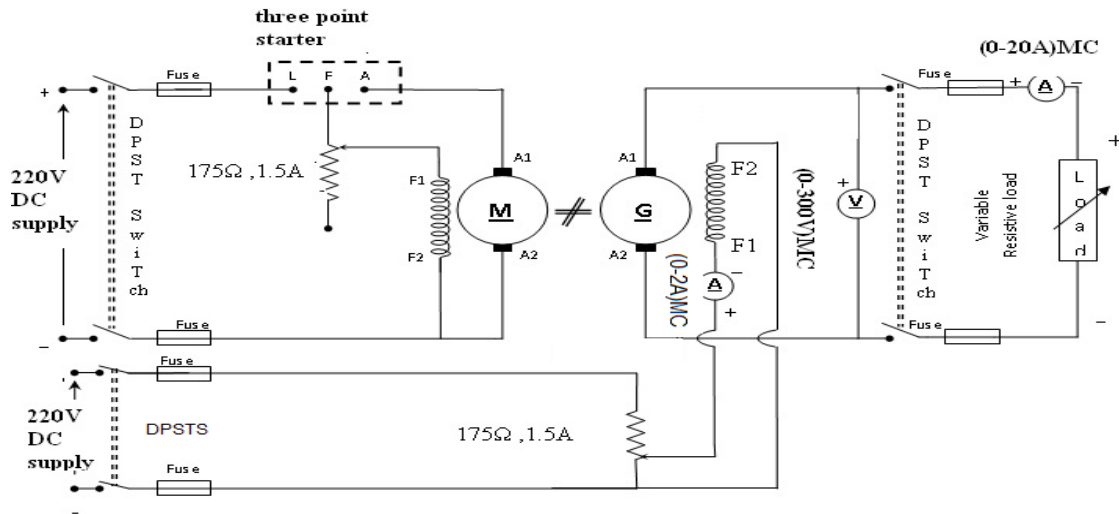
I_a = Armature Current in Amps, I_L =Line Current in Amps

I_f =Field Current in Amps, R_a =Armature Resistance in Ohms

PROCEDURE:

1. Connections are made as per the circuit diagram
2. Supply is given by closing the DPST Switch in the motor side.
3. Using the DC three point starter, start the motor.
4. The field rheostat of motor is adjusted to run the motor at rated speed.
5. The generator field rheostat is adjusted for the rated voltage.
6. The DPST switch in the generator side is closed. Increase the resistive load in steps of 1 Amps and note down the corresponding load current and terminal voltage values
7. Then the resistive load is gradually decreased and the DPST Switch on the generator side is open. Then the supply is switched off.
8. The generated voltage E_g is calculated by using the formulae as mentioned above and enters the values.

CIRCUIT DIAGRAM



Fuse rating: 125% of rated current

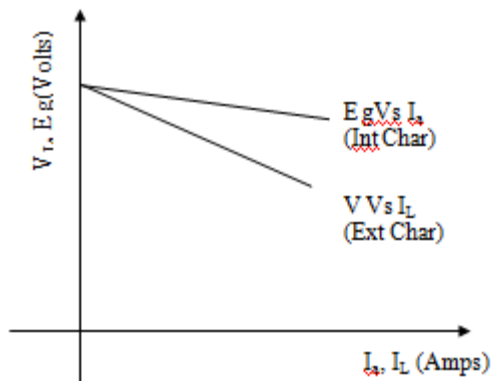
Name plate details

Machine	DC shunt motor	DC shunt Generator
Power		
Voltage		
Current		
Speed		
Field excitation		

TABULATION FOR LOAD TEST:

I_f Amps	I_L Amps	Terminal voltage (V_L) Volts	I_a (Amps)	$I_a R_a$ Volts	$E_g = V_L + I_a R_a$ Volts

LOAD CHARACTERISTICS CURVES



RESULT:

Thus the no load and load tests on a separately -excited DC shunt generator were conducted and the characteristics were obtained.

EXP.NO. 5**MEASUREMENT OF THREE PHASE POWER****AIM:**

To conduct load test on three phase resistive load to find real, reactive and apparent power

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-10A)	MI	1
2	Voltmeter	(0-600)V	MC	1
3	Wattmeter	600V, 10A	upf	2
4	Three phase auto transformer	(0-470V)		1
5	Connecting Wires		Copper	Few

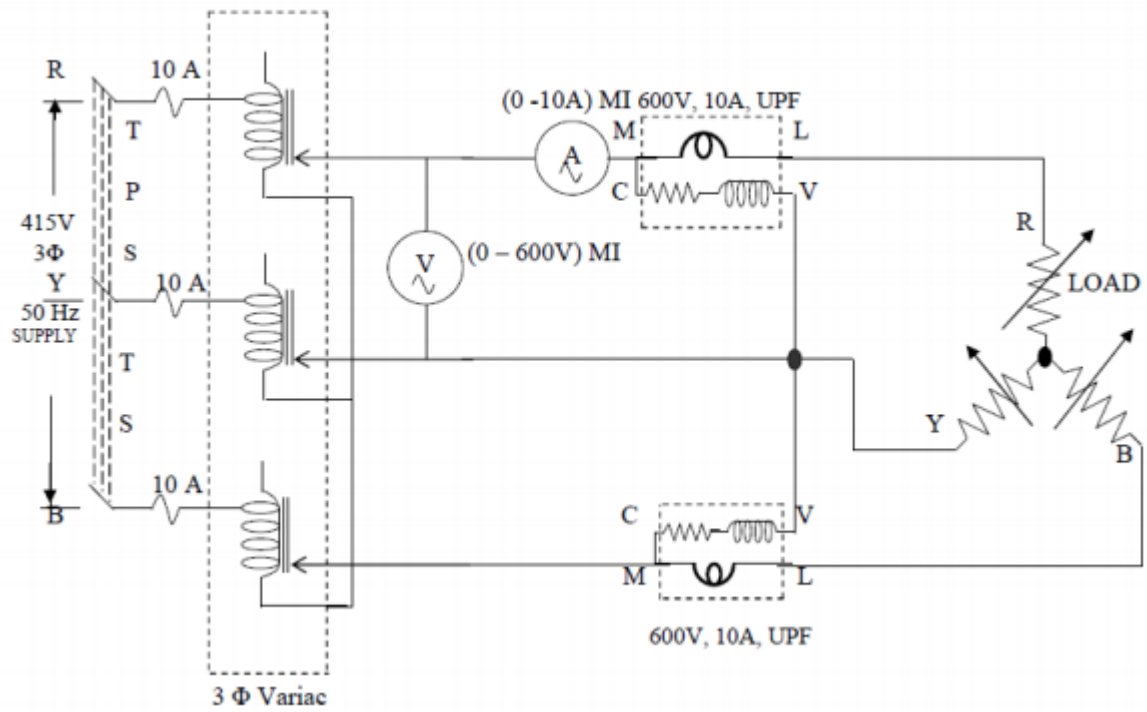
PRECAUTIONS:

1. The resistive load should be started without any load.
2. The supply should not be switched OFF before the resistive load is unloaded.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking the no load condition, and minimum auto transformer position, TPST switch is closed.
3. By adjusting the auto transformer apply the rated voltage of the resistive load. Ammeter, Voltmeter & wattmeter readings, are noted under no load condition.
4. The load is then added gradually and for each load, voltmeter, ammeter, wattmeter are noted up to 80 % of rated current
5. The resistive load is then brought to no load condition and auto transformer is to minimum position, then TPST switch is opened.

CIRCUIT DIAGRAM



FUSE RATNG:
125% of rated current

Name plare details

Power	Voltage	Current	Type

OBSERVATIONS:

S. No.	Line Voltage (V_L) in Volts	Load current (I_L) in Amps	Wattmeter readings		Real power P in Watts	Power factor $\cos \phi$	$\sin \phi$	Reactive power Q In VAR	Apparent power S in VA
			$W_1 \times MF$	$W_2 \times MF$					

FORMULAE:

The Real power $P = (W_1 + W_2)$ watts

Power factor $\cos \phi = P / (1.732 * V_L * I_L)$

$\sin \phi = (1 - \cos^2 \phi)^{1/2}$

Reactive power $Q = 1.732 * V_L * I_L * \sin \phi$ VAR

Apparent power $S = 1.732 * V_L * I_L$ VA

RESULT:

Thus load test on three phase resistive load was conducted and its real ,reactive and apparent power wens determined,

EXP.NO. 6

RTD

AIM

To study the characteristics of RTD

APPARATUS REQUIRED

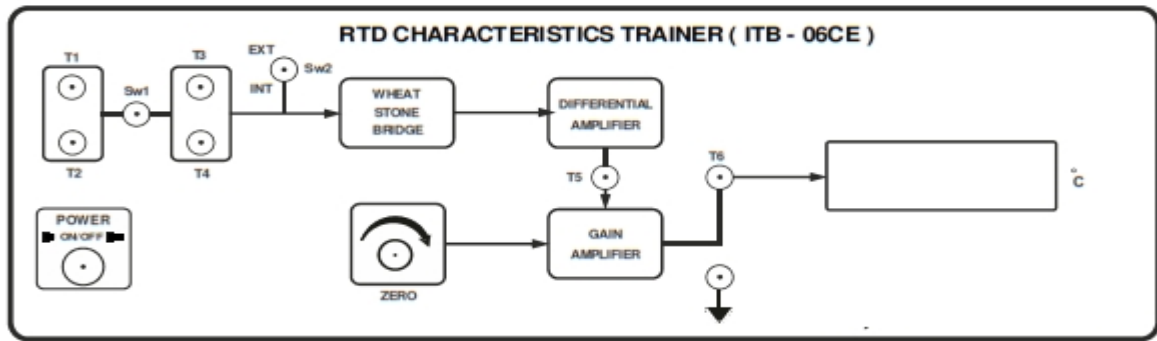
1. ITB-06CE
2. RTD sensor
3. Water Bath
4. Thermometer
5. Multimeter

PRECAUTIONS

1. Gradually heat the water and note the corresponding resistance simultaneously.
2. The multimeter / ohmmeter should be in the range (0-200)ohms to measure for (0-100)°C.

PROCEDURE

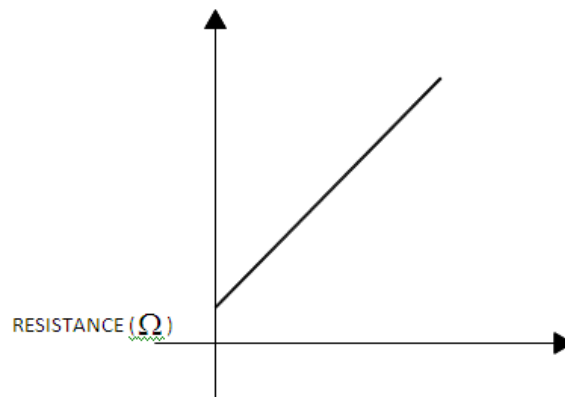
1. Patch the wires of RTD to the T1 and T2 terminal of the RTD input block and switch ON the unit.
2. Place the RTD and thermometer into the holes provides in the waterbath.
3. Keep the SW1 in right direction.
4. Place the multimeter in the resistance mode across T3 and T4 terminals.
5. Switch ON the water bath and note the temperature in thermometer and corresponding resistance value in multimeter.
6. Plot the temperature Vs resistance graph.



