# ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

ANGUCHETTYPALAYAM, PANRUTI-607 110.

## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

# BE 8261 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATIONENGINEERING LABORATORY MANUAL

## I YEAR / II SEMESTER

## MECHANICAL ENGINEERING

## DOs and DON'T DOs in Laboratory

1. Understand the equipment to be tested and apparatus to be used.
2. Do not touch the live terminals.
3. Select proper type (AC or DC) and range of meters, Use suitable wires (type and size).
4. All the connection should be tight. Do not leave loose wires (i.e. wires not connected).
5. Get the connection checked before switching 'ON' the supply.
6. Never exceed the permissible values of current, voltage, and / or speed of any machine.
7. Switch ON or OFF the load gradually and not suddenly.
8. Strictly observe the instructions given by the Staff / Lab Instructor

## LIST OF EXPERIMENTS

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

# INDEX

| S.NO | DATE | NAME OF EXPERIMENT | PAGE NO | SIGNATURE |
|---|---|---|---|---|
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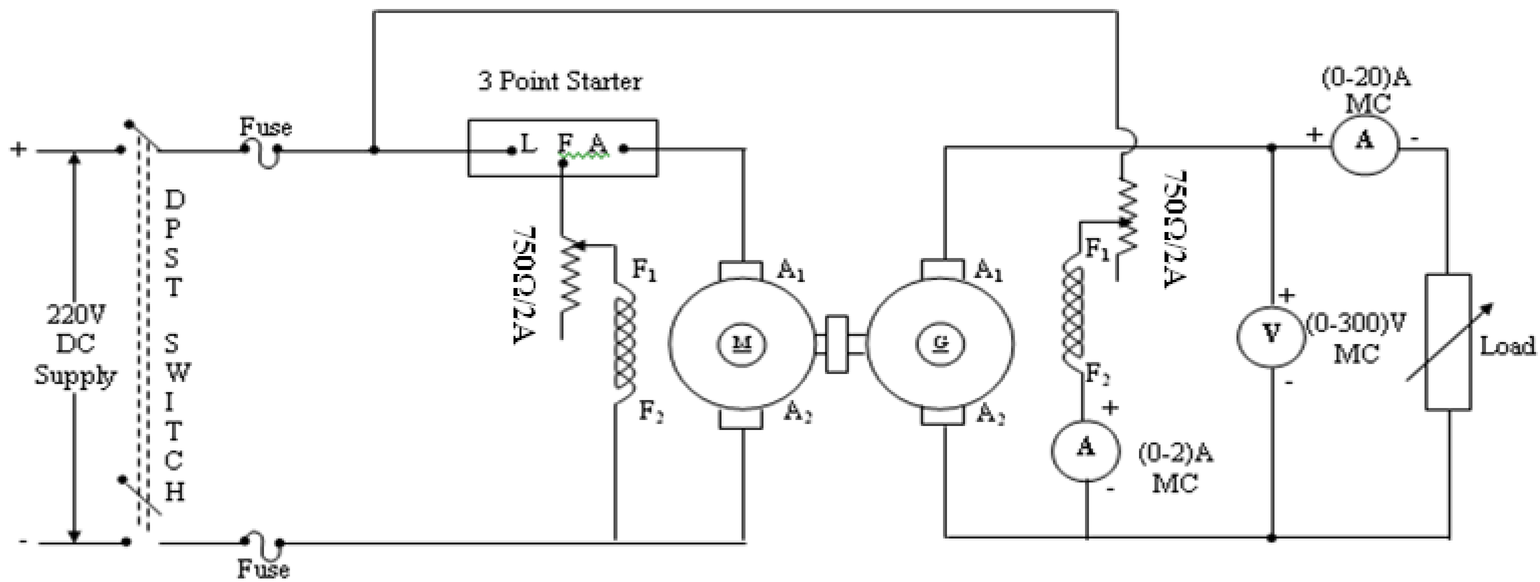
**CIRCUIT DIAGRAM:**




**FUSE RATING:**

125% of rated current

$$\frac{125 \times}{100} =$$

**NAME PLATE DETAILS:**

| | Motor | Generator |
|---|---|---|
| Rated Voltage : | | |
| Rated Current : | | |
| Rated Power : | | |
| Rated Speed : | | |

**Ex.No.**

## LOAD TEST ON SEPARATELY EXCITED DC SHUNT GENERATOR

**AIM:**

To obtain load characteristics of separately excited DC shunt generator.

**APPARATUS REQUIRED:**

| S.No. | Apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Ammeter | (0-1)A | MC | 1 |
| 2 | Voltmeter | (0-300)V | MC | 1 |
| 3 | Rheostats | 750Ω, 2A | Wire Wound | 2 |
| 4 | Tachometer | (0-1500)rpm | Digital | 1 |
| 5 | Connecting Wires | 2.5sq.mm. | Copper | Few |
| 4 | Loading Rheostat | 5KW, 230V | - | 1 |

**PRECAUTIONS:**

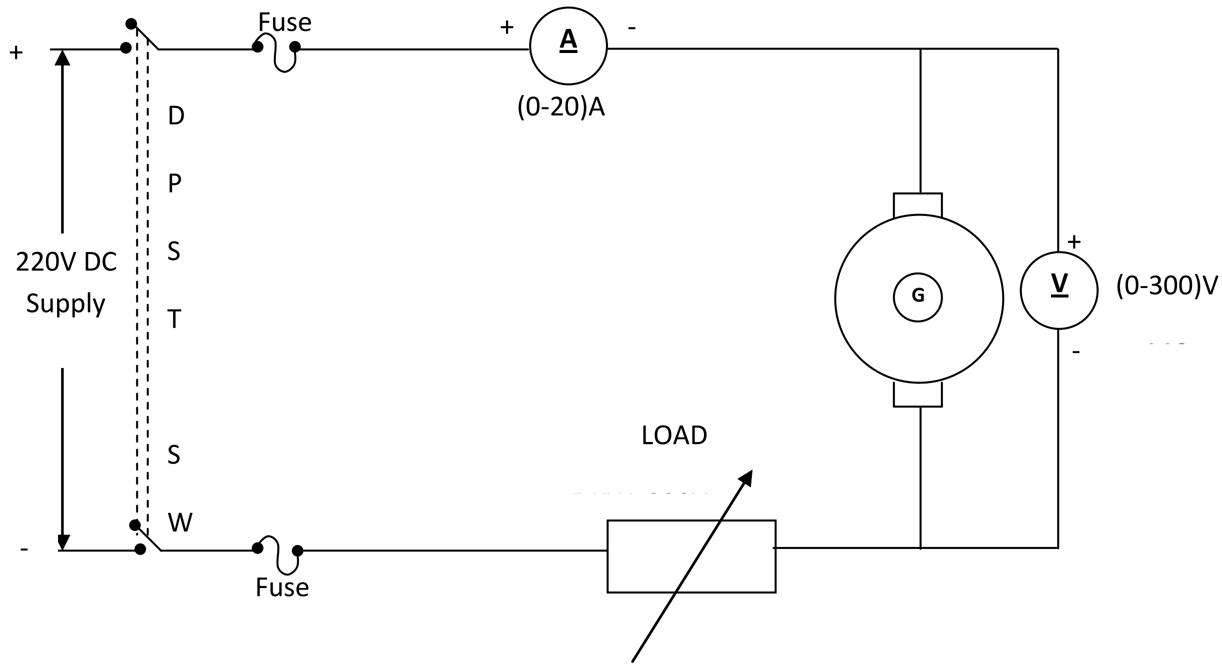
1. The field rheostat of motor should be in minimum resistance position at the time of starting and stopping the machine.
2. The field rheostat of generator should be in maximum resistance position at the time of starting and stopping the machine.
3. No load should be connected to generator at the time of starting and stopping.

**PROCEDURE:**

1. Connections are made as per the circuit diagram.
2. After checking minimum position of DC shunt motor field rheostat and maximum position of DC shunt generator field rheostat, DPST switch is closed and starting resistance is gradually removed.
3. Under no load condition, Ammeter and Voltmeter readings are noted, after bringing the voltage to rated voltage by adjusting the field rheostat of generator.
4. Load is varied gradually and for each load, voltmeter and ammeter readings are noted.

Then the generator is unloaded and the field rheostat of DC shunt generator is brought to maximum position and the field rheostat of DC shunt motor to minimum position, DPST switch is opened

## DETERMINATION OF ARMATURE RESISTANCE:




## TABULAR COLUMN:

| S.No. | Field Current $I_f$ (Amps) | Load Current $I_L$ (Amps) | Terminal Voltage (V) Volts | $I_a = I_L + I_f$ (Amps) | $E_g = V + I_a R_a$ (Volts) |
|---|---|---|---|---|---|
| | | | | | |

**PROCEDURE:**

1. Connections are made as per the circuit diagram.
2. Supply is given by closing the DPST switch.
3. Readings of Ammeter and Voltmeter are noted.
4. Armature resistance in Ohms is calculated as $R_a$ = (Vx1.5) /I

**FORMULAE:**

$E_g$ = $V + I_a R_a$ (Volts)

$I_a$ = $I_L + I_f$ (Amps)

$E_g$ : Generated emf in Volts

$V$ : Terminal Voltage in Volts

$I_a$ : Armature Current in Amps

$I_L$ : Line Current in Amps

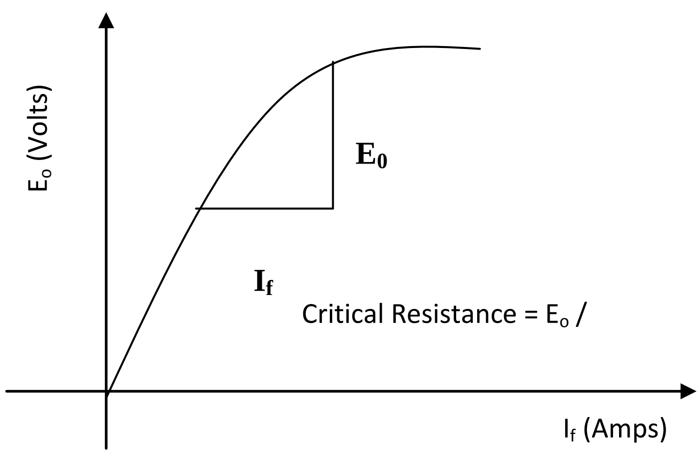
$I_f$ : Field Current in Amps

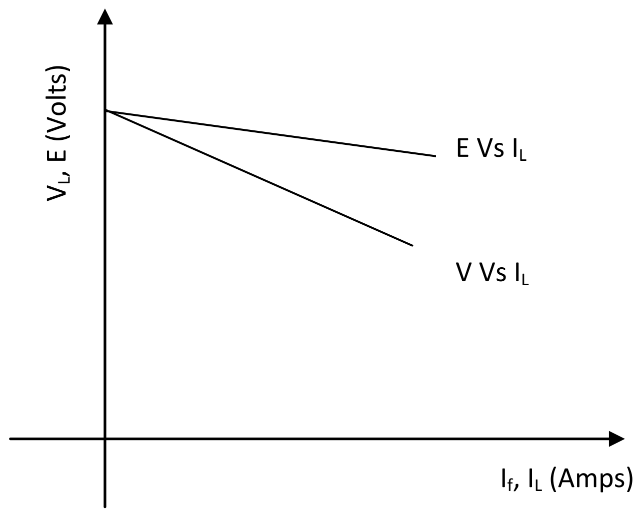
$R_a$ : Armature Resistance in Ohms

**TABULAR COLUMN:**

| S.No. | Voltage V (Volts) | Current I (Amps) | Armature Resistance $R_a$ (Ohms) |
|---|---|---|---|
| | | | |

**MODEL GRAPH:**

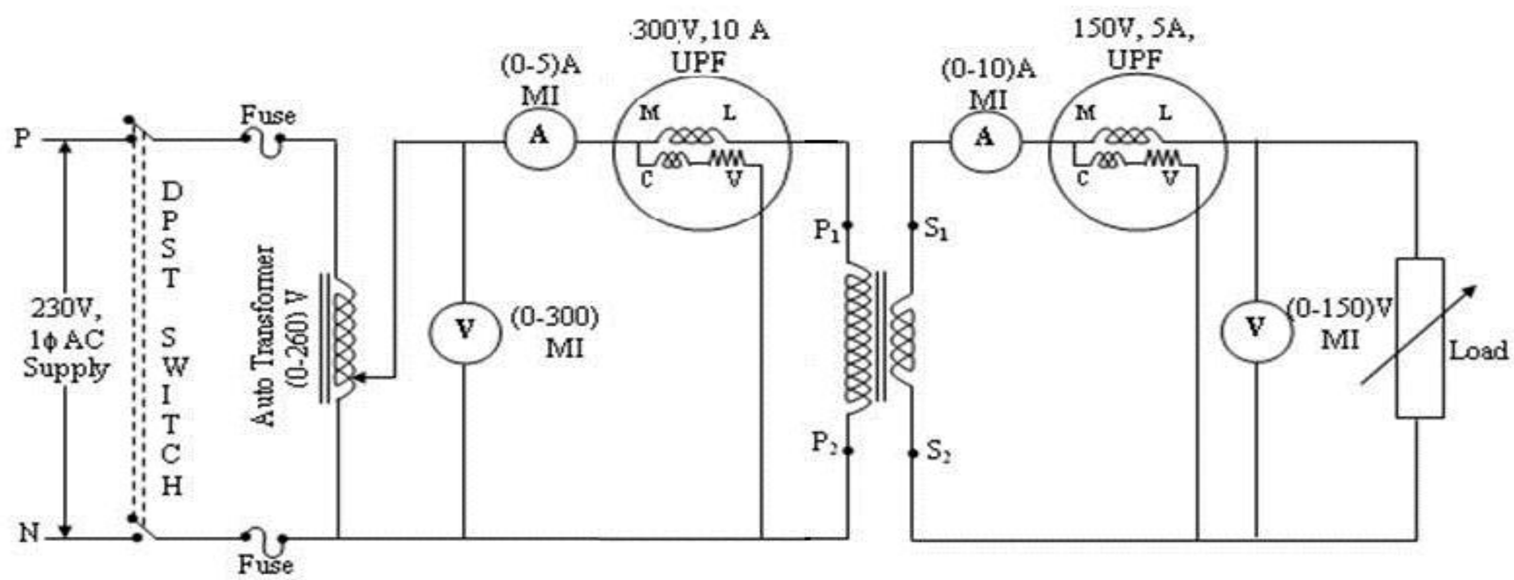


**RESULT:**

Thus a load characteristic of separately excited DC shunt generator is obtained.

