**EXPERIMENT NO. : ES-EEP101/01**

**TITLE:** **CHARACTERISTICS OF FLUORESCENT LAMPS.**

**OBJECTIVE:** To study the starting method, minimum striking voltage and the effect of varying Voltage or current of a fluorescent lamp using A.C. supply.

**APPARATUS:**

| Sl No | Apparatus Name | Apparatus Type | Range |
|---|---|---|---|
| 1 | Fluorescent Lamp | | |
| 2 | Choke | | |
| 3 | Starter | | |
| 4 | Ammeter | | |
| 5 | Voltmeter | | |
| 6 | Wattmeter | | |
| 7 | Variac | | |

**THEORY:**

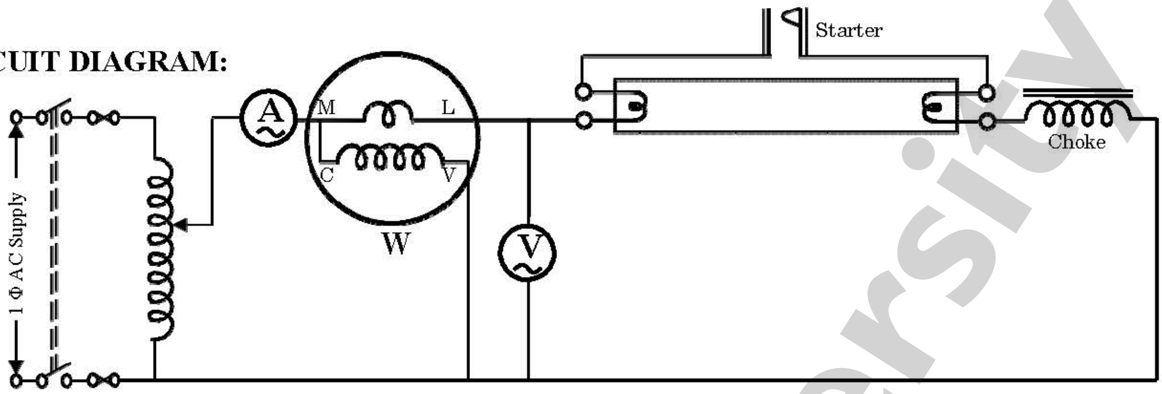
A fluorescent lamp is a low pressure mercury discharge lamp with internal surface coated with suitable fluorescent material. This lamp consists of a glass tube provided at both ends with caps having two pins and oxide coated tungsten filament. Tube contains argon and krypton gas to facilitate starting with small quantity mercury under low pressure. Fluorescent material, when subjected to electro-magnetic radiation of particular wavelength produced by the discharge through mercury vapors, gets excited and in turn gives out radiations at some other wavelength which fall under visible spectrum. Thus the secondary radiations from fluorescent powder increase the efficiency of the lamp. Tube lights in India are generally made either 61cm long 20 W rating or 122 cm long 40 Watt rating. In order to make a tube light self-starting, a starter and a chock are connected in the circuit.

When switch is on, full supply voltage from the variac appears across the starter electrodes P and Q which are enclosed in a glass bulb filled with argon gas. This voltage causes discharge in the argon gas with consequent heating of the electrodes. Due to this heating, the electrode V which is made of bimetallic strip, bends and cross contact of the starter. At this stage the choke, the filament $M_1$ and $M_2$ of the tube T and the starter become connected in series across the supply. A current flows through $M_1$ and $M_2$ and heats them. Meanwhile the argon discharge in the starter tube disappears and after a cooling time, the electrodes P and Q cause a sudden break in the circuit. This cause a high value of induced *emf* in the choke. The induced *emf* in the choke is applied across the tube light electrodes $M_1$ and $M_2$ and is responsible for initiating a gaseous discharge because initial heating has already created good number of free electrons in the vicinity of electrodes. Thus the tube light starts giving light output.

Power Factor (P.F.) of the lamp is somewhat low is about 0.5 lagging due to the inclusion of the choke. A condenser, if connected across the supply may improve the P.F. to about 0.95 lagging. The light output is a function of its supply voltage. At reduced supply voltage, the lamp may click a start but may fail to hold because of non-availability of reduced holding voltage across the tube. Higher normal voltage reduces the useful life of the tube light to very great extent.