TABULATION:

Temperature (°C)	Resistance (Ohms)

MODEL GRAPH



RESULT

Thus the characteristics was studied and graph is studied.

EXP.NO. 7

THERMISTOR

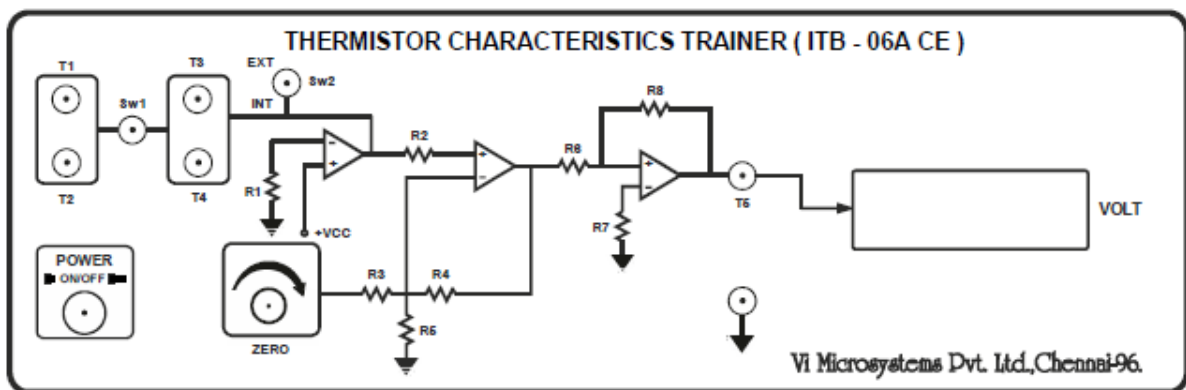
AIM

To study the characteristics of the thermistor.

APPARATUS REQUIRED

1. Thermistor characteristics trainer Unit.
2. Thermistor
3. PC Power Chord
4. Water bath
5. Thermometer

CIRCUIT DIAGRAM



THEORY

Thermistors (Thermal resistors) are generally composed of semi-conductor materials. Most Thermistors has a negative coefficient of temperature resistance, i.e., their resistance decreases with increase of temperature. The negative temperature coefficient of resistance can be as large as several percent per degree Celsius. This allows the Thermistors circuit to detect very small change in temperature, which could not be observed with a RTD or a thermocouple.

In some cases the resistance of Thermistors at room temperature may decrease as much as 5 percent for each 1°C rise in temperature. This high sensitivity of temperature change makes Thermistors extremely useful for precision temperature measurements control and compensation. Thermistors are widely used in applications which involve measurements in the range of -60°C to 150°C. The resistance of Thermistors ranges from 0.5Ω to 0.75MΩ. Thermistor is a highly sensitive device.

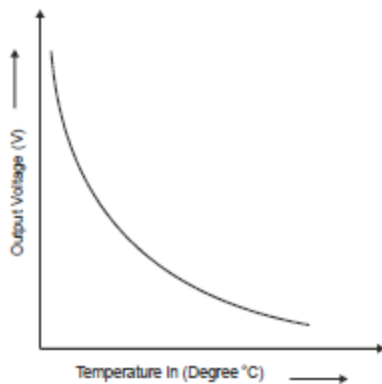
PROCEDURE

- * Connect the thermistor across T1 and T2 & switch ON the ITB-06A unit.
- * For resistance measurement, SW1 should be in Thermistor mode.
- * Connect the multimeter (in DC -Volt mode) across T5 & T6.
- * During zero calibration, SW2 should be in EXT mode.
- * The offset Potentiometer is adjusted to 5V. Because, thermistor is NTC type
- * Before conducting the experiment, SW2 should be in INT mode.
- * Insert the thermometer and thermistor into the water bath.
- * Switch ON the water bath.
- * Now note down the temperature of the thermometer and corresponding voltage output.
- * Plot the graph between temperature and resistance along X and Y axis respectively.

TABULATION:

S.No	Temperature ($^{\circ}\text{C}$)	Output voltage(V)

MODEL GRAPH



RESULT:

Thus, the characteristics of thermistor were studied.

EXP.NO. 8**VERIFICATION OF OHM'S LAW****AIM:**

To conduct a suitable experiment for verifying the ohm's law

APPARATUS REQUIRED:

S. NO.	NAME OF THE EQUIPMENT	RANGE	TYPE	QTY.
1	RPS	(0-30)V	DC	1
2	Ammeter	(0-10)mA	MC	1
3	Voltmeter	(0-10)V	MC	1
4	Resistor	1K Ω	-	1
5	Bread board	-	-	1
6	Connecting wires	-	Single strand	As required

THEORY:**OHM'S LAW:**

Ohm's law states that at constant temperature the current flow through a conductor is directly proportional to the potential difference between the two ends of the conductor.

$$I \propto V$$

Or $V \propto I$

$$V = IR$$

Where R is a constant and is called the resistance of the conductor.

PROCEDURE:

Connections are made as per the circuit diagram

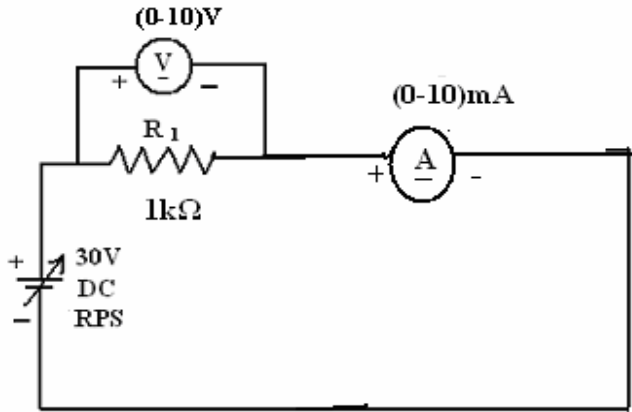
Switch on the power supply.

For various values of voltage V, note the values of current I.

Draw a graph of Voltage Vs Current.

The Slope of the graph gives the resistance value.

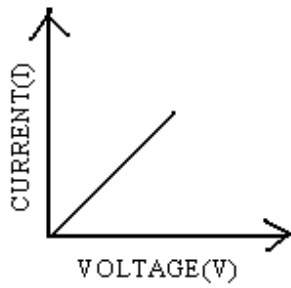
CIRCUIT DIAGRAM



TABULATION:

S.No	Voltage in volts	Current in mA

MODEL GRAPH.



RESULT:

Thus the Ohm's law for the given circuit is verified.

EXP.NO.9

KIRCHOFF'S VOLTAGE LAW

AIM:

To verify the Kirchoff's Voltage Law (KVL) for the given circuit.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Range	Type	Quantity
1	RPS	(0-30)V	-	1
2	Resistor	1K Ω	Fixed	1 each
3	Voltmeter	(0-10)V	MC	3
4	Bread board	-	-	1
5	Connecting wires	-	-	As Required

FORMULA USED:

1. OHM'S LAW:

$$V=IR$$

Where, V = Voltage in Volts
I = Current in Amperes
R = Resister in Ohms

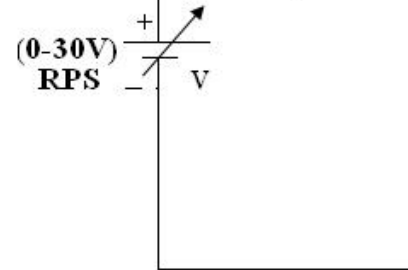
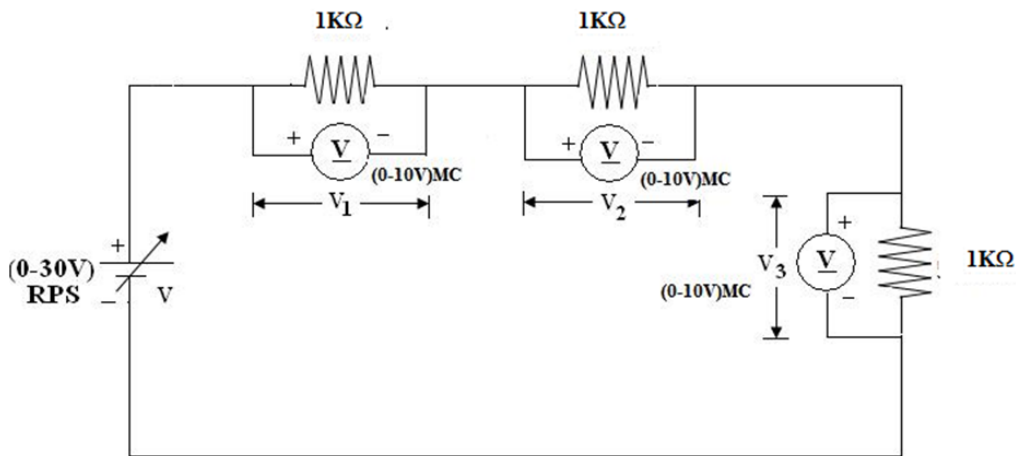
THEORY:

KIRCHOFF'S VOLTAGE LAW:

It states that the algebraic sum of all the voltages in a closed loop is equal to zero.

$$\sum V = 0$$

CIRCUIT DIAGRAM FOR KIRCHHOFF'S VOLTAGE LAW



PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Switch on the supply.
3. Set different values of voltages in the RPS.
4. Measure the corresponding values of voltages (V_1 , V_2 and V_3) across resistors R_1 , R_2 and R_3 respectively.
5. Enter the readings in the tabular column.
6. Find the theoretical values and compare with the practical values.

Calculation:

$$R_{tot} = 1000 + 1000 + 1000 = 3000 \text{ ohms}$$

$$I = V / R_{tot}$$

$$\text{for } V = 3V$$

$$I = 3 / 3000 = 0.001A$$

$$V_1 = I * R_1 = (0.001 * 1000) = 1V$$

$$V_2 = I * R_2 = (0.001 * 1000) = 1V$$

$$V_3 = I * R_3 = (0.001 * 1000) = 1V$$

$$V = V_1 + V_2 + V_3 = 1 + 1 + 1 = 3 \text{ Volts}$$

Tabulation:

		Theoretical			Practical			
S. No.	V Volts	V ₁ Volts	V ₂ Volts	V ₃ Volts	V ₁ Volts	V ₂ Volts	V ₃ Volts	V = V ₁ + V ₂ + V ₃ Volts
1								
2								
3								
4								
5								

RESULT:

Thus the Kirchoff's Voltage Law (KVL) for the given circuit is verified.