**CIRCUIT DIAGRAM:**




**FUSE RATING:**

125% of rated current

$$\frac{125 \times}{100} =$$

**NAME PLATE DETAILS:**

| | Primary | Secondary |
|---|---|---|
| Rated Voltage : | | |
| Rated Current : | | |
| Rated Power : | | |

**Ex.No.**

## LOAD TEST ON A SINGLE PHASE TRANSFORMER

**AIM:**

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

**APPARATUS REQUIRED:**

| S.No. | Apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Ammeter | (0-10)A<br>(0-5) A | MI<br>MI | 1<br>1 |
| 2 | Voltmeter | (0-150)V<br>(0-300) V | MI<br>MI | 1<br>1 |
| 3 | Wattmeter | (300V, 5A)<br>(150V, 5A) | Upf<br>Upf | 1<br>1 |
| 4 | Auto Transformer | 1ϕ, (0-260)V | - | 1 |
| 5 | Resistive Load | 5KW, 230V | - | 1 |
| 6 | Connecting Wires | 2.5sq.mm | 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.

**TABULAR COLUMN:**

| S. No. | Load | Primary | | Secondary | | | Input Power $W_1$ x MF | Output Power $W_2$ x MF | Efficiency η % | % Regulation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_1$ (Volts) | $I_1$ (Amps) | $V_2$ (Volts) | $I_2$ (Amps) | $W_2$ (Watts) | | | | |
| | | | | | | | | | | |

**FORMULAE:**

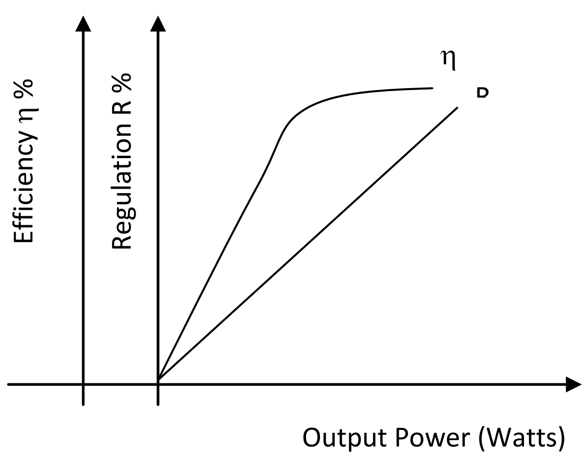
Output Power = $W_2$ x Multiplication factor

Input Power = $W_1$ x Multiplication factor

Efficiency η % $= \frac{Output\ power}{Input\ power} \times 100\%$

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

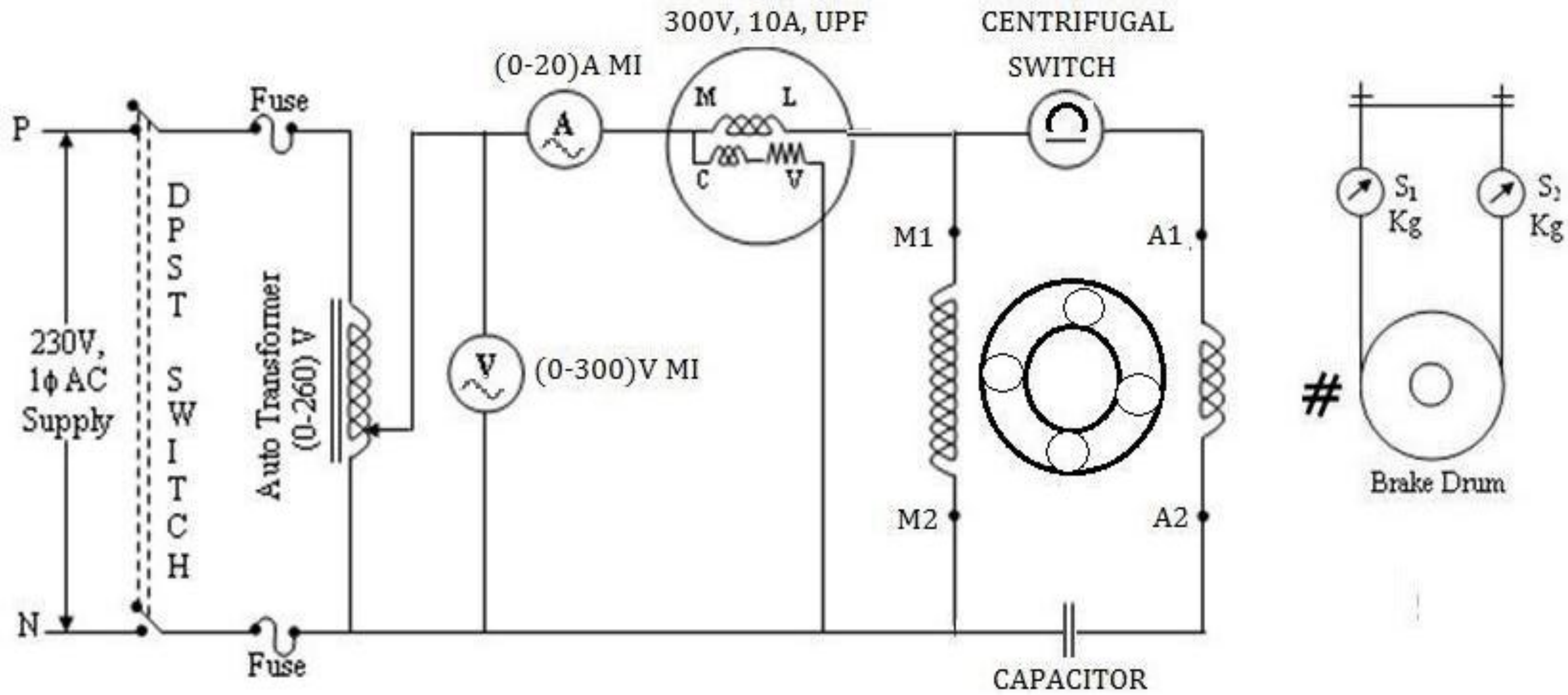
**MODEL GRAPHS:**



**RESULT:**

Thus the load test on single phase transformer is conducted.

## CIRCUIT DIAGRAM




**FUSE RATING:**

125% of rated current

$$\frac{125 \times}{100} = \quad A$$

**NAME PLATE DETAILS:**

**Motor**

| | |
|---|---|
| Rated Voltage : | V |
| Rated Current : | A |
| Rated Power : | KW |
| Rated Speed : | RPM |

**Ex.No.**

## LOAD TEST ON SINGLE PHASE INDUCTION MOTOR

**AIM:**

To predetermine performance characteristics of single phase induction motor and to plot the characteristic curves.

**APPARATUS REQUIRED:**

| S.NO | APPARATUS | RANGE | TYPE | QTY |
|---|---|---|---|---|
| 1 | Wattmeter | 600V,10A,UPF | M.C | 1 |
| 2 | Voltmeter | (0-300)V<br>(0-600)V | M.C<br>M.I | 1<br>1 |
| 3 | Ammeter | (0-10)A<br>(0-2)A | M.I<br>M.C | 1<br>1 |
| 4 | 3φ Auto-transformer | | | |

**NAME PLATE DETAILS:**

KW :
RPM :
Voltage :
Current :
Frequency :
Phase :

**PRECAUTIONS:**

**To start and stop the machine**

1. Keep the auto-transformer (at the input supply side) in its Minimum voltage position before starting the motor.
2. There should not be any load on the motor (loosen the belts on the brake drum)

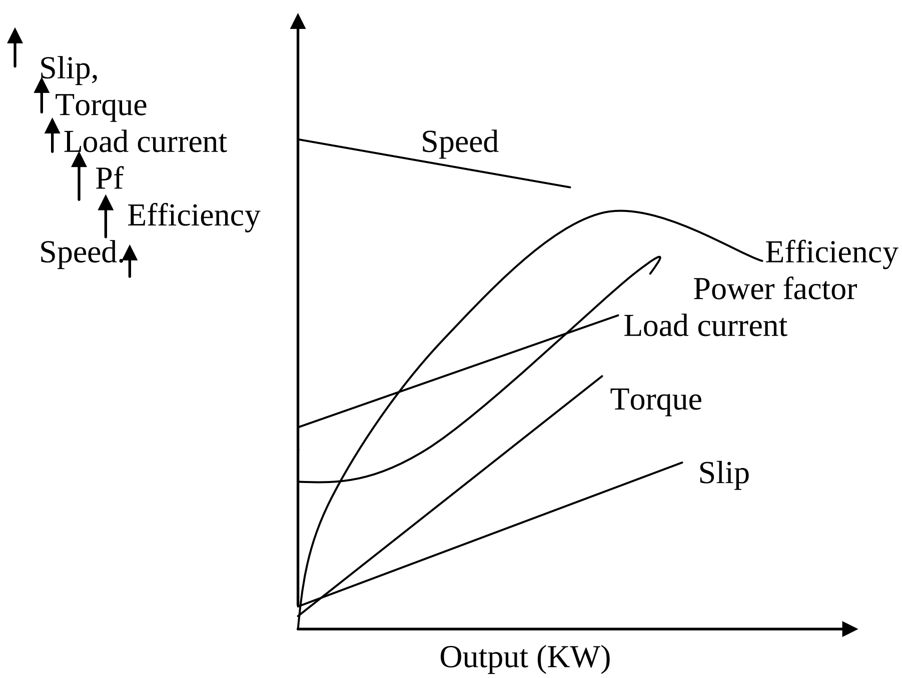
**PROCEDURE:**

1. The Circuit connections are given as per the Circuit diagram.
2. The input supply is increased until the motor runs at rated speed.

**TABULAR COLUMN:**

| S.N O | I | V | SPRING BALANCE READING S1 | S2 | SPEED | WATT METER READINGS W1 | W2 | INPUT POWER | OUTPUT POWER | TORQU E | η | SLIP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | VOL T | KG | KG | RPM | WATT S | WAT TS | WATTS | WATTS | NM | % | % |
| | | | | | | | | | | | | |

**MODEL GRAPH:**



3. Note down the no load readings for voltage, current, input power and speed.
4. Increase the no load torque by tightening the belt on the brake drum.
5. Note down the readings for voltmeter, wattmeter, spring balance, speed for different loads.

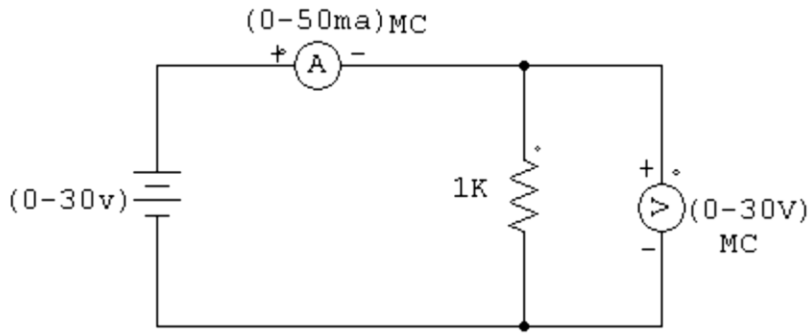
**MODEL CALCULATION:**

1. Torque T = ($S_1$~ $S_2$) x (R+t/2) x 9.81 Nm
2. Output Power $P_m = \frac{2\pi NT}{60}$ Watts
3. Efficiency η % $= \frac{Output\ power}{Input\ power} \times 100\%$
4. Power factor = $\frac{Input\ power}{\sqrt{3V_L I_L}}$
5. % Slip = $\frac{N_s - N}{N_s} \times 100$

**RESULT:**

Thus the load test on single phase Induction motor was conducted and the performance characteristics were drawn.

**Circuit Diagram:**




**OHM'S Law**

| S.No. | Voltage (V) | Current (I) | Calculated Resistance (ohm) | Actual Resistance (ohm) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

FORMULAE USED:

**V=I*R**

WHERE V - VOLTAGE

I - CURRENT

R -RESISTANCE

**THEORETICAL CALCULATION:**

**Ex.No.**

## VERIFICATION OF OHM'S LAW, KVL AND KCL

### (a) VERIFICATION OF OHM'S LAW

**AIM**

To practically verify the ohm's law, for the given electrical circuit with the theoretical calculations.