If applied voltage of a fluorescent lamp is $V$, line current is $I$ and input power is $P = VI\cos\Phi$ where COS Φ =(P/VI) = power factor of fluorescent lamp.

**CIRCUIT DIAGRAM:**




**PROCEDURE:**

1) Connect the circuit as shown in Fig.
2) Keep the variac in minimum or zero position.
3) Switch ON the ac supply and increase gradually till the lamp strikes.
4) Note down the reading of striking voltage.
5) Increase the applied voltage to the rated value step by step and note down the applied voltage, line current and power input to the lamp.
6) Now decrease applied voltage step by step till lamp extinguishes and note down applied voltage, line current and power input to lamp in each step. Note down the extinguishing voltage.
7) Switch OFF the power supply and disconnect the circuit from the supply.

**OBSERVATION TABLE:**

| Sl No | Applied Voltage Increasing | | | | Sl No | Applied Voltage Decreasing | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Striking Voltage (volt) | | | | | Extinguishing Voltage (volt) | | | |
| | Applied Voltage (volt) | Line Current (mA) | Power Input (watt) | Power Factor | | Applied Voltage (volt) | Line Current (mA) | Power Input (watt) | Power Factor |
| 1 | | | | | 1 | | | | |
| 2 | | | | | 2 | | | | |
| 3 | | | | | 3 | | | | |
| 4 | | | | | 4 | | | | |
| 5 | | | | | 5 | | | | |
| 6 | | | | | 6 | | | | |
| 7 | | | | | 7 | | | | |
| 8 | | | | | 8 | | | | |
| 9 | | | | | 9 | | | | |
| 10 | | | | | 10 | | | | |

**CALCULATION:**

**RESULT:** Draw graph of Input Power vs. Applied Voltage and Applied Voltage vs. Line Current.

**REPORT WRITING:**

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.
Write your final report as per work instruction.

## ANNEXURE – 1

NAME:____________________________________________

ROLL NO.:__________ DEPARTMENT:________________

DATE OF SUBMISSION:_________ DATE OF EXPERIMENT: _______

CO – WORKER

NAME ROLL NO.

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TITLE:________________________________________________________

OBJECTIVE:____________________________________________

Marks Obtained

Signature of the

Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/02**

**TILLE:** **CHARACTERISTICS OF TUNGSTEN AND CARBON FILAMENT LAMPS**

**OBJECTIVE :** To study and draw the following characteristics of Tungsten Filament Lamp

I. Voltage vs. Current
II. Resistance vs. Voltage
III. Voltage vs. Power

**APPARATUS:**

| Sl No | Apparatus Name | Apparatus Type | Range |
|---|---|---|---|
| 1 | Tungsten& Carbon Lamp | | |
| 2 | Ammeter | | |
| 3 | Voltmeter | | |
| 4 | Wattmeter | | |
| 5 | Variac | | |

**THEORY:**

There are two types of lamps which are in common use, one is filament lamp and the other is gaseous discharge lamp. The filament lamps are incandescent lamps, e.g. carbon, tungsten etc. The filament of these lamps, when heated due to electric current, emits radiations in visible spectrum. The filament of incandescent lamp is mostly made of tungsten wire whose melting point is $3400^0$C. At normal working voltage, the filament material gets heated to a very high temperature and emits white light. The filament is made in the form of a coiled-coil to contain a longer length of the filament in a shorter space and is enclosed in an evacuated glass bulb to minimize oxidation of filament material at such a high operating temperature. Usually the lamps above 15w or 25w are filled with an inert gas, e.g. argon or nitrogen, to enable the filament to operate at higher temperatures and achieve higher lumens/watt efficiency (in the range of 12-13watt).

The resistance of filament changes considerably when switched on. The initial resistance of the filament in cold condition can be measured by multi-meter or by ammeter-voltmeter method. The filament resistance at normal operating temperature is difficult to measure directly and is therefore, calculated by using the following relation:

$$R = W/I^2\ \Omega$$

Where, R = Resistance in ohm when normal voltage is applied across the lamp

I = Current taken by the lamp in ampere.

W= Power to the lamp in Watt

Basic reason of getting all these conductors heated is their resistance. Resistance is the physical property of a substance by virtue of which it opposes the flow of current through it. Conductors offer lower resistance than insulators.