KIRCHOFF'S CURRENT LAW

EX. NO: 9(b)

AIM:

To verify the Kirchoff's Current Law (KCL) for the given circuit.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Range	Type	Quantity
1	RPS	(0-30)V	-	1
2	Resistor	1K Ω	Fixed	1 each
3	Ammeter	(0-20)mA, (0-10)mA, (0-15)mA	MC	1 each
5	Bread board	-	-	1
6	Connecting wires	-	-	As Required

FORMULA USED:

OHM'S LAW:

$$V = IR$$

Where, V = Voltage in Volts
 I = Current in Amperes
 R = Resister in Ohms

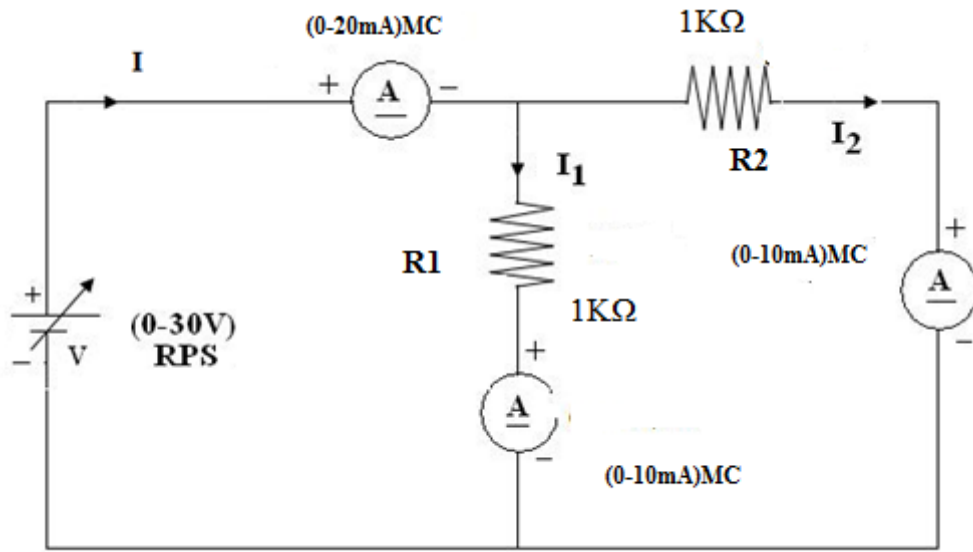
THEORY:

KIRCHOFF'S CURRENT LAW:

It states that the algebraic sum of the currents meeting at a node is equal to zero.

$$\sum \text{Current flow towards the node} = \sum \text{Current flow away from the node}$$

CIRCUIT DIAGRAM FOR KIRCHHOFF'S CURRENT LAW



Tabulation:

S.No	V (Volts)	Theoretical			Practical		
		I ₁ (mA)	I ₂ (mA)	I = I ₁ + I ₂ (mA)	I ₁ (mA)	I ₂ (mA)	I = I ₁ + I ₂ (mA)
1							
2							
3							
4							
5							
6							

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Switch on the supply.
3. Set different values of voltages in the RPS.
4. Measure the corresponding values of branch currents I_1 , I_2 and I .
5. Enter the readings in the tabular column.

Find the theoretical values and compare with the practical values

Model Calculations

$$\begin{aligned}R \text{ Total} = R1 \parallel R2 &= (R1 * R2) / (R1 + R2) \\ &= (1000 * 1000) / (1000 + 1000) \\ &= 500 \text{ ohms}\end{aligned}$$

$$I = V / R_{\text{total}}$$

(for $V = 1\text{V}$)

$$I = 1 / 500 = 2\text{mA}$$

$$I1 = I * (R2) / (R1 + R2)$$

$$= 2\text{m} * (1000 / 2000) = 1\text{mA}$$

$$I2 = I * (R1) / (R1 + R2)$$

$$= 2\text{m} * (1000 / 2000) = 1\text{mA}$$

$$I = I1 + I2 = 1 + 1 = 2\text{mA}$$

RESULT:

Thus the Kirchoff's Current Law (KCL) for the given circuit is verified.

SUPERPOSITION THEOREM

EX. NO: 10

AIM:

To verify the superposition theorem for the given circuit.

APPARATUS REQUIRED:

S.NO	APPARATUS	TYPE	RANGE	QUANTITY
1	RPS	DC	(0-30)V	2
2	Resistor	-	1K Ω	3
3	Ammeter	DC	(0-10)mA	1
4	Bread board	-	-	1
5	Connecting wires	-	-	Few

THEORY:

SUPERPOSITION THEOREM:

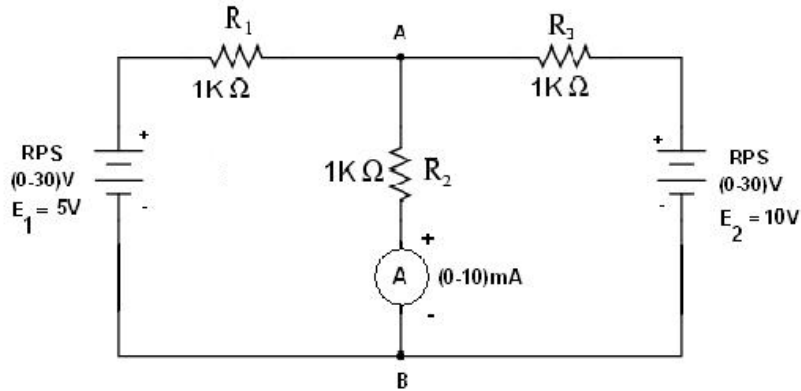
The superposition theorem for electrical circuits states that the total current in any branch of a bilateral linear circuit equals the algebraic sum of the currents produced by each source acting separately throughout the circuit.

To ascertain the contribution of each individual source, all of the other sources first must be "killed" (set to zero) by:

1. replacing all other voltage sources with a short circuit (thereby eliminating difference of potential. i.e. $V=0$)
2. replacing all other current sources with an open circuit (thereby eliminating current. i.e. $I=0$)

This procedure is followed for each source in turn, and then the resultant currents are added to determine the true operation of the circuit. The resultant circuit operation is the superposition of the various voltage and current sources.

Circuit Diagram for Superposition Theorem



By inspection
method

$$2000I_1 - 1000I_2 = 5 \dots (1)$$

$$-1000I_1 + 2000I_2 = 10 \dots (2)$$

Solving equations (1) & (2)

$$I_1 = 0 \text{ mA}$$

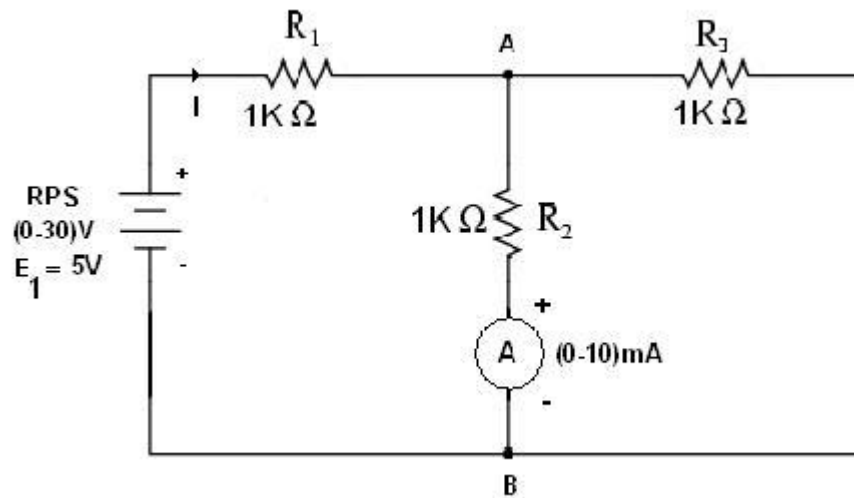
$$I_2 = -5 \text{ mA}$$

$$I_{ab} = I_1 - I_2 = 5 \text{ mA}$$

Table:

S.No	E ₁ voltage(Volts)	E ₂ voltage(Volts)	Load current across the branch AB (mA)	
			Theoretical	Practical
1	5	10	5mA	

E₁ SOURCE IS ACTING:



CALCULATION:

$$R_1 = 1\text{Kohm} ; R_2 = 1\text{Kohm}; R_3 = 1\text{Kohm}$$

$$R_T = R_1 + R_P$$

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

$$= 1.5\text{Kohm}$$

$$I = \frac{V}{R_T}$$

for V=5V
 $I = (5/1.5\text{K}) = 3.33\text{mA}$

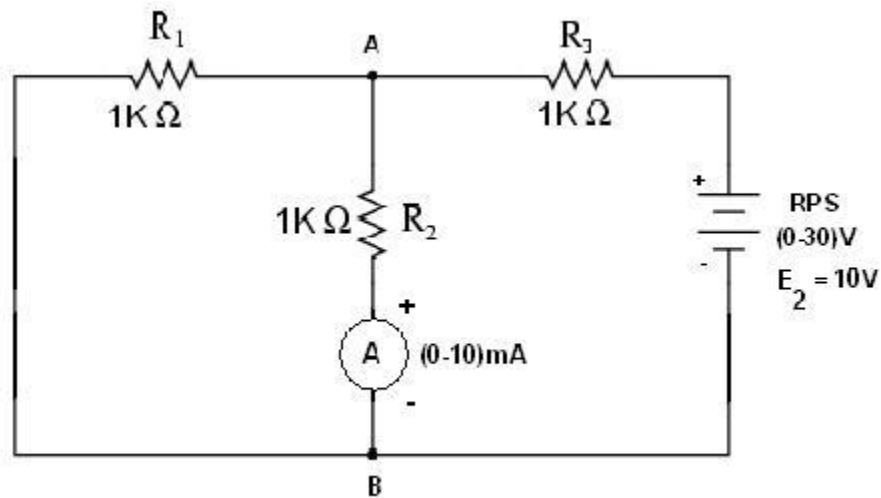
$$I_{AB1} = I \times \frac{R_3}{R_2 + R_3} = 3.3 \times 10^{-3} \times \frac{1000}{1000 + 1000}$$

$$= 1.667\text{mAmps}$$

Table:

S.No	E ₁ voltage(Volts)	Load current across the branch AB (mA)	
		Theoretical	Practical
1	5	1.667mA	

E₂ SOURCE IS ACTING:



CALCULATION:

$$R_1 = 1\text{Kohm} ; R_2 = 1\text{Kohm} ; R_3 = 1\text{Kohm}$$

$$R_T = R_3 + R_p$$

$$= R_3 + \frac{R_2 R_1}{R_1 + R_2} = 1.5\text{Kohms}$$

$$I = \frac{V}{R_T}$$

for $V = 10\text{V}$, $I = 10/1.5\text{K} = 6.67\text{mA}$

$$I_{AB2} = I \times \frac{R_3}{R_2 + R_3} = 6.66 \times 10^{-3} \times \frac{1000}{1000 + 1000} = 3.33\text{mA}$$

Table:

S.No	E ₂ voltage(Volts)	Load current across the branch AB (mA)	
		Theoretical	Practical
1	10	3.33mA	

E₁ and E₂ SOURCES ARE ACTING:

$$I_{AB} = I_{AB1} + I_{AB2}$$

RESULT:

Thus the superposition theorem for the given circuit is verified.