**APPARATUS REQUIRED**

| Sl.No | Name of the apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Regulated power supply | (0 - 30) V | Analog | 1 |
| 2 | Voltmeter | (0 - 30) V | MC | 4 |
| 3 | Resistor | | 1W | 3 |
| 4 | Bread board | | | 1 |
| 5 | Connecting wires | | | As Required |

**Statement:**

**Ohm's law:** Ohm's law states that " At constant temperature, the steady current flowing through the conductor is directly proportional to the potential difference across the two ends of the conductor"**.**

**Procedure:-**

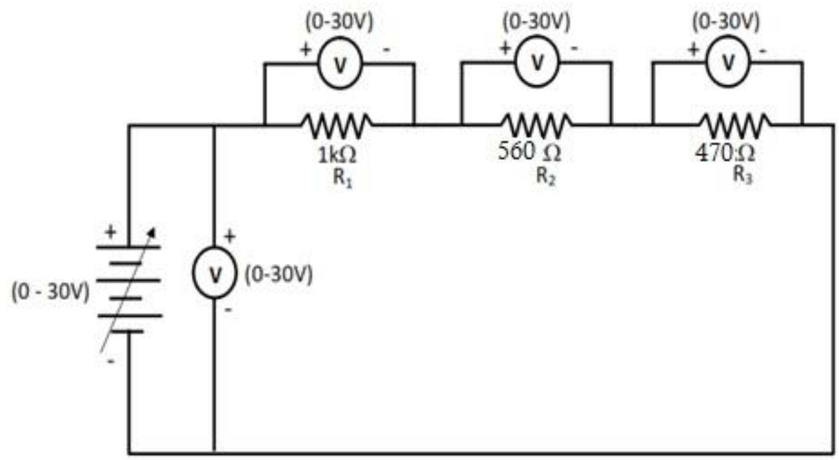
1. Connections are made as per the circuit diagram

**2.** By Varying the Input Voltage , the voltage and the corresponding current values are noted down for the given Resistor.

**RESULT:**

Thus Ohm's law has been verified both theoretically and practically.

**CIRCUIT DIAGRAM:**




**TABULAR COLUMN:-**

| S.No | Voltage (V) | Voltage V1 (V) | Voltage V2 (V) | Voltage V3 (V) | Total voltage Vt = V1+V2+V3 (V) | |
|---|---|---|---|---|---|---|
| | | | | | Theoretical | Practical |
| | | | | | | |
| | | | | | | |
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**THEORETICAL CALCULATION:**

## (b) VERIFICATION OF KIRCHOFF'S VOLTAGE LAW

### AIM

To practically verify the kirchoff's voltage law for the given electrical circuit with the theoretical calculations.

### APPARATUS REQUIRED

| Sl.No | Name of the apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Regulated power supply | (0 - 30) V | Analog | 1 |
| 2 | Voltmeter | (0 - 30) V | MC | 4 |
| 3 | Resistor | | | |
| 4 | Bread board | | | 1 |
| 5 | Connecting wires | | | As Required |

### KIRCHOFF'S VOLTAGE LAW

In any closed circuit the sum of potential drop is equal to the sum potential rise.

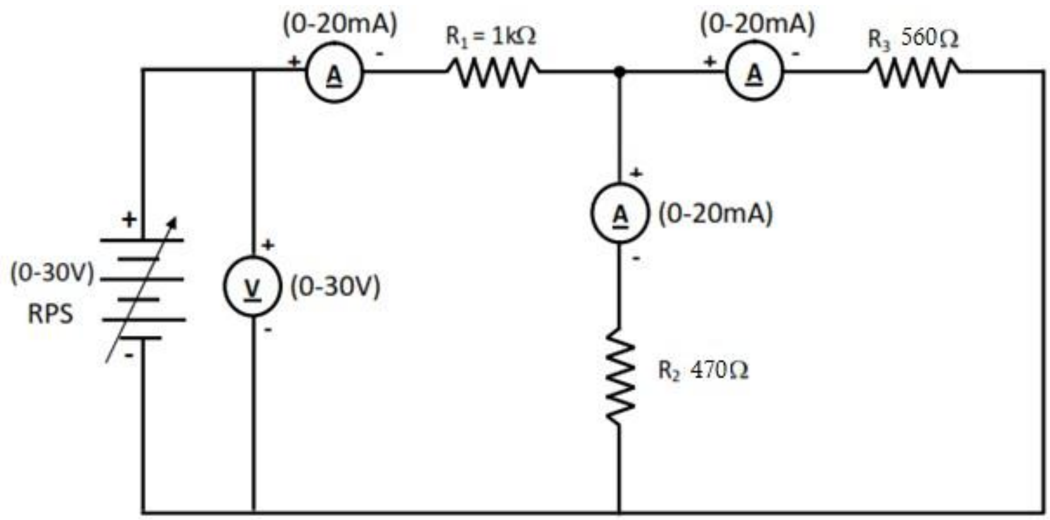
### PROCEDURE

1. Make the connections as per the circuit diagram
2. Switch on the power supply
3. Vary the RPS to a specified voltage and note down the corresponding voltage readings across resistors
4. Repeat the above step for various RPS voltages and tabulate the readings

### RESULT:

Thus Kirchoff's voltage law has been verified both theoretically and practically.

**CIRCUIT DIAGRAM:**




**TABULAR COLUMN:-**

| S.No | Voltage (V) | Current I1 (mA) | Current I2 (mA) | Current I3 (mA) | Current I1= I2 + I3 | |
|---|---|---|---|---|---|---|
| | | | | | Theoretical | practical |
| | | | | | | |
| | | | | | | |
| | | | | | | |
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**THEORETICAL CALCULATION:**

## (c) VERIFICATION OF KIRCHOFF'S CURRENT LAW

**AIM:**

To practically verify Kirchoff's current law, for the given circuit with the theoretical calculations.

**APPARATUS REQUIRED:**

| Sl.No | Name of the apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Regulated power supply | (0 - 30) V | Analog | 1 |
| 2 | Voltmeter | (0 - 30) V | MC | 4 |
| 3 | Ammeter | | | |
| 4 | Resistor | | | |
| 5 | Bread board | | | 1 |
| 6 | Connecting wires | | | As Required |

**KIRCHOFF'S CURRENT LAW**

The algebraicsum of the current meeting at any junction or node is zero. In other words, the sum of the current flowing towards a junction is equal to the sum of the current leaving from the junction.

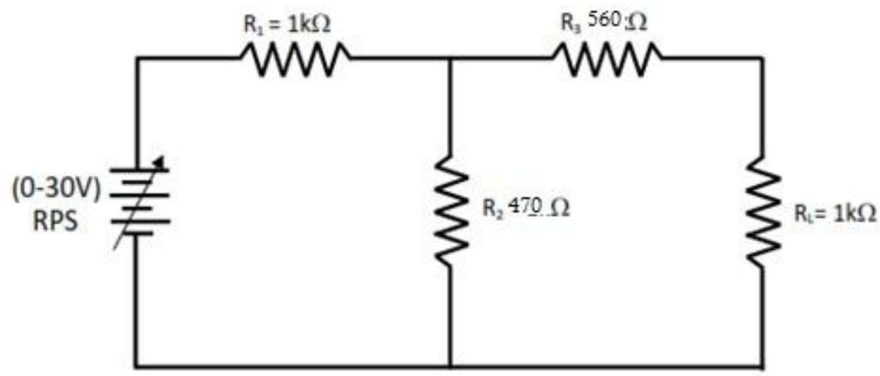
**PROCEDURE:**

1. Make the connections as per the circuit diagram
2. Switch on the power supply
3. Vary the RPS to a specified voltage and note down the corresponding ammeter readings
4. Repeat the above step for various RPS voltages and tabulate the readings

**RESULT:**

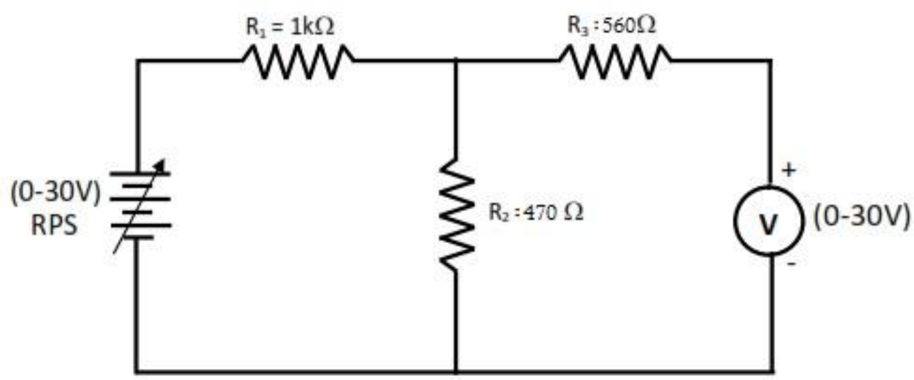
Thus the Kirchoff's current law has been verified both theoretically and practically.

**CIRCUIT DIAGRAM 1:**



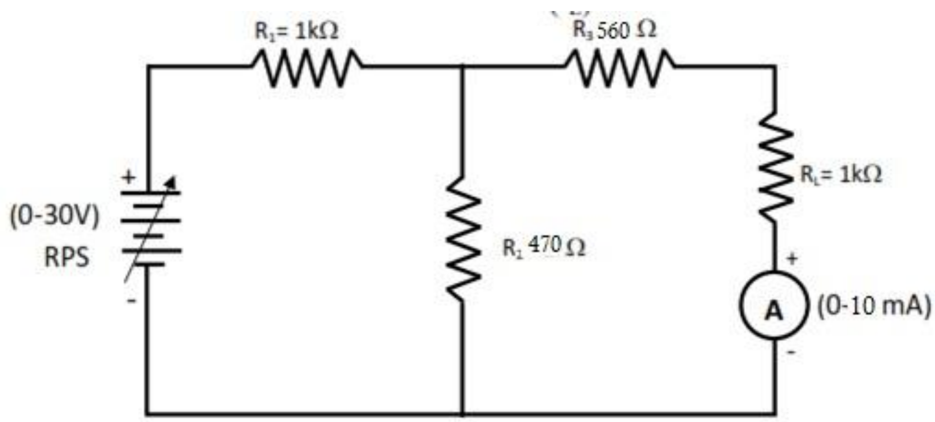

**CIRCUIT DIAGRAM 2:**

DETERMINATION OF THEVENIN VOLTAGE (Vth)




**CIRCUIT DIAGRAM 3:**

DETERMINATION OF LOAD CURRENT (IL)



**Ex.No.**

## VERIFICATION OF THEVENIN'S THEOREM, NORTON THEOREM, SUPERPOSITION THEOREM & MAXIMUM POWER TRANSFER THEOREM

### (i) VERIFICATION OF THEVENIN THEOREM

### AIM

To verify the Thevenin theorem, for the given electrical circuit and to find the load current.

### APPARATUS REQUIRED

| Sl. No | Name of the apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Regulated power supply | (0 - 30) V | Analog | 1 |
| 2 | Voltmeter | (0 - 30) V | MC | 4 |
| 3 | Ammeter | | | |
| 4 | Resistor | | | |
| 5 | Bread board | | | 1 |
| 6 | Connecting wires | | | As Required |

### THEVENIN'S THEOREM

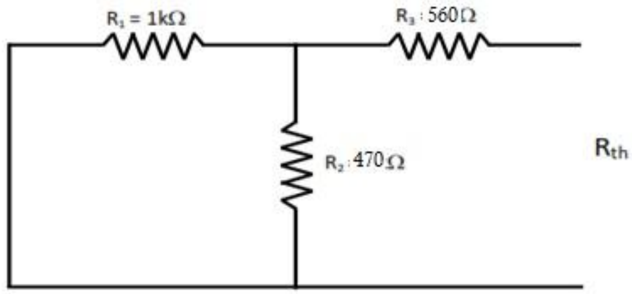
Any linear active network with output terminal A and B can be replaced by an equivalent circuit with a single voltage source Vth (thevenin's voltage) in series with Rth (thevenin's resistance)

Vth - open circuit voltage across terminal A & B

Rth – equivalent resistance obtained by looking back the circuit through the open circuit terminal A and B

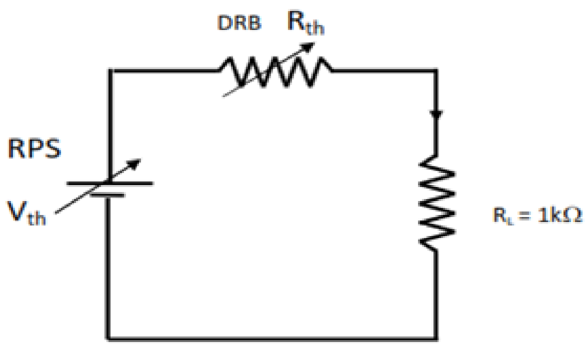
**CIRCUIT DIAGRAM 4:**

DETERMINATION OF Rth




**CIRCUIT DIAGRAM5:**

THEVENIN EQUIVALENT CIRCUIT:




**TABULAR COLUMN:-**

| S.No | Voltage (V) | Thevenin's Voltage (VTh) | | Load current (IL) | |
|---|---|---|---|---|---|
| | | Theoretical (V) | Practical (V) | Theoretical (I) mA | Practical (I) mA |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**THEORETICAL CALCULATION:**

**PROCEDURE:**

**To determine Thevenin's voltage, Vth**

1. Make the connections as per the circuit diagram
2. Switch on the power supply
3. Vary the regulated power supply to a specified voltage and note down the corresponding voltmeter readings
4. Repeat the previous step for different voltage by varying the RPS.
5. Switch off the power supply

**To determine of load current, IL**

1. Make the connections as per the circuit diagram
2. Switch on the power supply
3. Vary the regulated power supply to a specified voltage and note down the corresponding ammeter readings
4. Repeat the previous step for different voltage by varying the RPS.
5. Switch off the power supply

**RESULT:**

Thus the Thevenin's theorem was verified for the given electrical circuit.