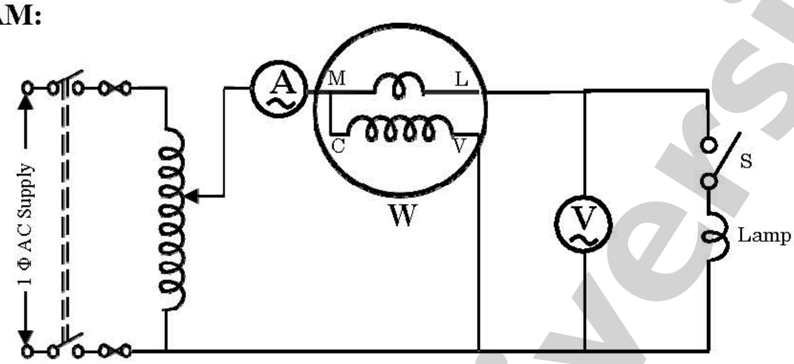
Experiments have shown that the resistivity is affected by the conductor's temperature. The resistivity and, hence, the resistance of most of the conducting materials increases with increase in temperature. The resistance changes with temperature according to the relation:

$$R_T = R_0\left[1+\alpha\left(T-T_0\right)\right]$$

Where $R_T$ and $R_0$ are the value of resistances of the conductor at $T$ and $T_0$ respectively and $\alpha$ is a constant called temperature coefficient of resistance. $T_0$ is often taken to be either room temperature or 0° C.

The value of $\alpha$ is very small for pure metal, so their resistance increase with increasing temperature. The temperature co-efficient of Tungsten Filament and Carbon Filament lamp are 0.0045 and – 0.0005 respectively.

**CIRCUIT DIAGRAM:**




**PROCEDURE:**

1) Connect the circuit diagram as shown in Fig.
2) Keep the variac in minimum or zero position.
3) Switch ON the power supply and increase the applied voltage gradually in step by step.
4) Note down the applied voltage, load current and input power for every step.
5) Switch OFF power supply and disconnect circuit. Calculate the resistance at every step.

**OBSERVATION TABLE:**

| Sl. No | Applied Voltage (volt) | Load Current (amp) | Input Power (watt) | Resistance (Ω) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |

**CALCULATION:**

**RESULT:** Draw the graph of Voltage vs. Current, Resistance vs. Voltage and Voltage vs. Power.

**REPORT WRITING:**

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.
Write your final report as per work instruction.

## ANNEXURE – 1

NAME:______________________________________________________

ROLL NO.:____________ DEPARTMENT:____________________

DATE OF SUBMISSION:_________ DATE OF EXPERIMENT: _______

CO – WORKER

NAME ROLL NO.

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TITLE:______________________________________________________________________

OBJECTIVE:______________________________________________________

Marks Obtained

Signature of the

Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/03A**

**TITLE: VERIFICATION OF THEVENIN'S THEOREM.**

**OBJECTIVE :** To verify the Thevenin's Theorem in the DC circuit.

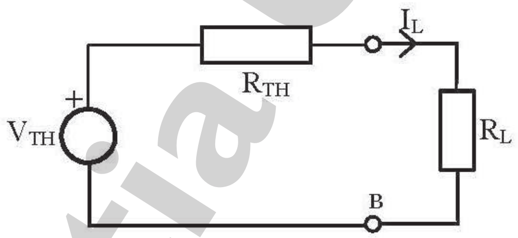
**APPRATUS :**

| Sl No | Apparatus Name | Apparatus Type | Range |
|---|---|---|---|
| 1 | Trainer Kit | | |
| 2 | Voltage Source | | |
| 3 | Resistor 1, 2 & 3 | | |
| 4 | Ammeter | | |
| 5 | Voltmeter | | |
| 6 | Multimeter | | |

**THEORY:**

Thevenin's theorem as applied to DC circuit may be stated as:

*Current fowling through a load resistance $R_L$ connected across any two terminal A and B of a linear, bilateral network is given $\frac{V_{TH}}{R_{TH}+R_L}$, where $V_{TH}$ is the open circuit voltage or thevenin's equivalent voltage (i.e. voltage across terminal AB when $R_L$ is removed) and $R_{TH}$ is the by equivalent resistance of the network as viewed from the open circuited load terminals i.e. from terminal AB deactivating all independent source.*




Mathematically current through the load resistance $R_L$ is given by the equation –

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

Where, $I_L$ = Load Current

$V_{TH}$ = Open circuit voltage across the terminals AB.