THEVENIN'S THEOREM

EX. NO: 11

AIM:

To verify the Thevenin's theorem for the given circuit.

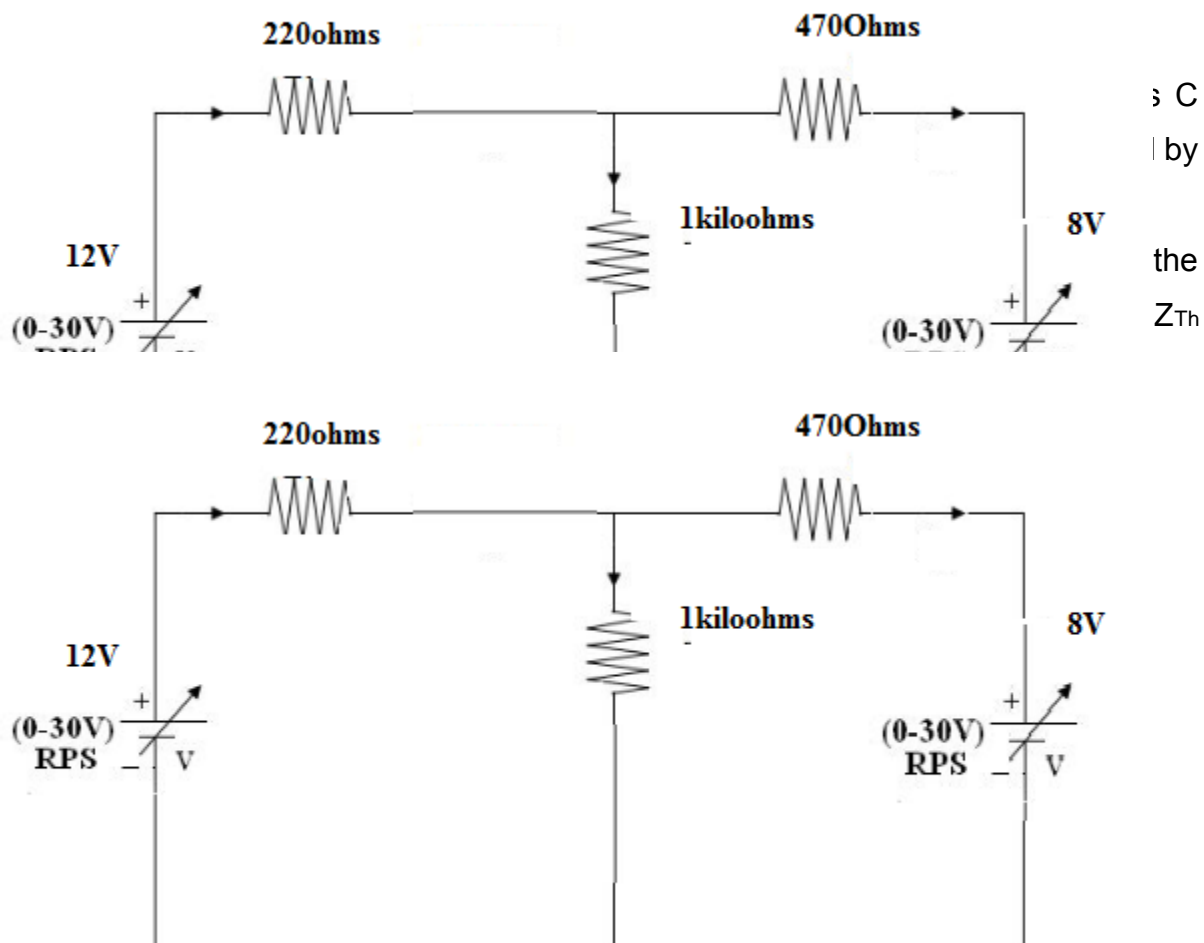
APPARATUS REQUIRED:

S.NO	APPARATUS	TYPE	RANGE	QUANTITY
1	RPS	DC	(0-30)V	1
2	Resistor	-	1KΩ	3
3	Ammeter	DC	(0-10)mA	1
4	Bread board	-	-	1
5	Connecting wires	-	-	Few

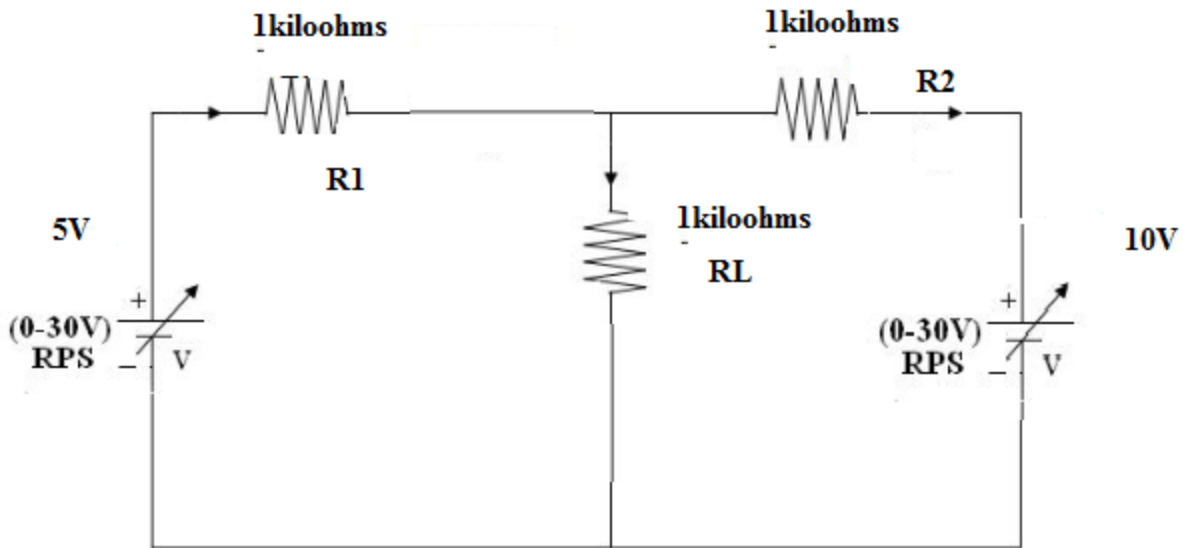
THEORY:

THEVENIN'S THEOREM:

Any linear active network with output terminals C and D can be replaced

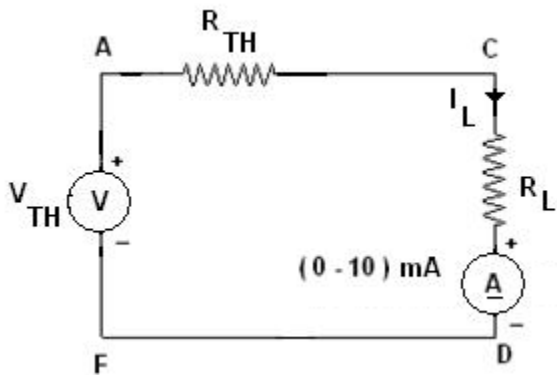


Using Thevenin's theorems find the current in load resistance



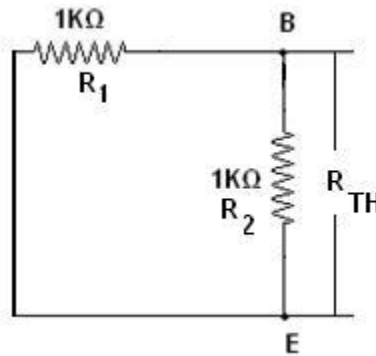
CALCULATION:

The Thevenin's equivalent circuit is,



$$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

To Find R_{TH} :

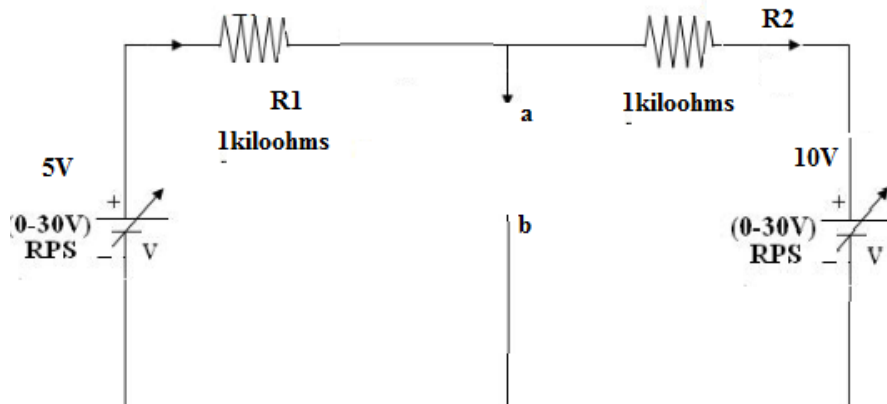


$$R_1 = 1\text{Kohm} ; R_2 = 1\text{Kohm};$$

$$R_{TH} = \frac{R_1 * R_2}{R_1 + R_2}$$

$$= 0.5\text{kohm}$$

To find V_{th}



By applying KVL,

$$5 - 10 = 2000I$$

$$-5 = 2000I$$

$$I = (-5/2000) = 2.5\text{mA}$$

$$V_o = V_{th} = V - IR_1$$

$$= 5 - (-2.5\text{m} * 1\text{K})$$

$$= 7.5\text{V}$$

$$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

$$= 2.5 / (1 + 0.5) = 5\text{mA}$$

PROCEDURE:

1. The circuit connections are given as per the circuit diagram.
2. Switch ON the power supply.
3. Initially set 5V and 10 V as input voltage from RPS.
4. The ammeter reading is noted and the load current value is tabulated.
5. With the help of multi meter find the thevenin's resistance (R_{Th})
6. Remove the load resistance in the given circuit, then find the value of the thevenin's voltage (V_{Th})
7. Calculate the value of load current using R_{th} & V_{Th} . Compare the result with the theoretical

Table:

V1 (Volts)	V2 (Volts)	Load Current in Amps	
		Theoretical value	Practical value

RESULT:

Thus the Thevenin's theorem for the given circuit is verified successfully.

NORTON'S THEOREM

EX. NO: 12

AIM:

To verify the Norton's theorem for the given circuit.