Theoretical:

**Vth =**

**Rth =**

IL =

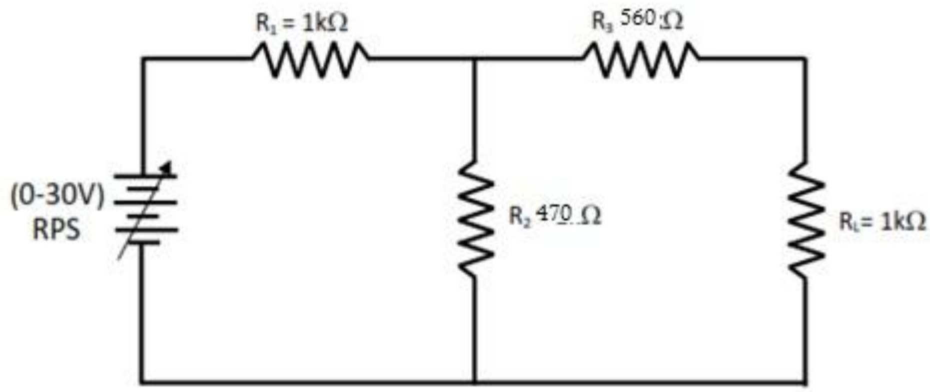
Practical:

**Vth =**

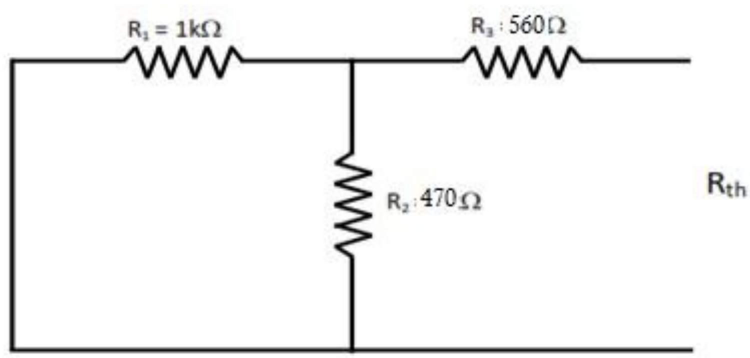
**Rth =**

IL =

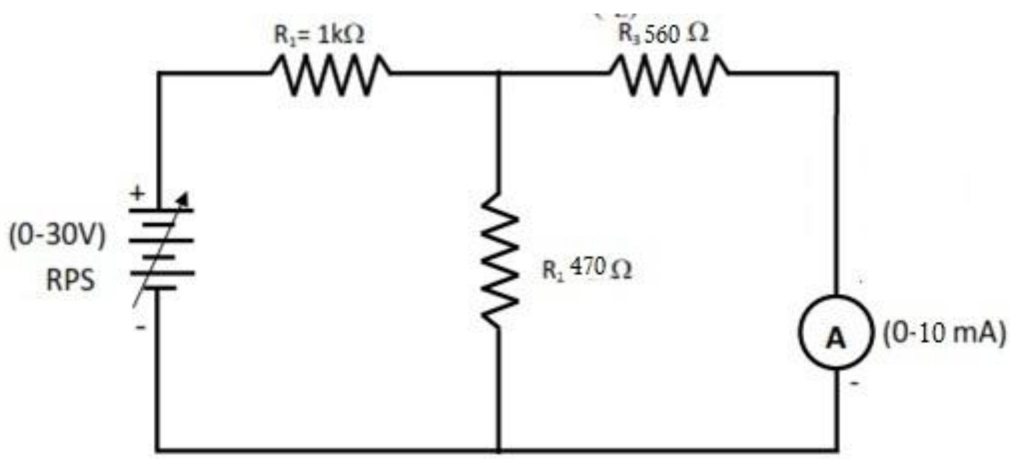
**CIRCUIT DIAGRAM**




**DETERMINATION OF Rth**




**DETERMINATION OF (ISC)**



## (ii) VERIFICATION OF NORTON THEOREM

**AIM:**

To verify the Norton theorem for the given electrical circuit.

**APPARATUS REQUIRED**

| Sl. No | Name of the apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Regulated power supply | (0 - 30) V | Analog | 1 |
| 2 | Voltmeter | (0 - 30) V | MC | 4 |
| 3 | Ammeter | | | |
| 4 | Resistor | | | |
| 5 | Bread board | | | 1 |
| 6 | Connecting wires | | | As Required |

**NORTON THEOREM**

Any linear active network with output terminals A & B can be replaced by an equivalent circuit with a single current source I in parallel with Rth( Thevenin equivalent resistance) Where Rth is the equivalent resistance obtained by looking back the circuit through the open terminal A & B

**FORMULAE**

**IL = ISC * ( Rth / (Rth + RL))**

where,ISC - Norton equivalent current source in amperes

IL - Current through the load in amperes

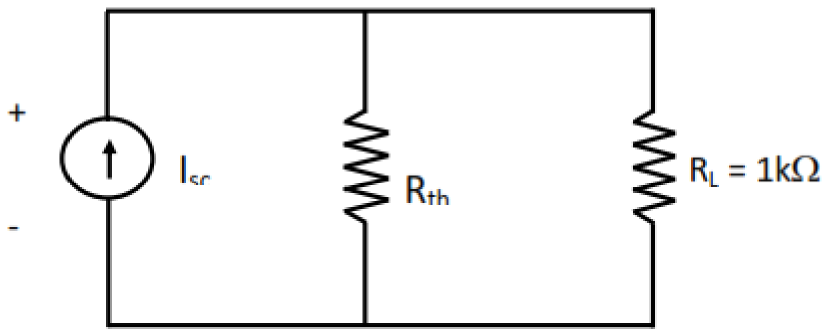
Rth - Thevenin's equivalent resistance in ohms

RL - Load resistance in ohms

VL = IL * RL

PL = $IL^2$ * RL

**EQUIVALENT CIRCUIT:**




**TABULAR COLUMN:-**

| S.No | Voltage (V) | Short circuit current(Isc) | | Load current (IL) | |
|---|---|---|---|---|---|
| | | Theoretical (mA) | Practical (mA) | Theoretical (mA) | Practical (mA) |
| | | | | | |

**THEORETICAL CALCULATION:**

**PROCEDURE :**

1. The connections are given as per the circuit diagram
2. Switch on the power supply
3. The current in short circuited branch is noted using the ammeter
4. Tabulate the readings and check with the theoretical values

**Determination of load current**

1. Make the connections as per the circuit diagram
2. Switch on the power supply
3. Vary the RPS to a specified voltage and note the corresponding ammeter reading
4. Repeat the above step for various RPS voltages and tabulate the reading

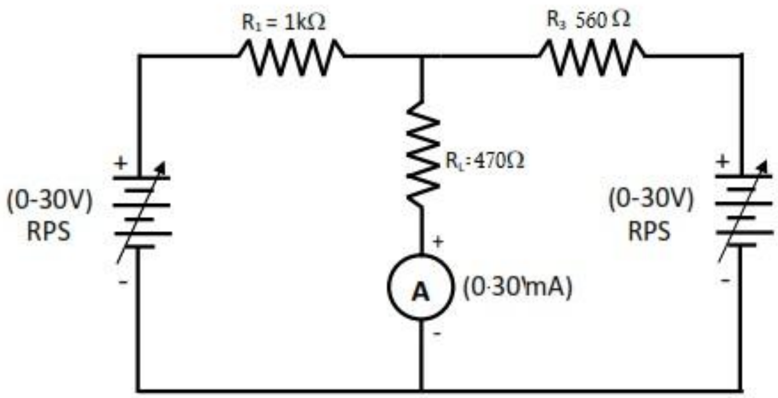
**RESULT**

Thus Norton theorem was verified for the given electrical circuit.

| Theoretical: | Practical: |
|---|---|
| **Isc =** | **Isc =** |
| **Rth =** | **Rth =** |
| IL = | IL = |

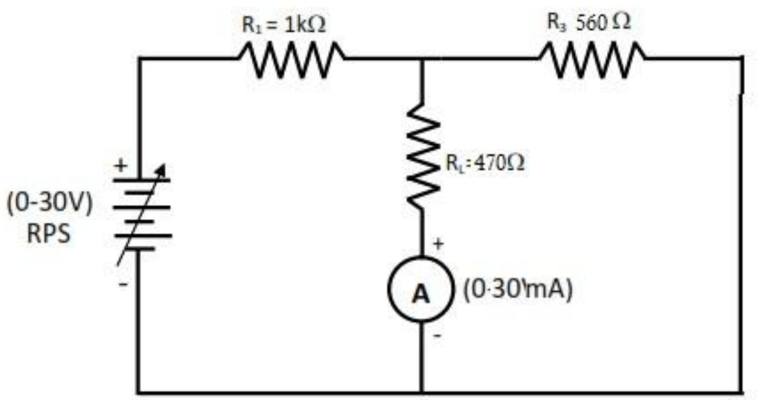
**CIRCUIT DIAGRAM 1:**

**CASE 1:When both voltage sources E1 and E2 are present**

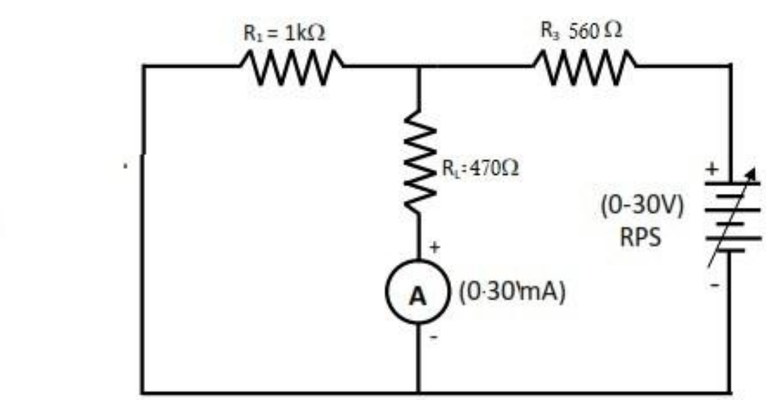



**CIRCUIT DIAGRAM2:**

**CASE 2:When voltage source E1 is present**




**CIRCUIT DIAGRAM3: CASE 3: When voltage source E2 is present**



## (iii) VERIFICATION OF SUPERPOSITION THEOREM

**AIM:**

To practically verify superposition theorem for the given network with the theoretical calculation.

**APPARATUS REQUIRED:**

| Sl. No | Name of the apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Regulated power supply | (0 - 30) V | Analog | 2 |
| 2 | Ammeter | | | |
| 3 | Resistor | | | |
| 4 | Bread board | | | 1 |
| 5 | Connecting wires | | | As Required |

**THEORY:**

In a linear bilateral active network containing more than one source the total response obtained is algebraic sum of response obtained individually considering only one source at a time the source being suitable suppressed.

**PROCEDURE:**

1. The connection is made as per the circuit diagram.
2. With V1 = 20V and V2 = 0V observe the ammeter reading.
3. The above procedure repeated with V1 = 0V and V2 = 20V.
4. The total response at the required terminal is obtained using sum of individual response.
5. Respect same procedure for different values of V1 and V2.

**TABULAR COLUMN:-**

**CASE 1:When both voltage sources V 1 and V 2 are present.**

| S.No | Voltage V 1 (V) | Voltage V 2 (V) | Current I | |
|---|---|---|---|---|
| | | | Practical (I) mA | Theoretical (I) mA |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**TABULAR COLUMN:-**

**CASE 2: When voltage source E1 is present. [Circuit Diagram 2]**

| S.No | Voltage V1 (V) | Current I | |
|---|---|---|---|
| | | Practical (I) mA | Theoretical (I) mA |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**TABULAR COLUMN:-**

**CASE 3:When voltage source E1 is present. [Circuit Diagram 3]**

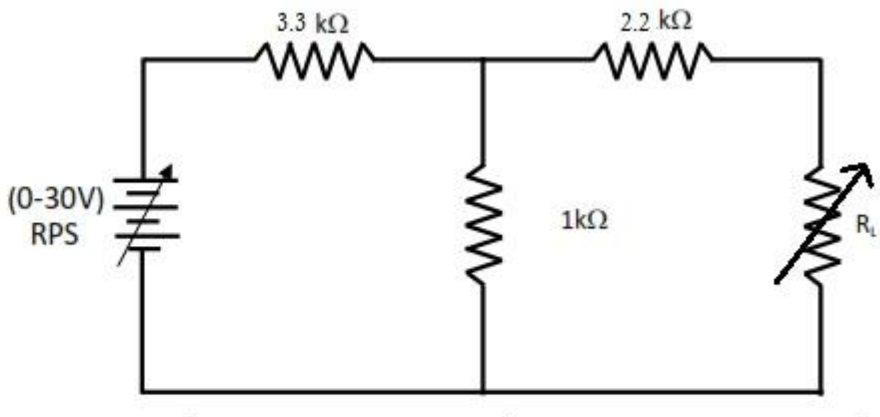
| S.No | Voltage V1 (V | Current I | |
|---|---|---|---|
| | | Practical (I) mA | Theoretical (I) mA |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**THEORETICAL CALCULATION:**

**RESULT:**

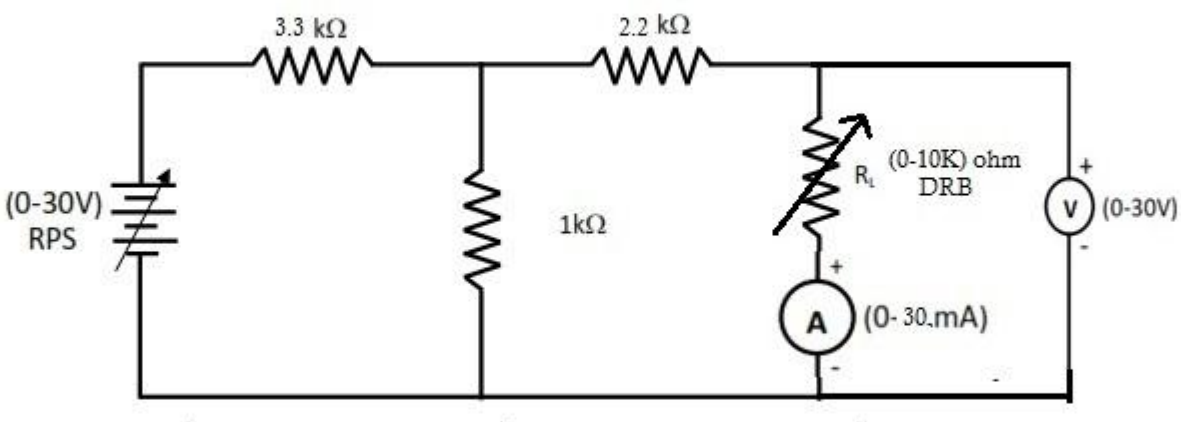
Thus superposition theorem was verified theoretically and experimentally.