$R_{TH}$ = Thevenin's Resistance

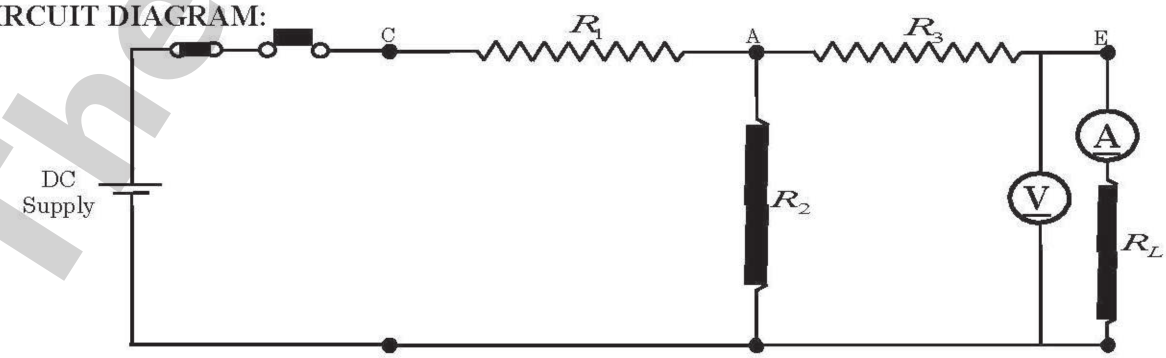
$R_L$ = Load Resistance

The following are the limitation of this theorem

i. Thevenin's theorem cannot be applicable for non-linear network.

ii. This theorem cannot calculate the power consumed internally in the circuit or efficiency of the circuit.

**CIRCUIT DIAGRAM:**



**PROCEDURE:**

1) Connect the circuit diagram as shown in Fig.
2) Measure the value of $R_1$, $R_2$ and $R_3$.
3) Remove the $R_L$ i.e. open the terminal EF.
4) Switch ON the power supply and note down the open circuit voltage ($V_{OC} = V_{TH}$).
5) Now remove the voltage source by replacing their internal resistance. If the internal resistance is assumed to be zero, then short the terminal C & D.
6) Measure the $R_{TH}$ across by opening the terminal EF by multimeter or ammeter-voltmeter method.
7) Reconnect the power supply and note down the load current $I_{Lo}$ with a load resistance of 25 Ω, 50 Ω and 100 Ω respectively and compare with calculated values of $I_{Lc}$. Also calculate the error for each load.
8) Switch OFF the power supply and disconnect the circuit.

**OBSERVATION TABLE:**

$R_1$ = Ω $R_2$ = Ω $R_3$ = Ω

| Sl. No. | Thevenin's Voltage (volt) | Equivalent Resistance (Ω) | Load Resistance (Ω) | Load Current $I_{Lo}$ (mA) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |

**CALCULATION TABLE:**

Calculated Thevenin's Voltage = volt
Calculated Equivalent Resistance = Ω

| Sl. No. | Load Resistance $R_L$ (Ω) | Load Current | | Error |
|---|---|---|---|---|
| | | Observed Value $I_{Lo}$ (mA) | Calculated Value $I_{Lc}$ (mA) | ——— |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |

**CALCULATION:**

**RESULT:** Thus the Thevenin's theorem is verified.

**REPORT WRITING:**

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.
Write your final report as per work instruction.

## ANNEXURE – 1

NAME:____________________________________________

ROLL NO.:__________ DEPARTMENT:________________

DATE OF SUBMISSION:_________ DATE OF EXPERIMENT: _______

CO – WORKER

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TITLE:________________________________________________________

OBJECTIVE:____________________________________________

Marks Obtained

Signature of the

Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/03B**

## TITLE: VERIFICATION OF NORTON'S THEOREM.

**OBJECTIVE :** To verify the Norton's Theorem in the DC circuit.

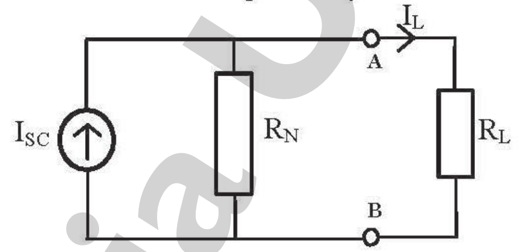
**APPRATUS:**

| Sl No | Apparatus Name | Apparatus Type | Range |
|---|---|---|---|
| 1 | Trainer Kit | | |
| 2 | Voltage Source | | |
| 3 | Resistor 1,2,3 & 4 | | |
| 4 | Ammeter | | |
| 5 | Multimeter | | |