APPARATUS REQUIRED:

S.NO	APPARATUS	TYPE	RANGE	QUANTITY
1	RPS	DC	(0-30)V	1
2	Resistor	-	1K Ω	3
3	Ammeter	DC	(0-10)mA	1
4	Bread board	-	-	1
5	Connecting wires	-	-	Few

THEORY:

NORTON'S THEOREM:

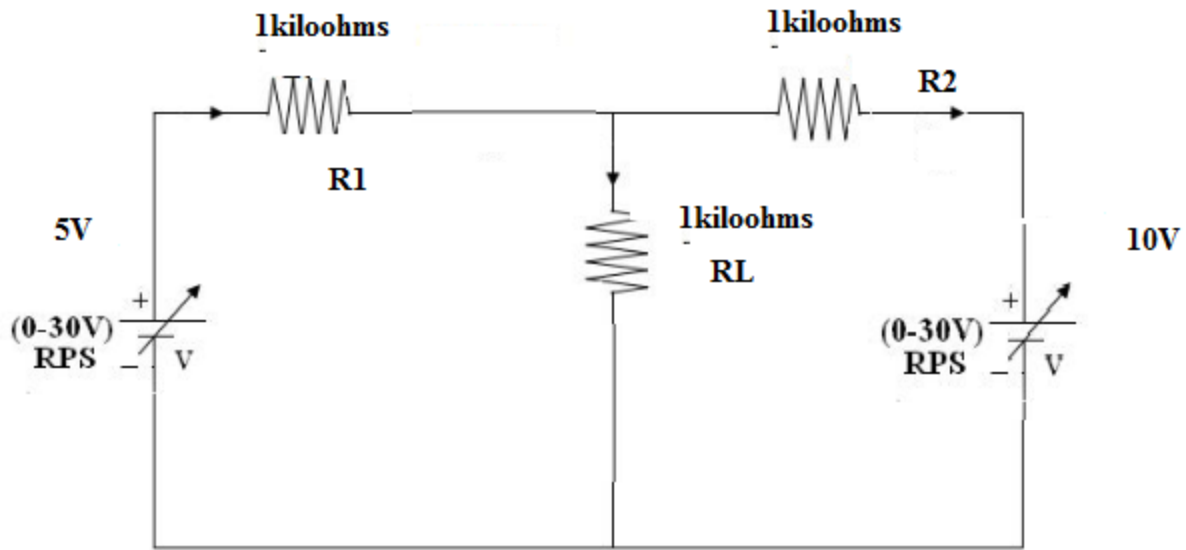
Any linear active network with output terminals C and D can be replaced by a single current source $I_{sc}(I_N)$ in parallel with a single impedance ($Z_{Th} = Z_n$).

I_{sc} is the current through the terminals C and D on short circuit condition.

Z_{Th} is called Thevenin's impedance. In case of DC Z_{Th} is replaced by R_{Th} .

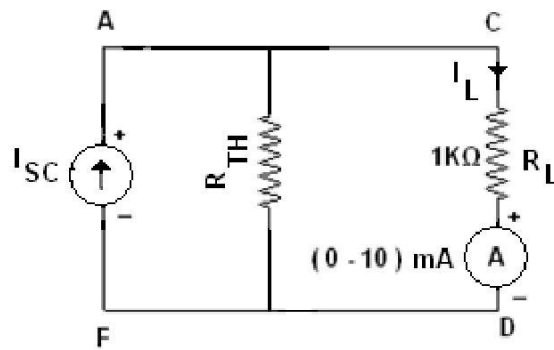
The current through impedance connected to the terminals of the Norton's equivalent circuit must have the same direction as the current through the same impedance connected to the original active network.

Using Norton's theorems find the current in load resistance



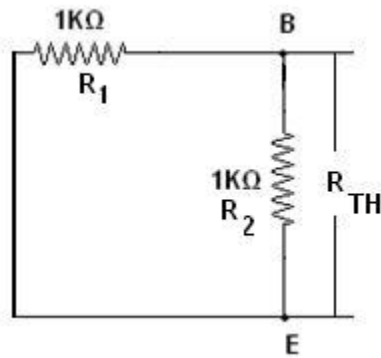
CALCULATION:

The Norton's equivalent circuit is,



$$I_L = \frac{I_{SC} R_{TH}}{R_{TH} + R_L}$$

To Find R_{TH} :

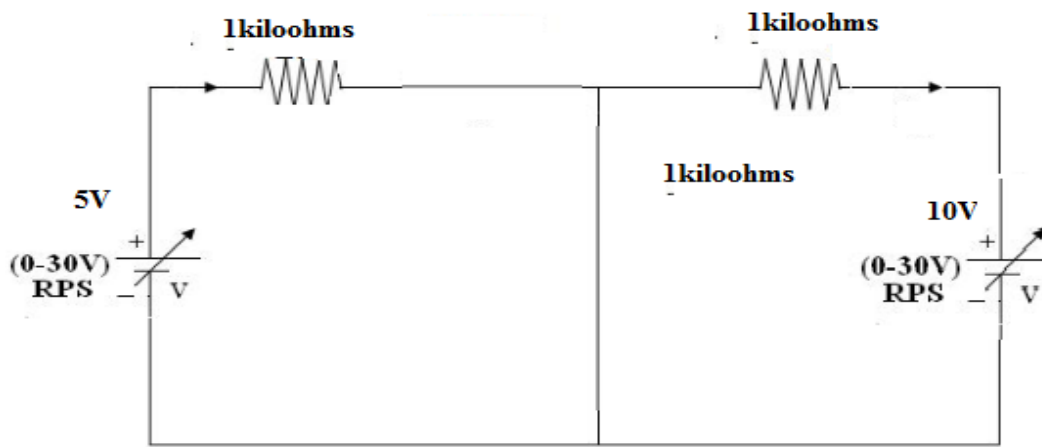


$$R_1 = 1\text{Kohm} ; R_2 = 1\text{Kohm};$$

$$R_{TH} = \frac{R_1 * R_2}{R_1 + R_2}$$

$$= 0.5\text{Kohm}$$

To Find I_{sc} :



$$I_1 = V_1 / R_1 = 5 / 1K = 5\text{mA}$$

$$I_2 = V_2 / R_2 = 10 / 1K = 10\text{mA}$$

$$I_{sc} = I_N = I_1 + I_2 = 15\text{mA}$$

$$I_L = I_N * (R_{th}) / (R_{th} + R_L)$$

$$= 15\text{mA} * (0.5) / (1.5) = 5\text{mA}$$

PROCEDURE:

1. The circuit connections are given as per the circuit diagram.
2. Switch ON the power supply.
3. Initially set 5V and 10 Vas input voltage from RPS.
4. The ammeter reading is noted and the load current value is tabulated.
5. With the help of multi meter find the thevenin's resistance (R_{Th})
6. Remove the load resistance in the given circuit, then find the value of the Norton's current (I_N)
8. Calculate the value of load current using R_{th} & I_N . Compare the result with the theoretical

Table:

	I_N	I_L
Theoretical		
Practical		

RESULT:

Thus the Norton's theorem for the given circuit is verified successfully.

EX. NO: 13

MAXIMUM POWER TRANSFER THEOREM

AIM:

To verify the maximum power transfer theorem for the given circuit.

APPARATUS REQUIRED:

S.NO	APPARATUS	TYPE	RANGE	QUANTITY
1	RPS	DC	(0-30)V	1
2	Resistor	-	1K Ω	2
3	Variable Resistor		1K Ω	1
4	Ammeter	DC	(0-10)mA	1
5	Bread board	-	-	1
6	Connecting wires	-	-	Few

THEORY:

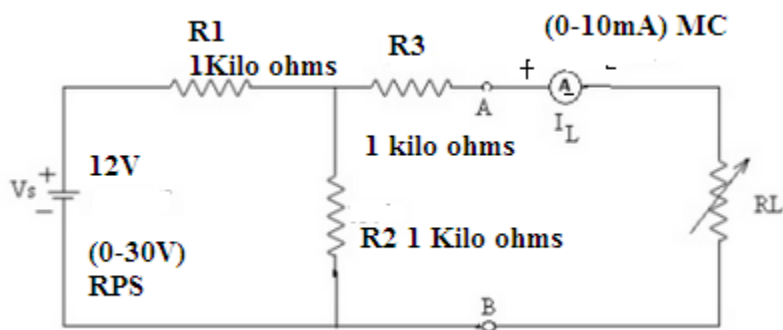
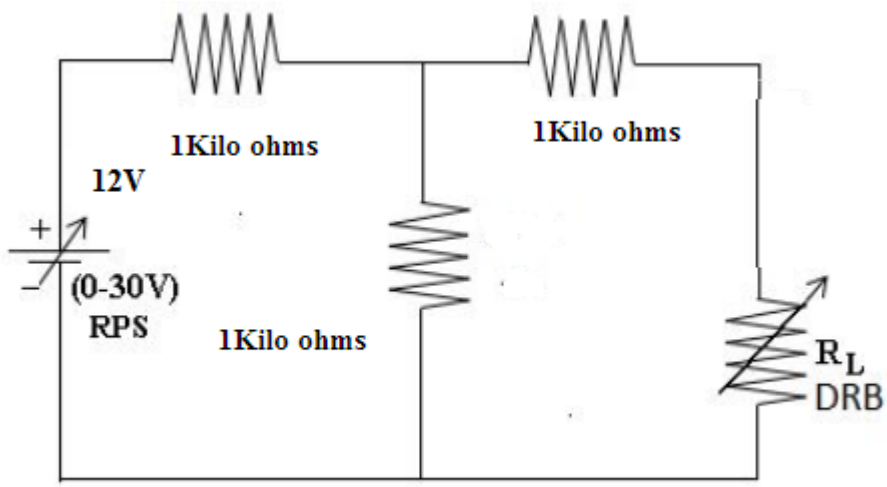
MAXIMUM POWER TRANSFER THEOREM:

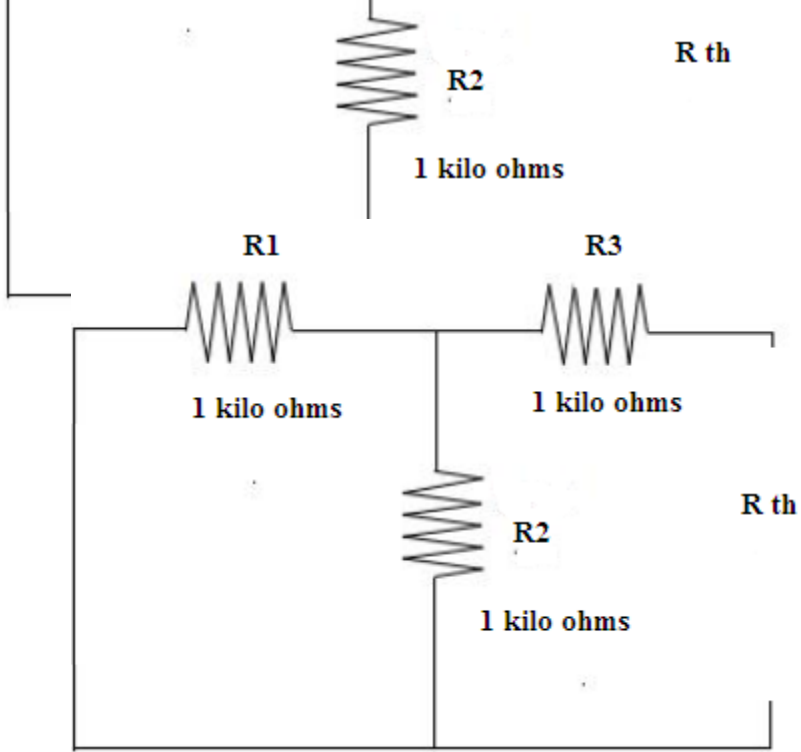
In electrical engineering, the **maximum power (transfer) theorem** states that, to obtain maximum external power from a source to a load with a finite internal resistance, the resistance of the load must be made the same as that of the source.