**CIRCUIT DIAGRAM 1:**



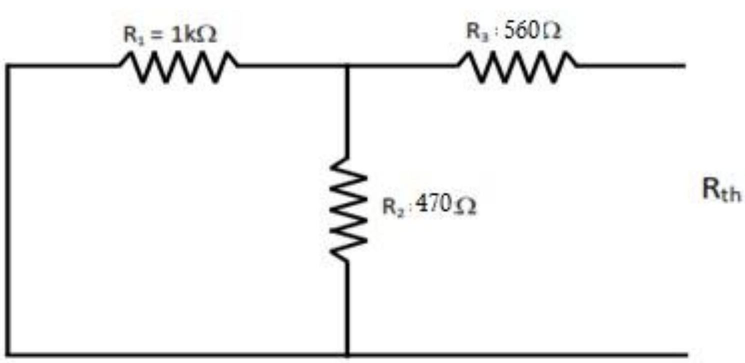

**CIRCUIT DIAGRAM 2:**

DETERMINATION OF POWER




**CIRCUIT DIAGRAM 3:**

DETERMINATION OF Rth



## (iv) VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM

**AIM:**

To verify the maximum power transformation in purely passive circuit and the load resistance is variable.

**APPARATUS REQUIRED:**

| Sl.No | Name of the apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Regulated power supply | (0 - 30) V | Analog | 1 |
| 2 | Ammeter | | | |
| 3 | Resistor | | | |
| 4 | Bread board | | | 1 |
| 5 | Connecting wires | | | As Required |

**THEORY:**

Maximum power will be delivered from a voltage source to a load, if load resistance is equal to the internal resistance of the sources.

- $R_{TH}=R_L$

**PROCEDURE:**

1. Connections are made as per the circuit diagram.
2. Remove the load resistor on the network
3. Calculated RTH by substituting all sources with their internal resistances looking back at the network.
4. Calculate VTH, the open circuit voltage between the terminals by replacing all the sources to their original position.

**FORMULAE:**

Maximum Power $=V_{oc}^2/4R_{th}$

**TABULAR COLUMN:-**

| S.No | Load resistor ($R_L$) Ω | Voltage (V) | Current (I mA) | power Watts |
|---|---|---|---|---|
| | | | | |
| | | | | |
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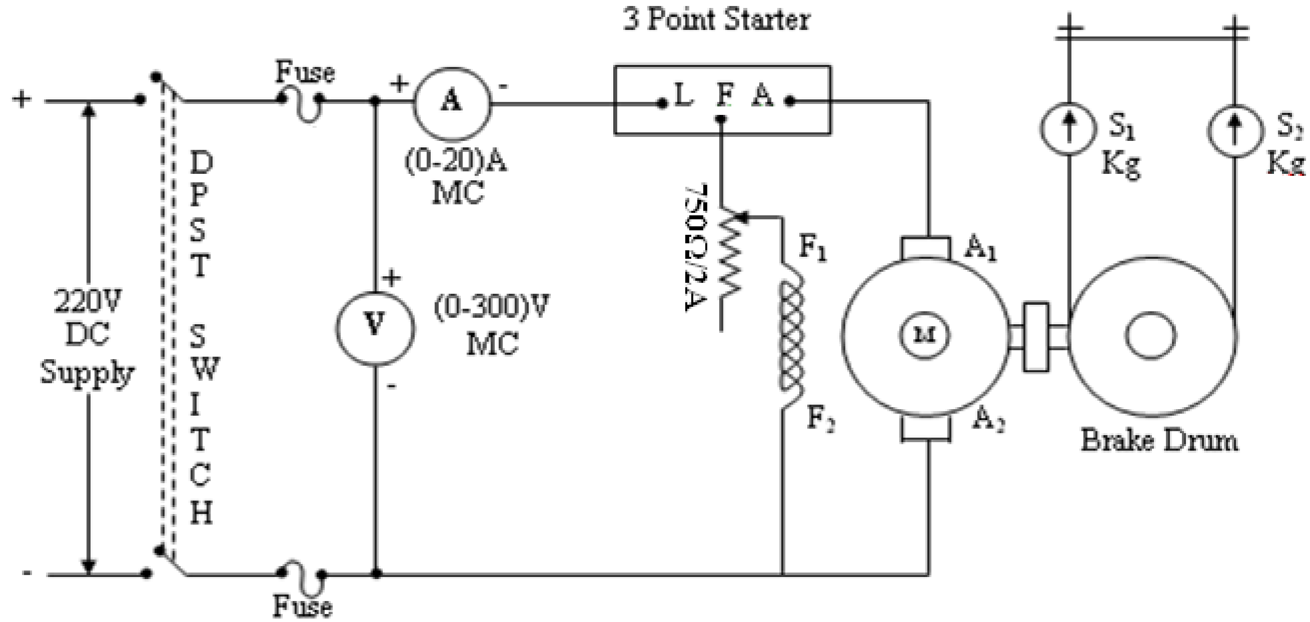
**THEORETICAL CALCULATION:**

**RESULT:**

Thus the maximum power transfer theorem was verified theoretically and experimentally.

**CIRCUIT DIAGRAM:**




**FUSE RATING:**

125% of rated current

$$\frac{125 \times \quad}{100} =$$

**NAME PLATE DETAILS:**

Rated Voltage :
Rated Current :
Rated Power :
Rated Speed :

**Ex.No.**

## LOAD TEST ON DC SHUNT MOTOR

**AIM:**

To conduct load test on DC shunt motor and to find efficiency.

**APPARATUS REQUIRED:**

| S.No. | Apparatus | Range | Type | Quantity |
|---|---|---|---|---|
| 1 | Ammeter | (0-20)A | MC | 1 |
| 2 | Voltmeter | (0-300)V | MC | 1 |
| 3 | Rheostat | 750Ω, 2A | Wire Wound | 1 |
| 4 | Tachometer | (0-1500) rpm | Digital | 1 |
| 5 | Connecting Wires | 2.5sq.mm. | 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.

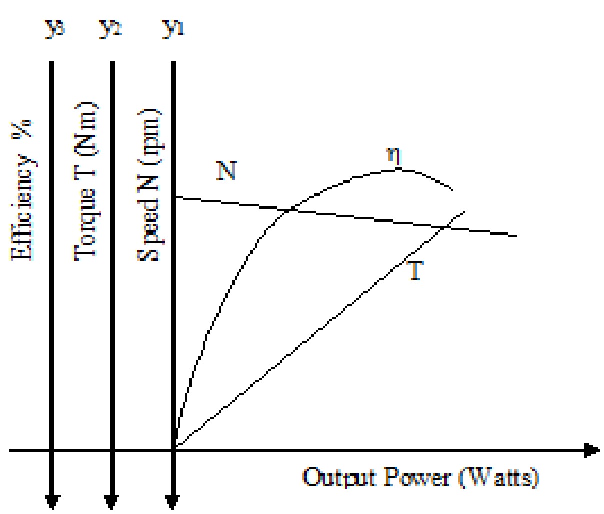
**TABULAR COLUMN:**

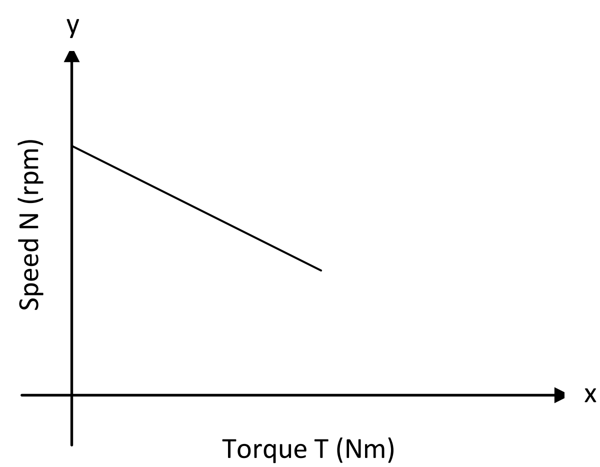
| S.No. | Voltage V (Volts) | Current I (Amps) | Spring Balance Reading | | $(S_1 \sim S_2)$Kg | Speed N (rpm) | Torque T (Nm) | Output Power Pm (Watts) | Input Power $P_i$ (Watts) | Efficiency η% |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $S_1$(Kg) | $S_2$(Kg) | | | | | | |
| | | | | | | | | | | |

Radius of the Brake drum = cm

Thickness of the Brake drum Belt = cm

**MODEL GRAPHS:**



**FORMULAE:**

Torque $T = (S_1 \sim S_2) \times (R+t/2) \times 9.81$ Nm

Input Power $P_i = VI$ Watts

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

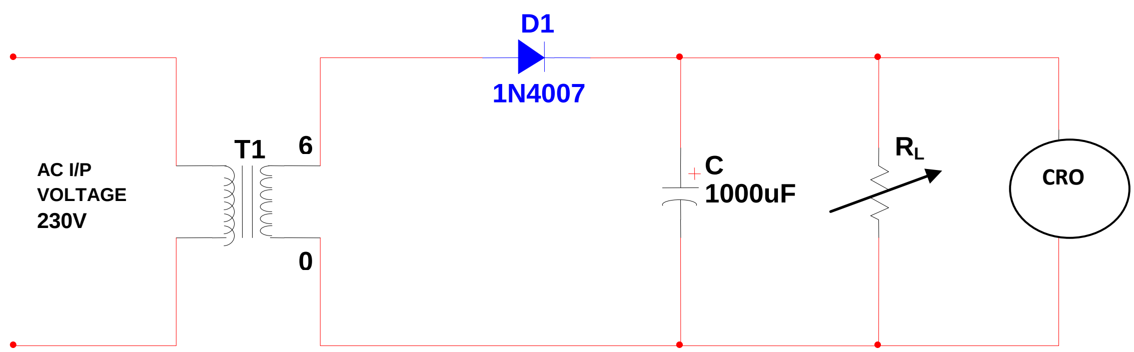
Efficiency $\eta$ % $= \frac{Output\ power}{Input\ power} \times 100\%$

**RESULT:**

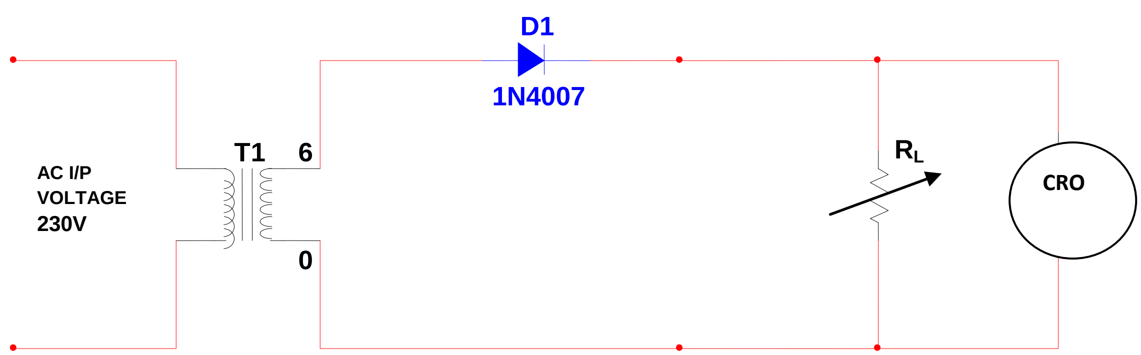
Thus load test on DC shunt motor is conducted and its efficiency is determined.

## CIRCUIT DIAGRAM:

### WITH FILTER:




### WITHOUT FILTER:




## TABULAR COLUMN:

**WITHOUT FILTER:** **T=**

| S.No | $R_L(\Omega)$ | $V_m$ (volts) | $V_{rms} = \frac{V_m}{2}$ | $V_{dc} = \frac{V_m}{\pi}$ | $I_{dc} = \frac{V_{dc}}{R_L}$ | $\gamma = \sqrt{\frac{(V_{rms})^2}{(V_{dc})^2} - 1}$ |
|---|---|---|---|---|---|---|
| | | | | | | |
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**Ex. No.**

## HALF WAVE RECTIFIER

**AIM:**

1. To design a half wave rectifier with and without simple capacitor filter.
2. Measurement of DC voltage under load and ripple factor, comparison with calculated values.

**APPARATUS REQUIRED:**

| S.NO | COMPONENT | RANGE | QUANTITY |
|---|---|---|---|
| 1 | Center Tapped Transformer | 6-0-6 | 1 |
| 2 | Diode | 1N4007 | 1 |
| 3 | Capacitor | 1000μF | 1 |
| 4 | CRO | (0-30)MHz | 1 |
| 5 | DRB | | 1 |

**FORMULA USED:**

**WITHOUT FILTER**, $\gamma = \sqrt{\frac{(V_{rms})^2}{(V_{dc})^2} - 1}$

**WITH FILTER**, $\gamma = \frac{V_{rms}}{V_{dc}}$

**DESIGN:**

**Ripple factor with filter,** $\gamma = \frac{1}{2\sqrt{3}f * C * R_L}$

**Ripple factor without filter**, $\gamma = \sqrt{\frac{(V_{rms})^2}{(V_{dc})^2} - 1}$ where $V_{rms} = \frac{V_m}{2}$ , $V_{dc} = \frac{V_m}{\pi}$

$$\gamma = \sqrt{\frac{(\frac{V_m}{2})^2}{(\frac{V_m}{\pi})^2} - 1} = \sqrt{\frac{(\pi)^2}{4} - 1} = \sqrt{1.4674} = 1.211$$

**THEORY:**

It converts an ac voltage into pulsating dc voltage using only one half of the applied ac voltage. The rectifying diode conducts during one half of the ac cycle only.