**THEORY:**

Norton's Theorem as applied for DC circuit may be stated as:

*Any two terminal linear, active, bilateral networks containing voltage source and resistance when viewed from its output terminals is equivalent to a constant current source and a parallel connected equivalent resistance. The constant current source (Norton's equivalent current source) is of magnitude of the short circuit current at the terminals. The internal resistance is equivalent resistance of the network looking back into the terminal with all the sources replaced by their internal resistance.*



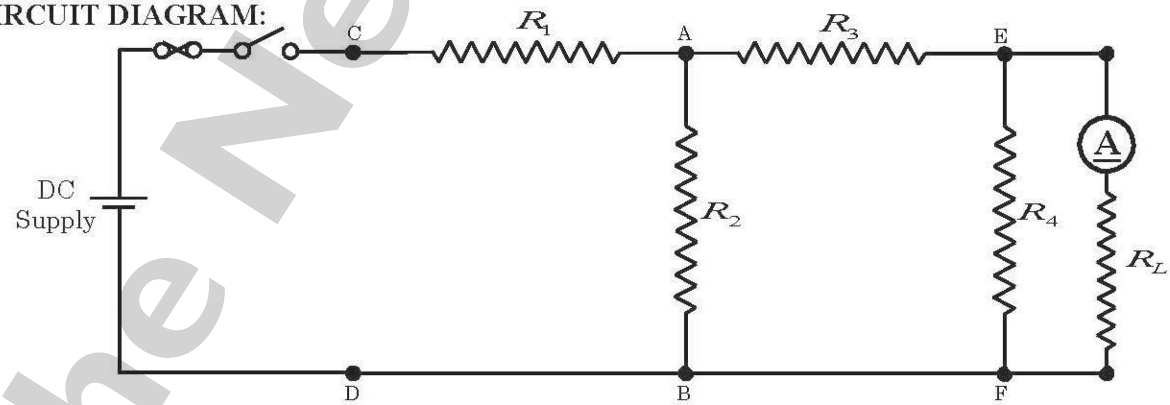

Mathematically, current through the load resistance $R_L$ is given by the equation

$$I_L = I_{SC}\frac{R_N}{R_N + R_L}$$

Where, $I_L$ = Load Current; $R_N$ = Norton's Resistance

$I_{SC}$ = Short circuit current across the terminals; $R_L$ = Load Resistance

**CIRCUIT DIAGRAM:**



**PROCEDURE:**

1) Connect the circuit diagram as shown in Fig.
2) Measure the value of $R_1$, $R_2$, $R_3$ and $R_4$.
3) Remove the $R_L$ and short the line.
4) Switch ON the power supply and note down ammeter reading as short circuit current ($I_{SC} = I_N$).
5) Now remove the voltage source by replacing their internal resistance. If the internal resistance is assumed to be zero, then short the terminal C & D.
6) Measure the $R_N$ across by opening the terminal EF by multimeter or ammeter-voltmeter method.
7) Note down the load current $I_{Lo}$ with a load resistance of 25 Ω, 50 Ω and 100 Ω respectively and compare with calculated values of $I_{Lc}$. Also calculate the error for each load.
8) Switch OFF the power supply and disconnect the circuit.

**OBSERVATION TABLE:**

$R_1$ = Ω $R_2$ = Ω $R_3$ = Ω $R_4$ = Ω

| Sl. No. | Norton's Current (mA) | Equivalent Resistance (Ω) | Load Resistance (Ω) | Load Current $I_{Lo}$ (mA) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |

**CALCULATION TABLE:**

Calculated Norton's Current = mA
Calculated Equivalent Resistance = Ω

| Sl. No. | Load Resistance $R_L$ (Ω) | Load Current | | Error |
|---|---|---|---|---|
| | | Observed Value $I_{Lo}$ (mA) | Calculated Value $I_{Lc}$ (mA) | ——— |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |

**CALCULATION:**

**RESULT:** Thus the Norton's theorem is verified.

**REPORT WRITING:**

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.
Write your final report as per work instruction.

## ANNEXURE – 1

NAME:____________________________________________

ROLL NO.:__________ DEPARTMENT:________________

DATE OF SUBMISSION:_________ DATE OF EXPERIMENT: _______

CO – WORKER

NAME ROLL NO.