The theorem applies to maximum power, and not maximum efficiency. If the resistance of the load is made larger than the resistance of the source, then efficiency is higher, since most of the power is generated in the load, but the overall power is lower since the total circuit resistance goes up.

If the internal impedance is made larger than the load then most of the power ends up being dissipated in the source, and although the total power dissipated is higher, due to a lower circuit resistance, it turns out that the amount dissipated in the load is reduced.

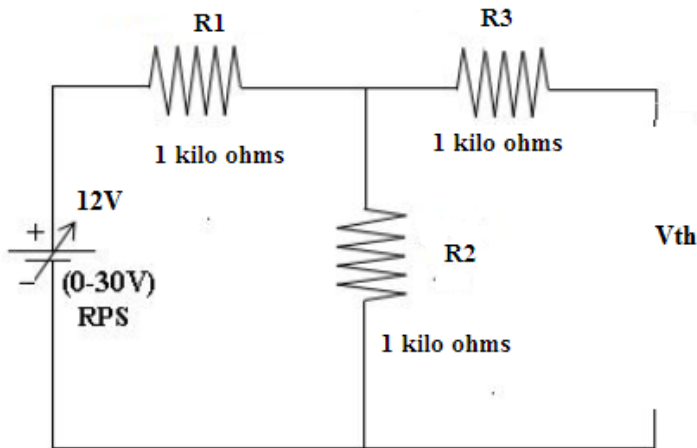
Circuit Diagram for Maximum Power Transfer Theorem





$$\begin{aligned}
 R_{th} &= R_3 + (R_1 \parallel R_2) \\
 &= 1K + (1K \parallel 1K) \\
 &= 1K + 500 \\
 &= 1.5K \text{ ohms}
 \end{aligned}$$

To Find V_{TH}:



$$\begin{aligned}
 V_{th} &= V_{R2} = V * (R_2) / (R_1 + R_2) \\
 &= 12 * (1K) / (1K + 1K) \\
 &= 12 * (1K / 2K) \\
 &= 6 \text{ volts}
 \end{aligned}$$

Load current $I_L = V_{th} / (R_{th} + R_L)$

Power $P_L = I_L^2 * R_L$

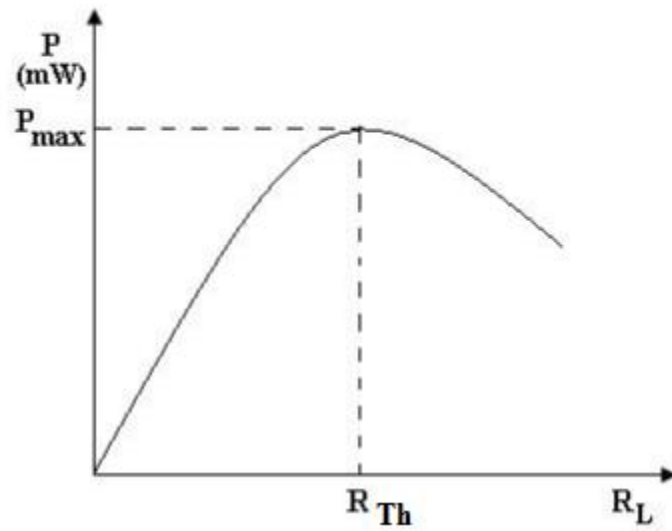
PROCEDURE:

1. The circuit connections are given as per the circuit diagram.
2. Switch ON the power supply.
3. Initially set 12V as input voltage from RPS.
4. The ammeter reading is noted for various values of load resistance and the values are tabulated.
5. For the value of load resistance, find for the power and the values are tabulated.
6. With the help of multi meter find the thevenin's resistance (R_{Th})
7. Remove the load resistance in the given circuit, then find the value of the thevenin's voltage (V_{Th})
8. Calculate the value of load current using R_{th} & V_{Th} . Compare the result with the theoretical.

Tabulation:

	Theoretical		Practical	
	Load current(I_L) in amps	Power in watts	Load current (I_L) in amps	Power in watts
Load Resistance (R_L) in ohms				
300				
600				
900				
1000				
1200				
1500				
1800				
2000				

MODEL GRAPH



RESULT:

Thus the maximum power transfer theorem for the given circuit is verified successfully.

Expt No.14

STUDY OF CRO AND MEASUREMENT OF AC SIGNALS

AIM:- To study block wise construction of Cathode ray Oscilloscope

THEORY:-

The Cathode Ray Oscilloscope is probably the most versatile tool for deployment of electronic circuit and system. The CRO allow the amplitude of the electronic signals where they are voltage, current or power to be displayed as a function of time. The CRO depends on the moments of an electron beam which is being bombarded (impinged) on a screen coated with a fluorescent produce a visual spot. If the electron is being deflected along the conventional axes, i.e. x-axis & y-axis, two different displays are produced.

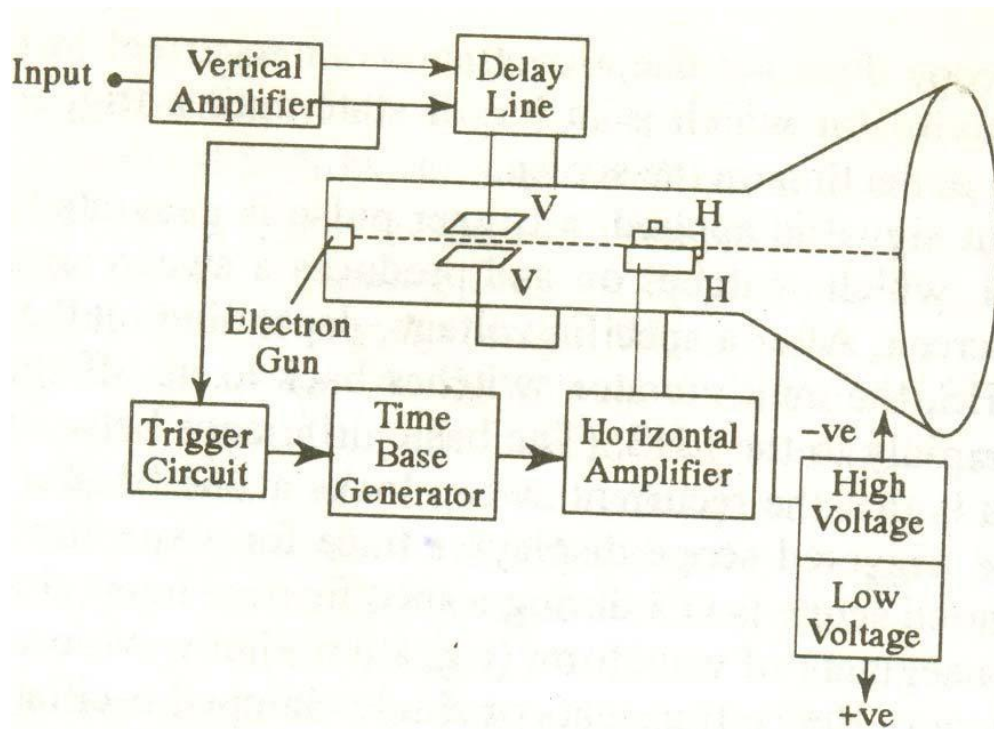


Fig:1 Block Diagram of CRO

Main parts of CRO-

CRT: - This is cathode ray tube in which electron beam strikes the screen internally to provide visual display of signal.

VERTICAL AMPLIFIER:- This is a wide band amplifier used to amplify signal in the vertical section of the signal.

DELAY LINE: – It is used to delay signal for sometime in the vertical section.

TIME BASE: – It is used to generate sawtooth voltage which it is applied to Horizontal deflection plates.

HORIZONTAL AMPLIFIER: - This is used to amplify the sawtooth voltage before it is applied to horizontal deflection plates.

TRIGGER CIRCUIT: - This is used to convert the incoming signal into trigger pulse so that the input signal and the sweep frequency can be synchronized.

POWER SUPPLY: – There are two power supplies, A negative high voltage (HV). supply and a +ve low voltage supply (LV). . The +ve voltage supply is from +300V to 400V, the negative voltage supply is from -1000V to -1500V.

Front panel controls

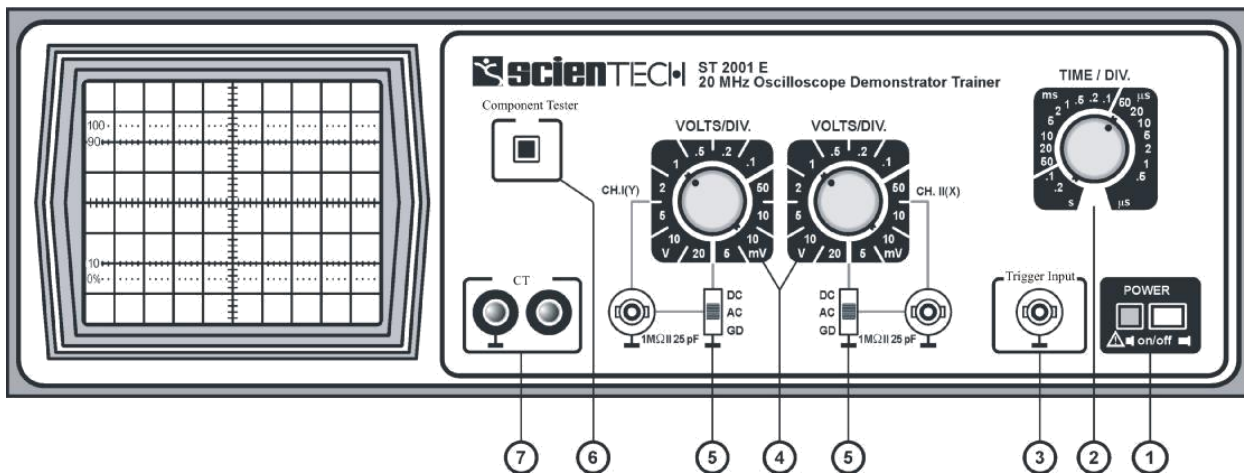


Fig:2 Front Panel of CRO

- (1) **Power 'On/Off'** : Turns 'On' & 'Off'. LED indicates power 'On'. Use position & Int/Focus controls to get the beam. All are push buttons.
- (2) **Time / Div** : Rotary Switch for TB speed control.
- (3) **Trigger Input** : For feeding external trigger signal.
- (4) **Volts/Div** : For sensitivity selection of CH 1 & CH 2.
- (5) **DC-AC-Gnd** : Switch provided for Input coupling. BNC inputs provided for connecting the Input signal.
- (6) **Component Tester** : Switch when pressed converts scope into Component Tester mode.
- (7) **CT** : Input & Gnd terminals to be used for CT.