During the positive half of the cycle the input signal, the anode of the diode becomes positive with respect to the cathode and hence the diode conducts.

**WITH FILTER:** **T=** **$T_R$=** **$T_F$ =**

| S.No | $R_L(\Omega)$ | $V_m$ (volts) | $V_r$ (volts) | $V_{rms} = \frac{V_r}{\sqrt{3}}$ | $V_{dc} = V_m - \frac{V_r}{2}$ | $I_{dc} = \frac{V_{dc}}{R_L}$ | $\gamma = \frac{V_{rms}}{V_{dc}}$ |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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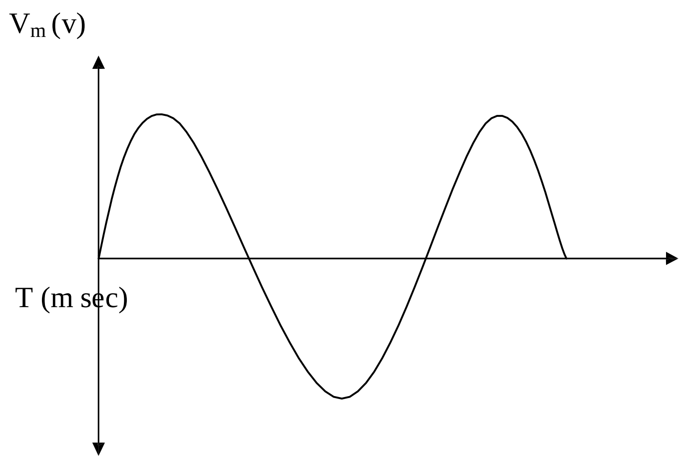
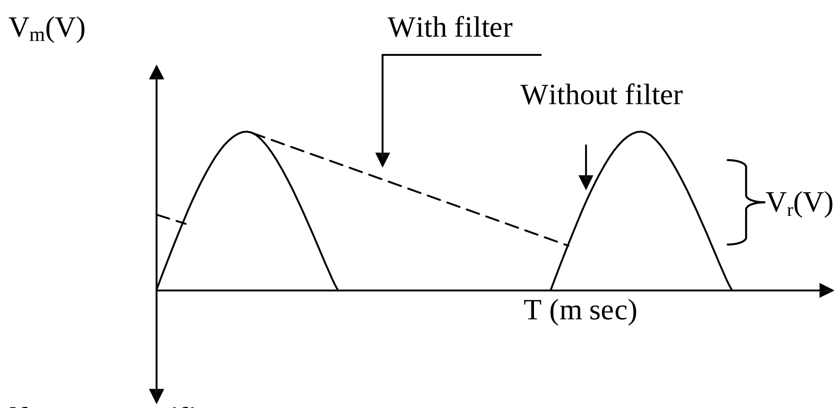
| | | | | | | | |

## MODEL GRAPH:




**Input Waveform**




**Half Wave Rectifier Output**

During the negative half of the cycle of the input signal, of the anode of the diode becomes negative with respect to the cathode and hence the diode does not conduct.

Output voltage is seen for positive Half of input only. Output Of rectifier is pulsating DC (With ripples) and remove them, C filter is connected parallel with load which bypasses AC components to ground.

**PROCEDURE:**

1. Connections are given as per the circuit diagram.
2. Output waveform in CRO is observed, Amplitude, Time period is noted.
3. A capacitor is inserted in parallel to load resistor $R_L$ which acts as filter section.
4. The output waveform with filter obtained in CRO is observed, the amplitude and the time period are noted and the graph is plotted.

The zener diode is connected in parallel with the load and determines the load regulation characteristics.

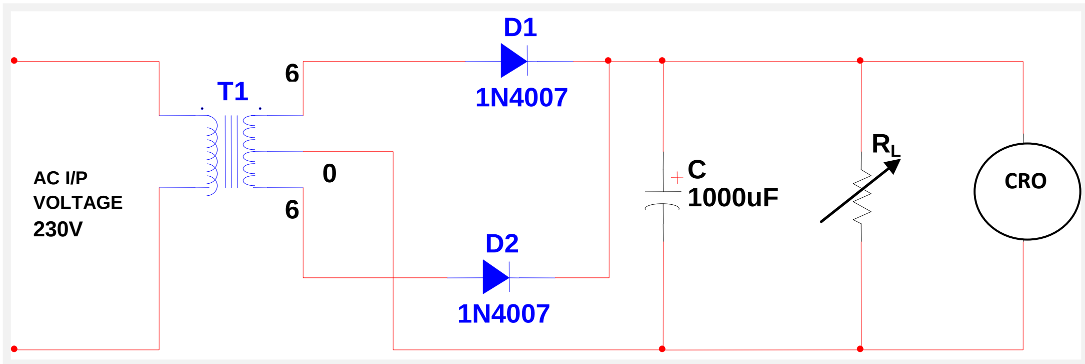
**RESULT:**

Thus the half wave rectifier is designed with and without capacitor filter and the corresponding dc output voltages and the ripple factors are measured and verified with thetheoretical values.

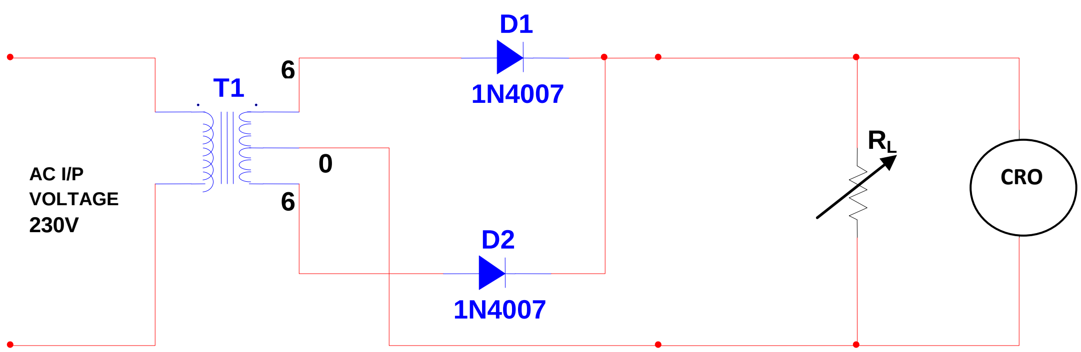
| RIPPLE FACTOR | | |
|---|---|---|
| | **THEORETICAL** | **PRACTICAL** |
| WITH FILTER | | |
| WITH OUT FILTER | | |

## CIRCUIT DIAGRAM:

### WITH FILTER:




### WITHOUT FILTER:




## TABULAR COLUMN:

**WITHOUT FILTER:** **T=**

| S.No | $R_L(\Omega)$ | $V_m$ (volts) | $V_{rms} = \frac{V_m}{\sqrt{2}}$ | $V_{dc} = \frac{2V_m}{\pi}$ | $I_{dc} = \frac{V_{dc}}{R_L}$ | $\gamma = \sqrt{\frac{(V_{rms})^2}{(V_{dc})^2} - 1}$ |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
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**Ex. No.**

# FULL WAVE RECTIFIER

**AIM:**

1. To designn a full wave rectifier with and without simple capacitor filter.
2. Measurement of DC voltage under load and ripple factor, comparison with calculated values.
3. Plot the load regulation characteristics using zener diode.

**APPARATUS REQUIRED:**

| S.NO | COMPONENT | RANGE | QUANTITY |
|---|---|---|---|
| 1 | Center Tapped Transformer | 6-0-6 | 1 |
| 2 | Diode | 1N4007 | 2 |
| 3 | Capacitor | 1000µF | 1 |
| 4 | CRO | (0-30)MHz | 1 |
| 5 | DRB | | 1 |
| 6 | Voltmeter | (0-10)V | 1 |
| 7 | Ammeter | (0-10)mA | 1 |
| 8 | Zener Diode | 1Z5.6 | 1 |
| 9 | Resistor | 1KΩ | 1 |

**FORMULA USED:**

**WITHOUT FILTER,** $\gamma = \sqrt{\frac{(V_{rms})^2}{(V_{dc})^2} - 1}$

**WITH FILTER,** $\gamma = \frac{V_{rms}}{V_{dc}}$

**DESIGN:**

**Ripple factor with filter,** $\gamma = \frac{1}{4\sqrt{3}f * C * R_L}$

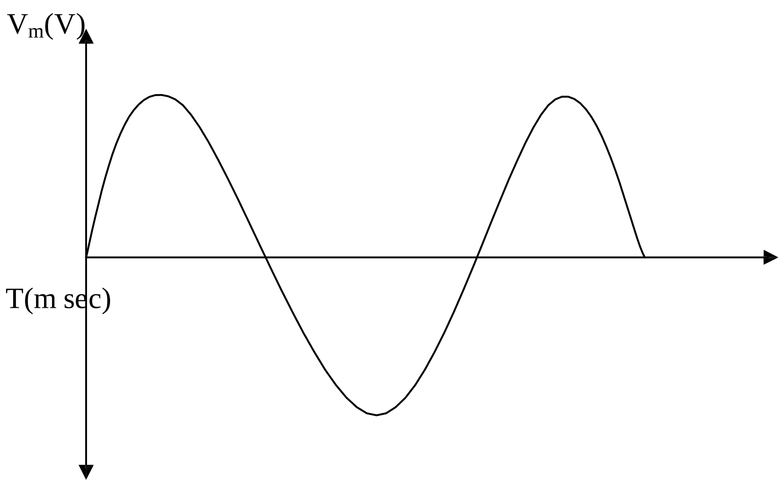
**Ripple factor without filter**, $\gamma = \sqrt{\frac{(V_{rms})^2}{(V_{dc})^2} - 1}$ where $V_{rms} = \frac{V_m}{\sqrt{2}}$ , $V_{dc} = \frac{2V_m}{\pi}$

$$\gamma = \sqrt{\frac{(\frac{V_m}{\sqrt{2}})^2}{(\frac{2V_m}{\pi})^2} - 1} = \sqrt{\frac{(\pi)^2}{8} - 1} = \sqrt{0.23245} = 0.48$$

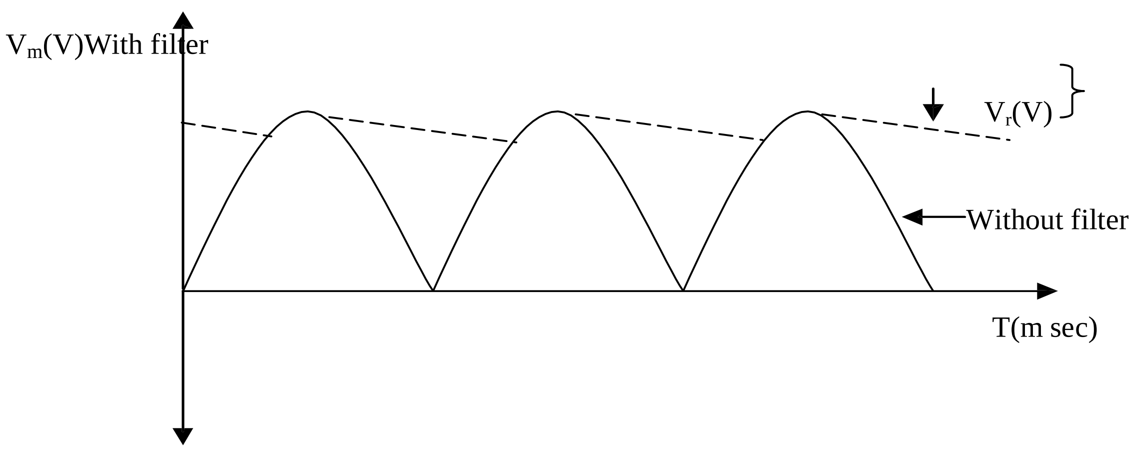
**WITH FILTER:** **T=** **$T_R$=** **$T_F$ =**

| S.No | $R_L(\Omega)$ | $V_m$ (volts) | $V_r$ (volts) | $V_{rms} = \frac{V_r}{2\sqrt{3}}$ | $V_{dc} = V_m - \frac{V_r}{2}$ | $I_{dc} = \frac{V_{dc}}{R_L}$ | $\gamma = \frac{V_{rms}}{V_{dc}}$ |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

## MODEL GRAPH:




**Input Waveform**




**Full Wave Rectifier Output**

**THEORY:**

The Full wave rectifier conducts for both the positive and negative half cycles of the input ac supply. In order to rectify both the half cycles of the ac input, two diodes are used in this circuit. The diode feed a common load $R_L$ with the help of a centre tapped transformer. The ac voltage is applied through a suitable power transformer with proper turn's ratio. The rectifier's dc output is obtained across the load.

The dc load current for the full wave rectifier is twice that of the half wave rectifier. The lowest ripple factor is twice that of the full wave rectifier. The efficiency of full wave rectifier is twice that of full wave rectifier. The ripple factor also for the full wave rectifier is less compared to the half wave rectifier.

**PROCEDURE:**

1. Connections are given as per the circuit diagram.
2. Output waveform in CRO is observed, Amplitude, Time period is noted.
3. A capacitor is inserted in parallel to load resistor $R_L$ which acts as filter section.
4. The output waveform with filter obtained in CRO is observed, the amplitude and the time period are noted and the graph is plotted.
5. The zener diode is connected in parallel with the load and determines the load regulation characteristics.