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TITLE:_______________________________________________________

OBJECTIVE:___________________________________________

Marks Obtained

Signature of the

Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/04**

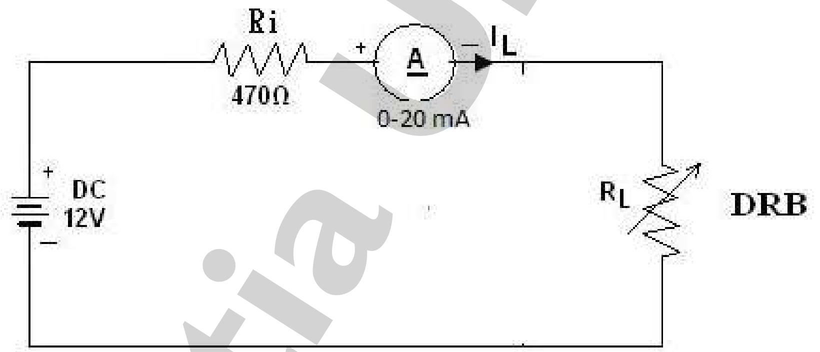
**TITLE: VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM.**

**OBJECTIVE:** To Verify The Maximum Power Transfer Theorem For The Given Circuit.

**APPARTUS REQUIRED:**

| Sl. No | Equipment | Range | Qty |
|---|---|---|---|
| 1 | Bread board | - | 1 NO |
| 2 | DC Voltage source. | 0-30V | 1 NO |
| 3 | Resistors | 470 Ω | 1 NO |
| 4 | Decade resistance box | 0-10k Ω | 1 NO |
| 5 | Ammeter | 0-20mA | 1 NO |
| 6 | Connecting wires | 1.0.Sq.mm | As required |

**CIRCUIT DIAGRAM:**




**THEORY:**

**STATEMENT:**

It states that the maximum power is transferred from the source to load when the load resistance is equal to the internal resistance of the source.

(or)

The maximum transformer states that "A load will receive maximum power from a linear bilateral network when its load resistance is exactly equal to the Thevenin's resistance of network, measured looking back into the terminals of network.

Consider a voltage source of V of internal resistance $R_i$ delivering power to a load Resistance $R_L$

Circuit current = $\frac{V}{R_L+R_i}$

Power delivered $P = I^2 R_L$

$$= \left|\frac{V}{R_L+R_i}\right|^2 R_L$$

for maximum poewer $\frac{d(p)}{dt} = 0$

RL+Ri cannot be zero,

Ri – RL = 0

$$R_L == Ri$$

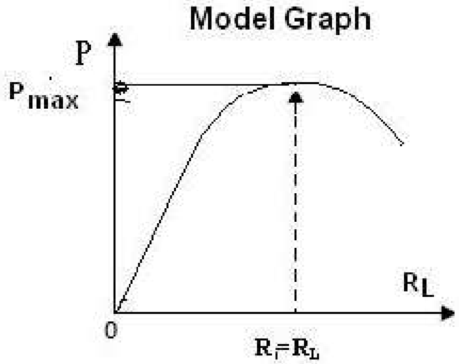
$$Pmax = \frac{V^2}{4R_L} \text{ watts}$$

**PROCEDURE:**

1. Connect the circuit as shown in the above figure.
2. Apply the voltage 12V from RPS.
3. Now vary the load resistance ($R_L$) in steps and note down the corresponding Ammeter Reading
( $I_L$) in milli amps and Load Voltage ($V_L$) volts
6. Tabulate the readings and find the power for different load resistance values.
7. Draw the graph between Power and Load Resistance.
8. After plotting the graph, the Power will be Maximum, when the Load Resistance will be equal to source Resistance

**TABULAR COLUMN:**

| S.No | $R_L$ | $I_L$(mA) | Power(P max)=$I_L^2$*$R_L$(mW) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |




**Theoretical Calculations:-**

$R = (R_i + R_L) = ...\Omega$

$I_L = V / R = ...$ **mA**

Power = $(I^2)$ $\mathbf{R_L}$ = ...**mW**

**PRECAUTIONS:**

1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.

**RESULT:**

**REPORT WRITING:**

Attach the rough note with your final report.
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ANNEXURE – 1

NAME:________________________________________________________

ROLL NO.:_____________ DEPARTMENT:_____________________

DATE OF SUBMISSION:__________ DATE OF EXPERIMENT:________

CO – WORKER

NAME ROLL NO.