Controls on PCB

- (1) **Intensity** : Controls the brightness
- (2) **Focus** : Controls the sharpness
- (3) **Trace Rotation** : Controls the horizontal alignment of the trace.
- (4) **X Pos** : Controls the horizontal position
- (5) **Y Pos I & II** : Controls vertical position of the trace.
- (6) **X Y** : When pressed cuts-off internal TB & connects external horizontal signal via. CH II
- (7) **X 5** : When pressed gives 5 times magnification.
- (8) **External** : When pressed allows ext. trigger.

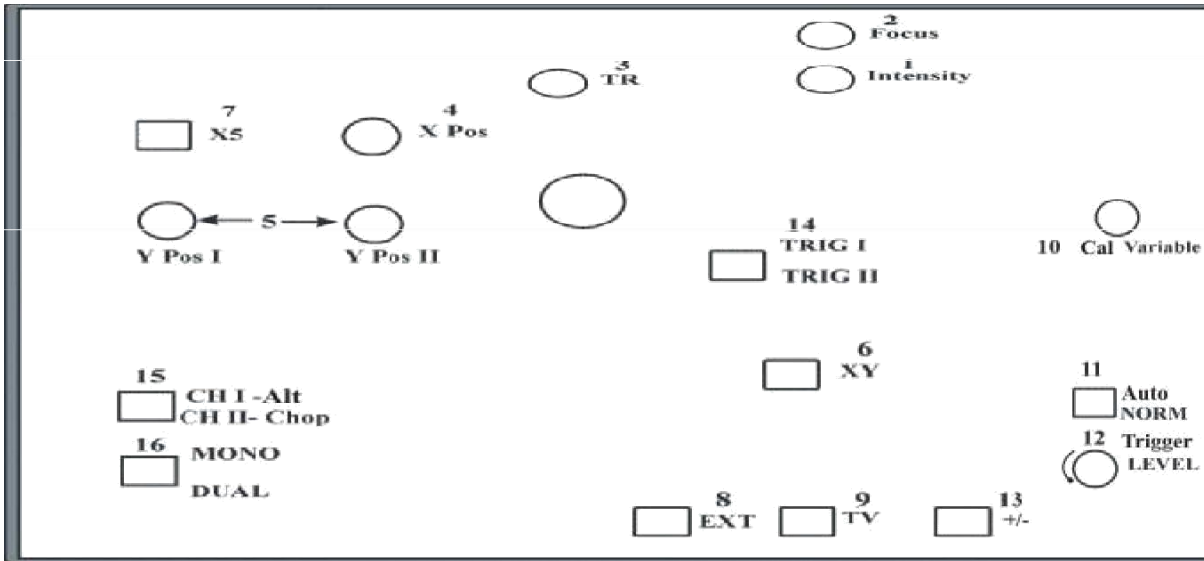


Fig:3 Controls on PCB

- (9) **TV** : When pressed allows TV frame to be synchronized.
- (10) **Cal Variable** : Controls the time speed in between the steps.
- (11) **Auto/ Norm** : In AT gives display of trace & auto trigger. When pressed becomes normal & gives variable level trigger.
- (12) **Level** : Controls the trigger level from positive peak to negative peak.
- (13) **+ / -** : Selects the slope of triggering.
- (14) **Trig 1/ Trig 2** : When out triggers CH I and when pressed triggers CH II
- (15) **CH I Alt/** : When out selects CH I and when pressed selects CH II. When dual switch also pressed this selects Alt or Chop modes.
- (16) **Mono / Dual** : When out, selects CH I only. When pressed selects both.

Amplitude Measurements :

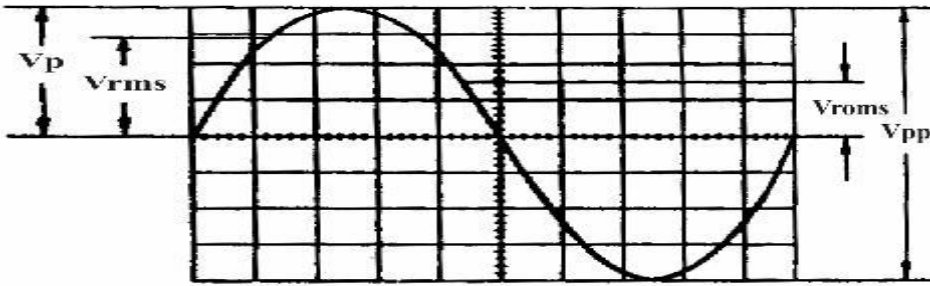


Fig:4 Amplitude measurement using CRO

V_{rms} = effective value

V_p = simple peak or crest value

V_{pp} = peak-to-peak value

V_{mom} = momentary value.

Frequency measurement

T = time in seconds for one period

F = recurrence frequency in Hz of the signals,

$F = 1/T,$

$T_{tot} = 1.6 \text{ cm} \times 0.5 \text{ s/cm} : 5 = 160\text{ns}$

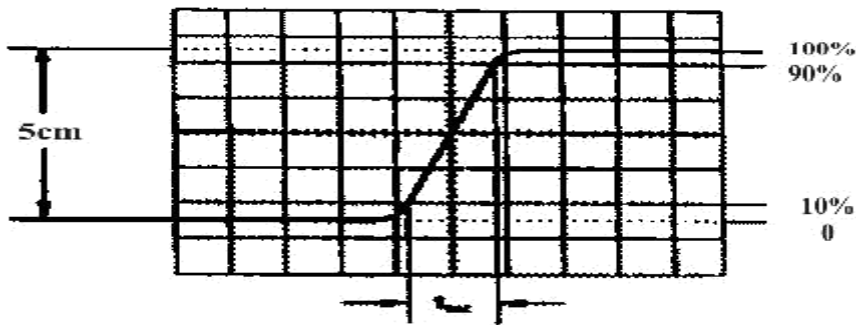


Fig:5 Frequency measurement using CRO

Phase Measurement

$\sin q = a/b$

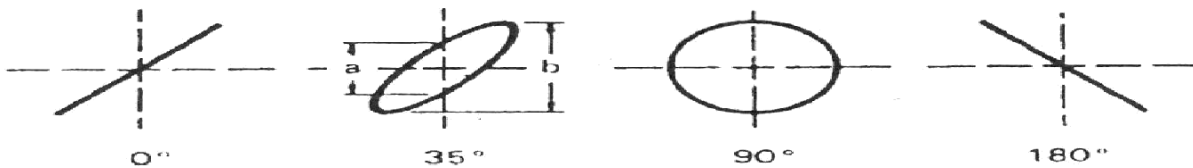


Fig: 6 Phase measurement using CRO

Result:

Thus the block wise construction of Cathode ray Oscilloscope was studied

DIODE BASED APPLICATION CIRCUIT

AIM:

To construct the biased positive & negative Clipper circuits using diodes.

APPARATUS REQUIRED:

S. NO.	APPARATUS REQUIRED	RANGE	QUANTITY
1.	RPS	(0 – 30) V	1
2.	Diode	1N4001	1
3.	Resistor	10 Kohm	1
4.	CRO	0-20 MHZ-	1
5.	Function generator(FGR)	--	1
6.	Bread Board	--	1
7.	Connecting Wires	--	1 Set

PROCEDURE:

Connections are made as shown in fig.

Power supply is switched ON.

Using Function Generator we can vary the frequency and fixed at particular frequency.

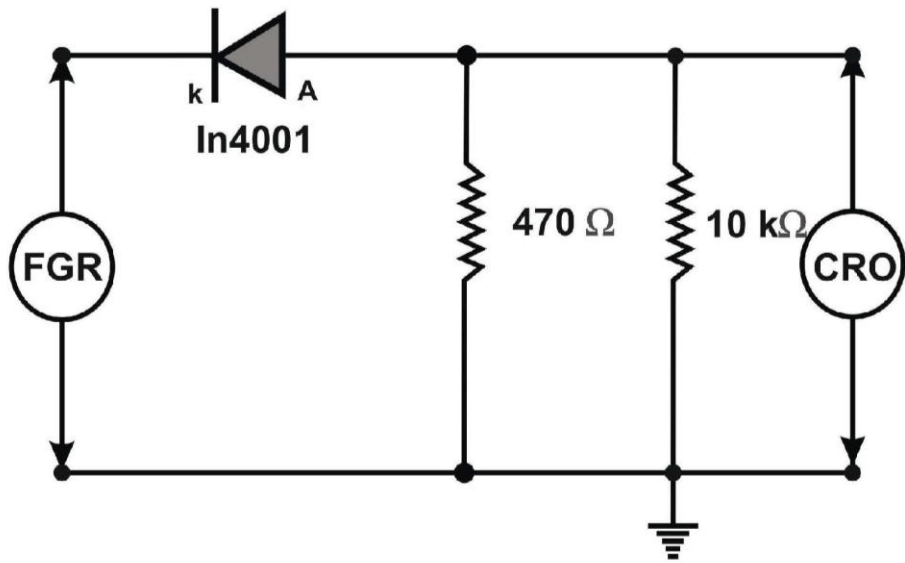
Now the corresponding input and output waveforms are drawn.

Amplitude and time, input & output waveforms are drawn.

And graph is drawn for input and output waveform.