**RESULT:**

Thus the Full Wave Rectifier is designed with and without capacitor filter and the corresponding dc output voltages and the ripple factors are measured and verified with the theoretical values.

| **RIPPLE FACTOR** | | |
|---|---|---|
| | **THEORETICAL** | **PRACTICAL** |
| WITH FILTER | | |
| WITH OUT FILTER | | |

**TABULATION FOR CRO:**

| S.No | TYPE OF WAVE | TIME (SEC) | AMPLITUDE (V) | SET FREQUENCY(Hz) | MEASURED FREQUENCY $= \frac{1}{TIME}$ Hz |
|---|---|---|---|---|---|
| 1 | SINE | | | | |
| 2 | RAMP | | | | |
| 3 | SQUARE | | | | |

**Ex. No.**

## STUDY OF CRO AND MEASUREMENT OF AC SIGNALS

**AIM:**

To study electronic equipment such as usage of CRO.

**COMPONENTS REQUIRED:**

1. Oscilloscope

**THEORY:**

**Oscilloscope:**

An oscilloscope (sometimes abbreviated CRO for cathode-ray oscilloscope) is electronic test equipment that allows signal voltages to be viewed, usually as a two- dimensional graph of one or more electrical potential differences (vertical axis) plotted as a function of time or some other voltage (horizontal axis).

A typical oscilloscope is a rectangular box with a small screen, numerous input connectors and control knob sand buttons on the front panel. To aid measurement, a grid called the graticule is drawn on the face of the screen. Each square in the graticule is known as a division. The signal to be measured is fed to one of the input connectors, which is usually a coaxial connector such as a BNC or N type.

In the simplest mode, the oscilloscope repeatedly draws a horizontal line called the trace across the middle of the screen from left to right. One of the controls, the time base control, sets the speed at which the line is drawn, and is calibrated in seconds per division. If the input voltage departs from zero, the trace is deflected either upwards or downwards. Another control, the vertical control, sets the scale of the vertical deflection, and is calibrated in volts per division. The resulting trace is a graph of voltage gain at time.

If the input signal is periodic, an early stable trace can be obtained just by setting the time base to match the frequency of the input signal. For example, if the input signal is a 50Hz sine wave, then its period is 20ms, so the time base should be adjusted so that the time between successive horizontal sweeps is 20ms.This mode is called continual sweep. To provide a more stable trace, modern oscilloscopes have a function called the trigger. When using triggering, the scope will pause each time the sweep reaches the extreme right side of the screen. The scope then waits for a specified event before drawing the next trace.

The trigger event is usually the input waveform reaching some user-specified threshold voltage in the specified direction (going positive or going negative).

The effect is to resynchronize the time base to the input signal, preventing horizontal drift of the trace. In this way, triggering allows the display of periodic signals such as sine wave sand square waves. Trigger circuits also allow the display of no periodic signals such as a single pulses or pulses that don't recur at a fixed rate.

Most oscilloscopes sallow the user to bypass the time base and feed an external signal into the horizontal amplifier. This is called X-Y mode, and is useful for viewing the phase relationship between tow signals, which is commonly done in radio and television engineering. When the two signals are sinusoids of varying frequency and phase, the resulting trace is called a Lissajous curve.

Oscilloscopes may have two or more input channels, allowing them to display more than one input signal on the screen. Usually, the oscilloscope has a separate set of vertical controls for each channel, but only one triggering system and time base.

**Usage of CRO:**

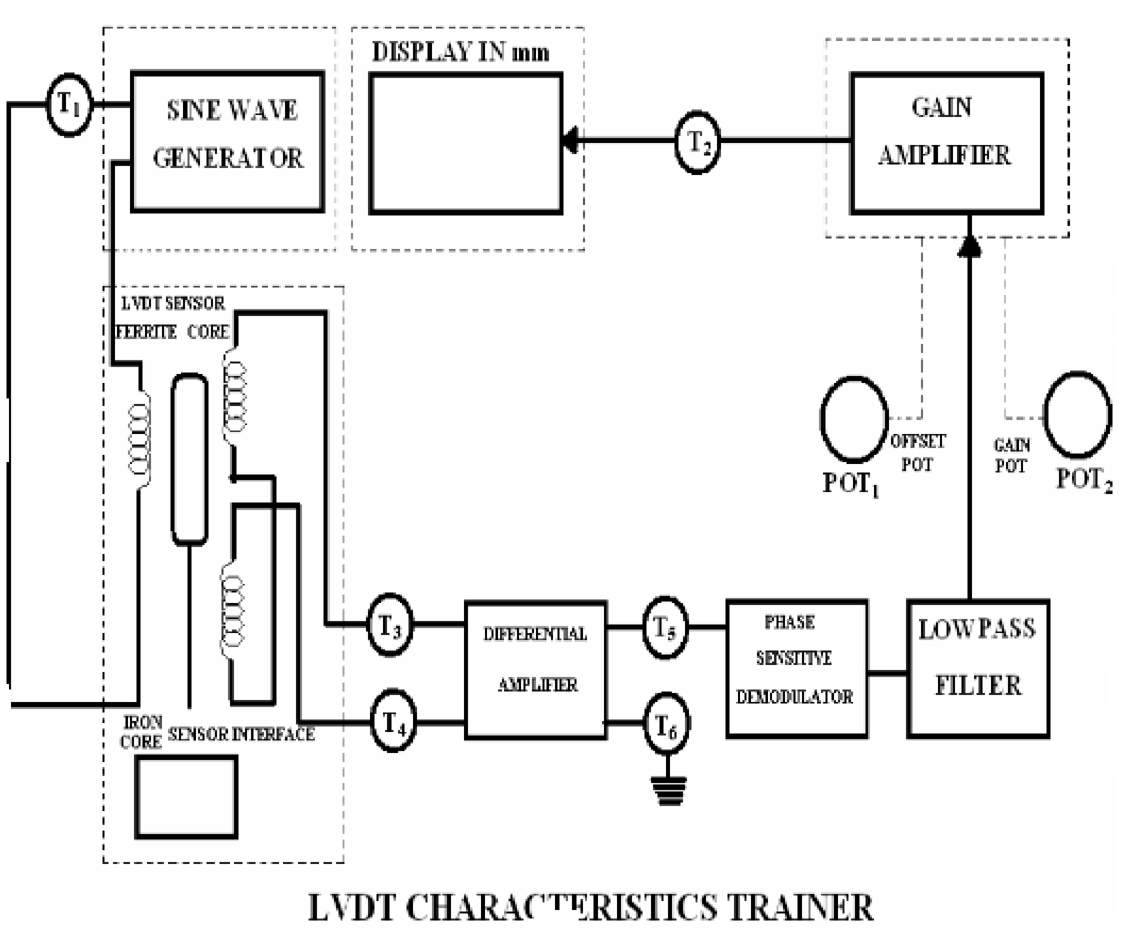
One of the most frequent uses of oscilloscopes is trouble shooting malfunctioning electronic equipment's. An oscilloscope can graphically show signals: whereas a voltmeter can show totally unexpected voltage, a scope may reveal that the circuit is oscillating. In other cases, the precise shape of pulse is important.

In electronic equipment, for example, the connections between stages (e.g. electronic mixers, electronic oscillators, amplifiers) may be 'probed' for the expected signal, using the scope as a simple signal tracer. If the expected signal is absent or incorrect, some preceding stage of the electronics circuit is not operating correctly. Since most failures occur because of a single faculty component, each measurement can prove that half of the stages of a complex piece of equipment either work or probably did not cause the fault.

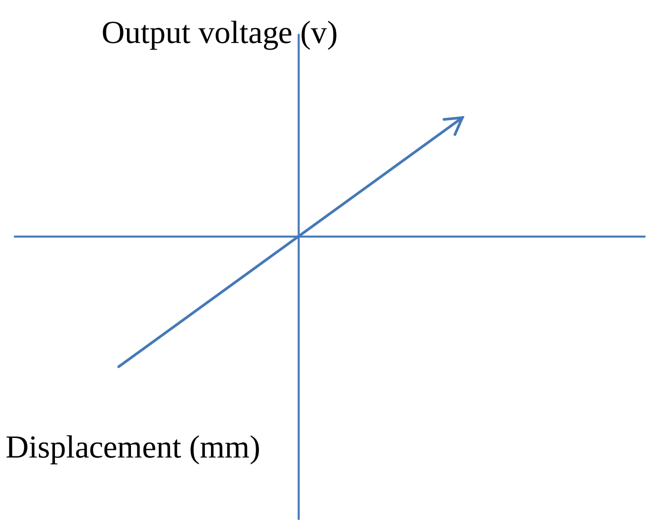
Once the faulty stage is discovered, further probing can usually tell a skilled technician exactly which component has failed. Once the component is replaced, the unit can be restored to service, or at least the next fault can be isolated. Another use is to check newly designed circuitry. Often a newly designed circuit will suffer from design errors, bad voltage levels, electrical noise etc.

**RESULT:**

**CONTROL CIRCUIT**




**MODEL GRAPH**



**Ex.No.**

## LINEAR VARIABLE DISPLACEMENT TRANSDUCER

### AIM

To measure the signal conditioning output voltage and secondary output voltage of displacement by using LVDT and draw its characteristics.

### APPARATUS REQUIRED

- ITB-12CE unit
- LVDT setup
- Multimeter
- Power chord

### FORMULA USED :

$$\text{error}(\%) = \frac{\text{core displacement} - \text{micrometer displacement}}{\text{micrometer displacement}} * 100$$

### PROCEDURE

1. Install the LVDT position sensor and interface the 9 pin D type cable with ITB-12CE unit
2. Switch ON the unit
3. Connect the multimeter or CRO (in DC volt mode) across T6 and T7 for signal conditioned output voltage measurement.
4. Set the micrometer position at 10mm and calibrate the display at 10mm using zero potentiometer. The voltage across T6 and T7 should be 0.
5. Set the micrometer position at 20mm and calibrate the display at 10mm using span potentiometer. The voltage across T6 and T7 should be 5 volt.
6. Repeat the zero and span calibration until the core displacement is 00 mm for 10mm displacement in micrometer and core displacement is 10.00mm for 20mm displacement in the micrometer.
7. After completion of the calibration place the core of the LVDT to 10mm by adjusting the micrometer.
8. Gradually increases the micrometer displacement from 10mm to 20mm and note down the forward core displacement from zero mm to 10 mm on the display and signal conditioned output voltage (v) across T6 and T7.
9. Similarly, decreases the micrometer displacement from 10mm to zero mm and note down the reverse core displacement of zero to -10mm on the display and signal conditioned output voltage (v) across T6 and T7.
10. Tabulate the reading of the core displacement , micrometer displacement and signal conditioned output voltage (v)
11. Plot graph between core displacement (mm) along x-axis and the signal conditioned output voltage (v) along y-axis

**TABULATION:**

| S.NO | MICROMETER DISPLACEMENT (mm) | CORE DISPLACEMENT(mm) | SIGNAL CONDITIONED OUTPUT VOLTAGE (volt) | ERROR |
|---|---|---|---|---|
| | | | | |
| | | | | |
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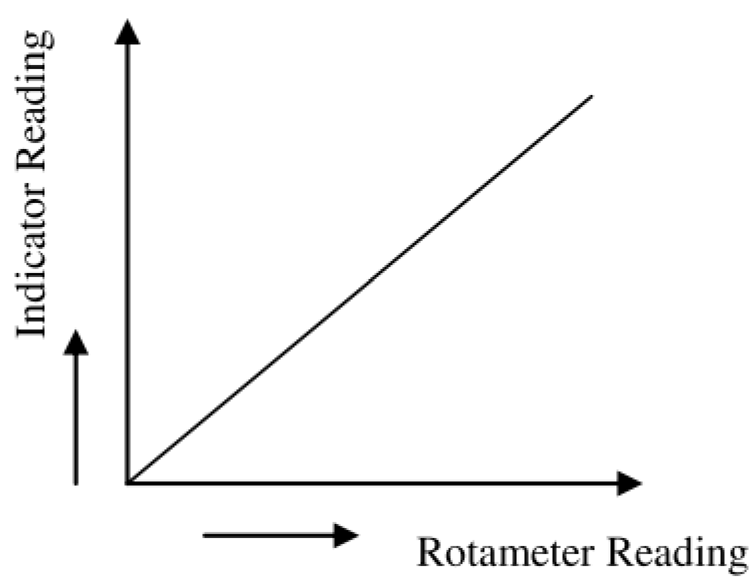
**MODEL CALCULATION:**

**RESULT:**

**TABULATION**

| Sl.No. | Set Flow in L.P.M. | Rotameter Reading in L.P.M. | Digital Reading | Error Between Rotameter & Digital reading |
|---|---|---|---|---|
| | | | | |

**MODEL GRAPH**



**Ex.No.**

## STUDY AND CALIBRATION OF A ROTOMETER FOR FLOW MEASUREMENT

## ROTOMETER

**AIM:**

To obtain the characteristics between rate of flow and bridge voltage and signal conditioned sensor output voltage using rotometer.

**APPARATUS REQUIRED:**

- Flow Measurement Kit
- Rotameter

**THEORY**

The obstruction is a float that rises in a vertical tapered column. The lifting force and thus the distance to which the float rises in the column is proportional to the flow rate. The lifting force is produced by the differential pressure that exists across the float, because it is a restriction in the flow. This type of sensor is used for both liquids and gases. A moving vane flow meter has a vane target-immersed in the flow region, which will be roted out of the flow as the flow velocity increases. The angle of the vane is a measure of the flow rate.