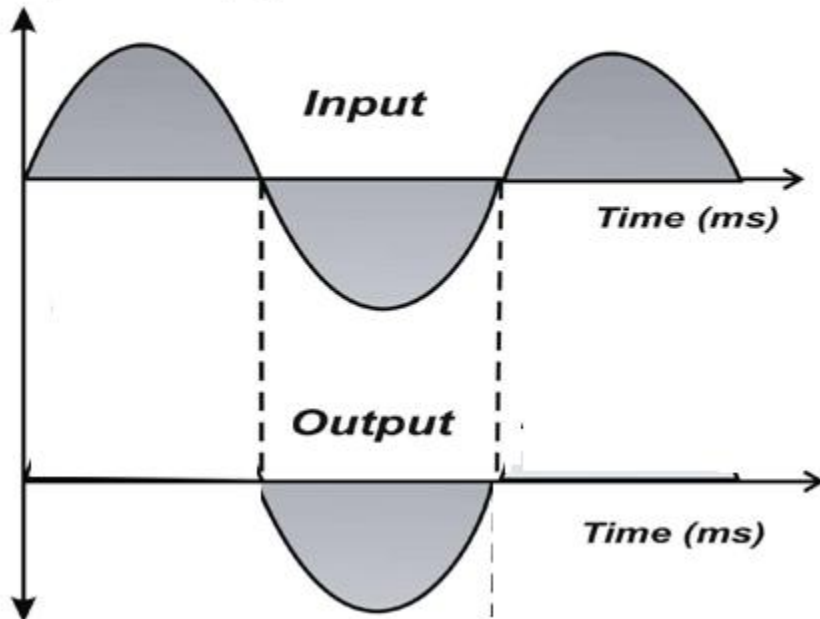
Power supply is switched OFF

CIRCUIT DIAGRAM
POSITIVE CLIPPER

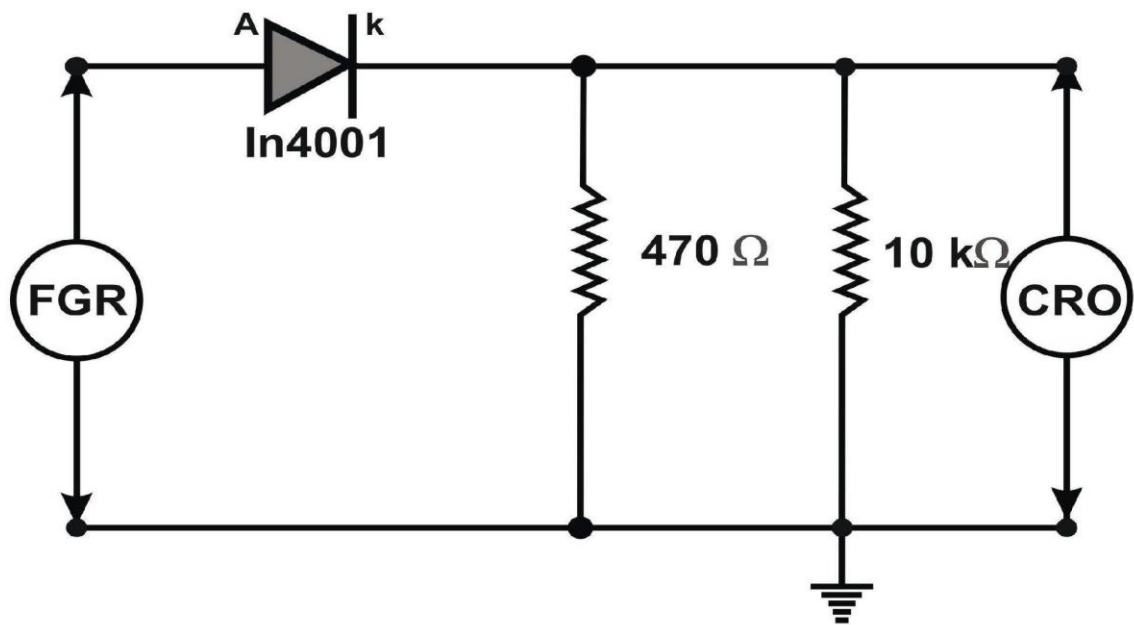


Model Graph

Amplitude (v)

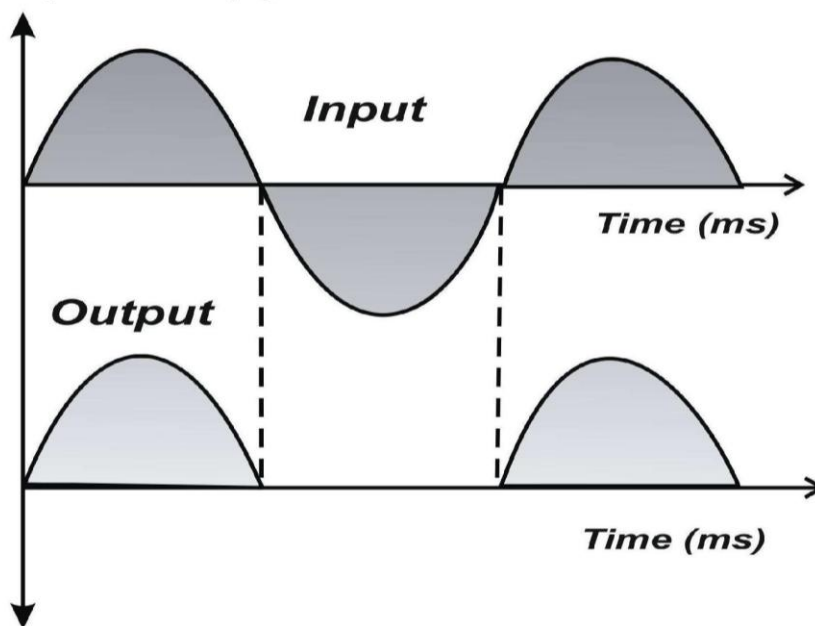


CIRCUIT DIAGRAM
NEGATIVE CLIPPER



Model Graph

Amplitude (v)



Tabulation For positive clipper

Wave form	Amplitude in volts	Time in msec
Input		
Output		

Tabulation For negative clipper

Wave form	Amplitude in volts	Time in msec
Input		
Output		

RESULT:

Thus the Positive and Negative Clipper Circuits were constructed and its input and output waveforms were drawn.

Viva voce questions

1. Load test on DC shunt motor

1. What is a motor? What is the working principle of a DC motor?
2. State the different types of DC motors?
3. Why a DC shunt motor is called as constant speed motor?
4. Why the motor field rheostat is kept in minimum position ?
5. Why a starter is used to start a DC shunt motor?

2. Load test on single phase induction motor

1. State the working principle of single phase induction motor
2. Classify the different types of single phase induction motor
3. Whether the single phase induction motors are self starting or not
4. How will you change the rotation of a single phase induction motor
5. Mention some applications of single phase induction motor

3. Load test on single phase transformer

1. What is the working principle of a transformer?
2. What kind of load used to perform the load test.
3. Name the coils available in the wattmeter
4. What is an instrument transformer?
5. Whether the load test to be done on lower rating or higher rating transformer?

4. Load test on separately excited DC shunt generator

1. What is a generator? State the working principle of generator
2. Why the motor field rheostat of a generator is kept in maximum position
3. State the different types of generators
4. What is meant by critical field resistance and residual magnetism?
5. Mention some applications of DC shunt generator

5. Measurement of three phase power

1. What is power and unit of power?
2. What is real power and unit of real power?
3. What is reactive power and unit of reactive power?
4. What is apparent power and unit of apparent power?
5. What is meant by power factor?

6. RTD

1. What is meant by Transducer?
2. What is meant by inverse transducer?
3. What are the advantages and disadvantages of RTD.
4. What are the applications of RTD.
5. What are the requirements of resistance material used in RTD?

7. Thermistor

1. What is meant by Thermistor?
2. What are the classifications of transducers?
3. What are the advantages of Thermistor?
4. What are the disadvantages of Thermistor?
5. What are the applications of Thermistor?

8.Verification of Ohm's law

- 1.State Ohm's law?
- 2.What are the limitations of Ohm's law?
3. What is meant by resistance?
4. Why a voltmeter is always connected in parallel in the circuit?
5. Why an ammeter is always connected in series in the circuit?

9. Verification of kirchoff's voltage law and kirchoff's current law

1. State Kirchhoff's voltage law?
2. State Kirchhoff's current law?
3. State voltage division rule?
4. State current division rule?
5. What are the properties of series and parallel circuits?

10. Verification of super position ,Thevenin's, Norton's & Maximum power transfer theorem

1. State the super position theorem?
2. State the thevenin's theorem?
3. State the Norton's theorem?
4. State the maximum power transfer theorem?
5. Write the formula for maximum power transfer in a given circuit?

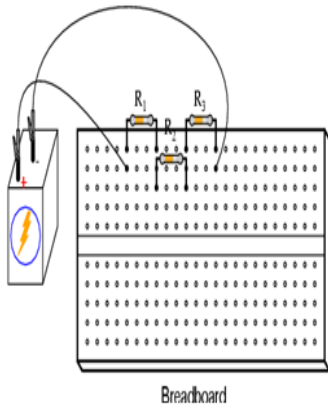
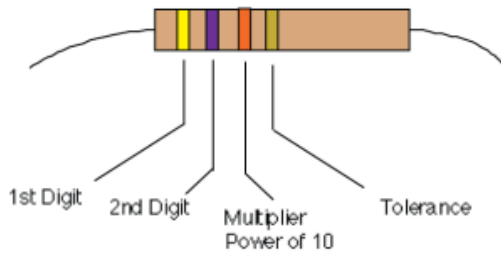
14.Study of CRO

- 1.What are the main parts of CRT
- 2.How did you measure the amplitude of AC signal in CRO?
3. How did you measure the frequency (time period) of AC signal in CRO?

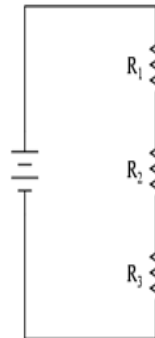
15.Diode based application- Clipper circuit

1. Define p-n junction
- 2.What are the applications of p-n junction diode
3. Define a Clipping Circuit
4. Mention the different types of clipping circuits
5. Mention the applications of clipper circuits

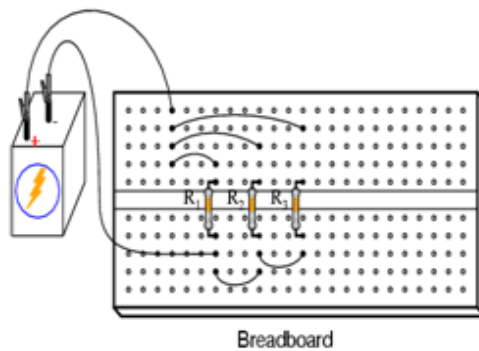
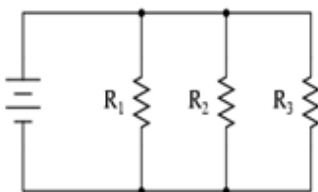
Color	1st digit	2nd digit	Power of 10	Tolerance
black	0	0	0	-
brown	1	1	1	-
red	2	2	2	-
orange	3	3	3	-
yellow	4	4	4	-
green	5	5	5	-
blue	6	6	6	-
violet	7	7	7	-
gray	8	8	8	-
white	9	9	9	-
gold	-	-	-	5%
silver	-	-	-	10%
none	-	-	-	20%



SCHMATIC DIAGRAM



SCHMATIC DIAGRAM



Breadboard