**FLOW CONTROL SYSTEM TURBINE METER**:

The turbine flow meter consists of a multi-bladed rotor that is supported centrally in the pipe along which the flow occurs. The fluid results in rotation of the rotor. The angular velocity bring approximately proportional to the flow rate. The rate of revolution of the rotor can be determined using a magnetic pick-up. The pulses are counted and so the number of revolutions of the rotor can be determined.

**PROCEDURE**

1. Press flow: This is a D.P.D.T Switch to set the required flow rate.

2. Flow Control: This is a potentiometer to set the flow rate. Operation: 1. Connect the turbine flow sensor with indicator marked as flow sensor input. 2. Connect the two pin of the motor to the instrument.

3. Now vary the flow control potentiometer to any required set level. Note: While controlling the flow make sure the pointer in Rotometer floats.

4. Compare the Rotometer reading and digital reading with set reading.

5. Take reading for different set of flows rate.

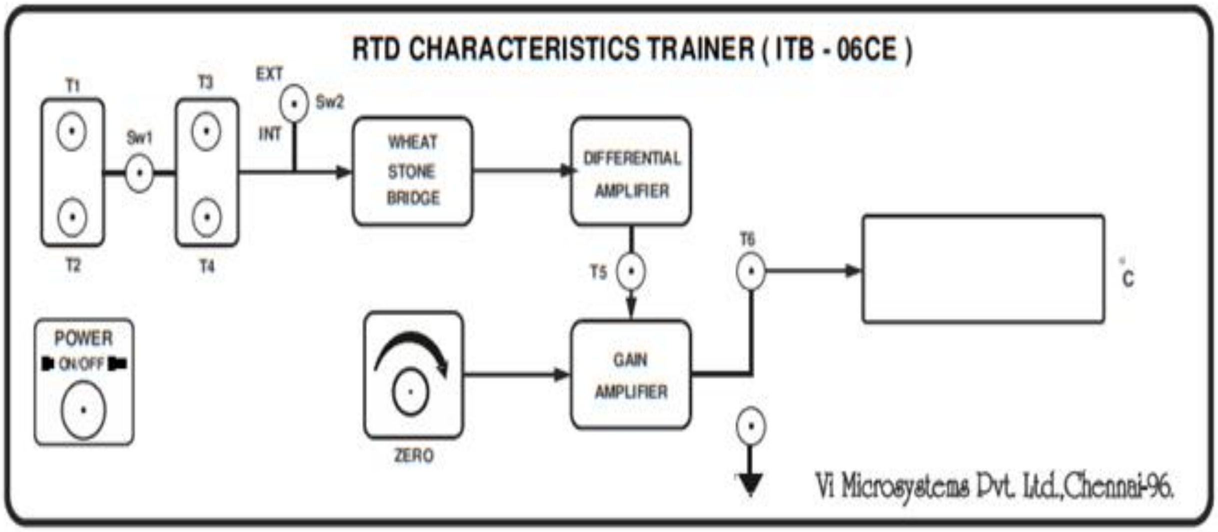
6. Plot the graph of Rotometer Reading with Digital Indicator Reading.

**Description Rotometer:**

The air source is centrifugal blower which controlled by the set valve of flow of air measured in L.P.M. The flow is measured directly on the rotometer. The turbine flow meter senses the flow rate and through microprocessor based signal conditioner. The flow is measure din digital form and acts us a set point controller also.

**RESULT:**

## CIRCUIT DIAGRAM




## TABULATION

| s.no | Bridge voltage(mv) | Resistances (Ω) | Temperature |
|---|---|---|---|
| | | | |
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**Ex.No.**

## MEASUREMENT OF TEMPERTURE USING RTD KIT

**AIM**

To measure the resistance and voltage of temperature by using RTD and also draw their characteristics.

**APPARATUS REQUIRED:**

- ITB-06A CE unit
- RTD Sensor
- PC power chord
- Water bath
- Thermometer

**SAFETY PRECAUTION:**

- Water level in the water bath should above the heating filament. Otherwise, heater will be spoiled.
- Thermistor and thermometer should not touch the body of the heater .

**PROCEDURE:**

**Resistance measurement:**

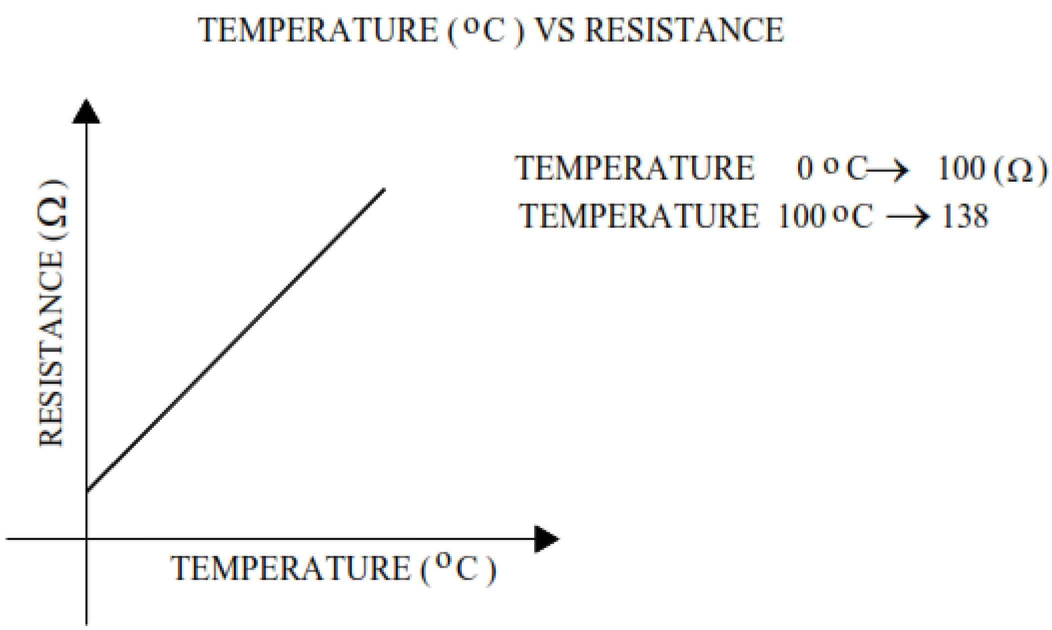
1. Patch the wires of RTD to the T1 and T2 terminal of the RTD input block and switch ON the unit.
2. Place the RTD and thermometer into the holes provides in the waterbath.
3. Keep the SW1 in right direction.
4. Place the multimeter in the resistance mode across T3 and T4 terminals.
5. Switch ON the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

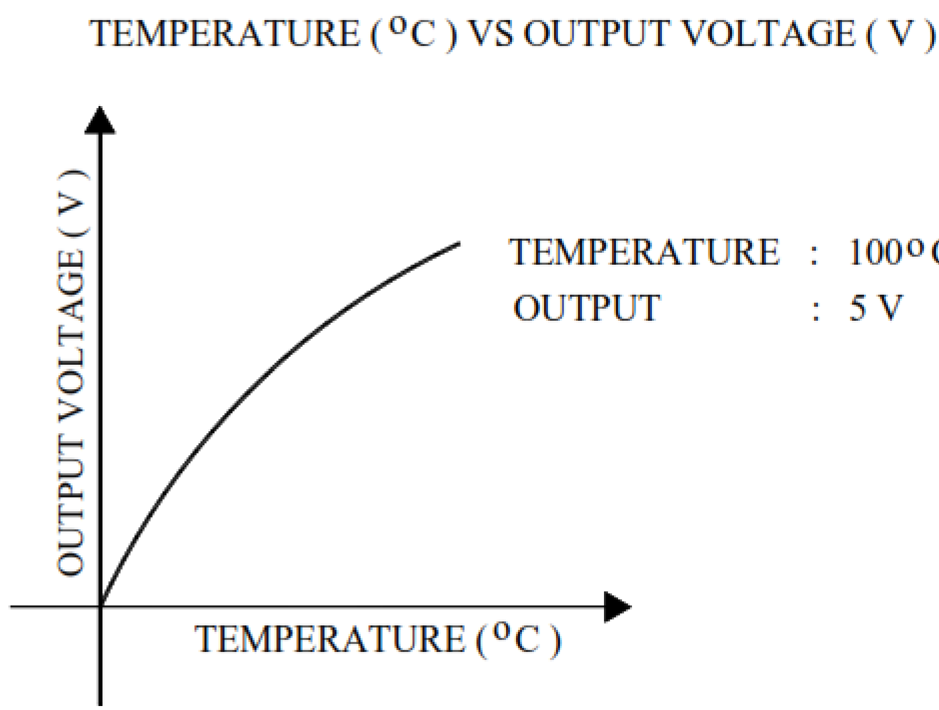
**Voltage measurement:**

1. Patch the wires of RTD to the T1 and T2 terminal of the RTD input block.
2. Switch ON the ITB-06CE Unit.

**MODEL GRAPH :**

**TEMPERATURE (°C) VS RESISTANCE**

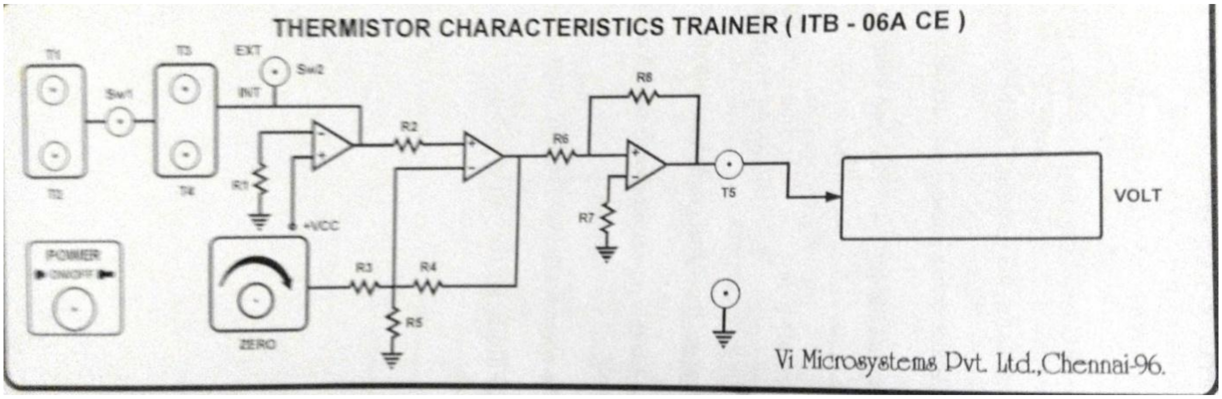


3. Keep the switch SW1 in left direction and switch SW2 in external mode.
4. Now adjust the ‘Zero’ Potentiometer to read 0°C at the display. This is done for initial setup of the unit and this adjustment should be left undisturbed.
5. Place the multimeter in voltage mode across the T6 and T7 terminals.
6. Insert the RTD and thermometer into the waterbath and note the temperature without any heating at ambient condition.
7. Switch ON the waterbath and note down the actual temperature in thermometer, output voltage of the unit and the displayed temperature simultaneously.
8. Plot the graph for Actual Temperature Vs Voltage.
9. Calculate the % error and plot the graph for Temperature Vs % Error.

**RESULT :**

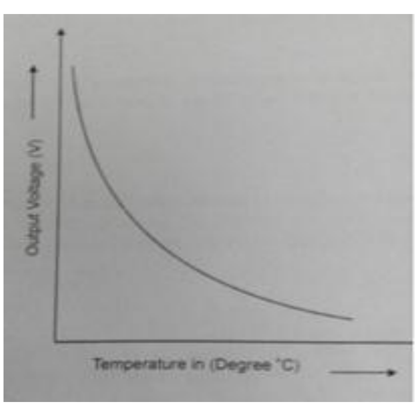
**CIRCUIT DIAGRAM**

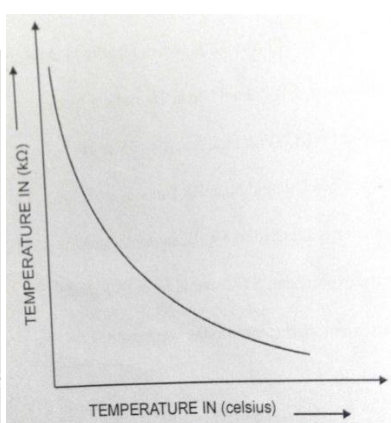



**TABULATION**

| s.no | Bridge voltage(mv) | Resistances (Ω) | Temperature |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**MODEL GRAPH :**



**Ex.No.**

## MEASUREMENT OF TEMPERTURE USING THERMISTOR KIT

**AIM**

To measure the resistance and voltage of temperature by using thermistor and also draw their characteristics.

**APPARATUS REQUIRED:**

- ITB-06A CE unit
- Thermistor
- PC power chord
- Water bath
- Thermometer

**SAFETY PRECAUTION:**

- Water level in the water bath should above the heating filament. Otherwise, heater will be spoiled.
- Thermistor and thermometer should not touch the body of the heater .

**PROCEDURE:**

- Connect the thermistor across T1 and T2 & switch ON the ITB-06A unit.
- For resistance measurement, SW1 should be in resistance mode.
- Connect the multimeter (in resistance mode) across T3 &T4.
- Connect the multimeter (in DC –volt mode) across T5 &T4.
- During zero calibration, SW2 should be in EXIT mode.
- The offset potentiometer is adjusted to 5V. Because, thermistor is NTC type.
- Before conducting the experiments, SW2 should be in INT mode.
- Insert the thermometer and thermistor into the water bath.
- Switch ON the water bath
- Note down the temperature in thermometer and corresponding resistances and voltage output of the thermistor.
- Plot the graph between temperature and resistances and voltage along X axis and Y axis respectively.

**RESULT :**