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TITLE:____________________________________________________________________

OBJECTIVE:____________________________________________________

Marks Obtained

Signature of the

Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/05**

**TITLE: VERIFICATION OF SUPERPOSITION THEOREM.**

**OBJECTIVE :** To verify the Superposition Theorem in the DC circuit.

**APPRATUS :**

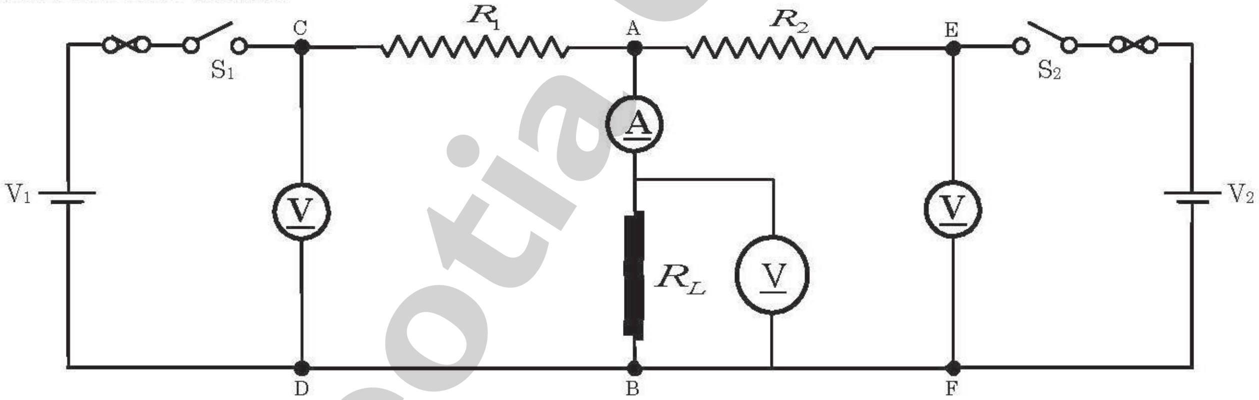
| Sl No | Apparatus Name | Apparatus Type | Range |
|---|---|---|---|
| 1 | Trainer Kit | | |
| 2 | Voltage Source | | |
| 3 | Resistor 1, 2 & 3 | | |
| 4 | Ammeter | | |
| 5 | Voltmeter 1 | | |
| 6 | Voltmeter 2 | | |
| 7 | Multimeter | | |

**THEORY:**

Superposition Theorem as applied for DC circuit may be stated as:

*In any linear active bilateral network containing several sources, the current through or voltage across any branch in the network equals the algebraic sum of the currents or voltages of each individual source considered separately with all other sources made inoperative, i.e. replaced by resistance equal to their internal resistance.*

**CIRCUIT DIAGRAM:**




**PROCEDURE:**

1) Connect the circuit diagram as shown in Fig.
2) Measure the value of $R_1$, $R_2$ and $R_L$.
3) Switch ON the power supply by closing switch $S_1$ and $S_2$.
4) Note down the total current ($I_L$) flowing through resistance $R_L$ due to both the sources is measured.
5) Replace the source $V_1$ by its internal resistance. If internal resistance is zero it is shorted C and D. Switch ON the power supply by closing switch $S_1$. Note down the load current $I_{L1}$ through the resistance $R_L$ due to the source $V_1$.
6) Reconnect the source $V_1$ and replace the source $V_2$ by its internal resistance. If internal resistance is zero it is shorted E and F. Switch ON the power supply by closing switch $S_2$. Note down the load current $I_{L2}$ through the resistance $R_L$ due to the source $V_2$.
7) Switch OFF the power supply and disconnect the circuit.
8) Compare the total load current $I_L$ with the sum of $I_{L1}$ and $I_{L2}$.

**OBSERVATION TABLE:**

$V_1$ = volt $V_2$ = volt

$R_1$ = Ω $R_2$ = Ω $R_L$ = Ω

| Condition | Measured Value (Me) | |
|---|---|---|
| | Load Voltage (Volt) | Load Current (mA) |
| Both $V_1$ and $V_2$ present | $V_L$ | $I_L$ |
| | | |
| $V_1$ present and $V_2$ replace by internal resistance | $V_{L1}$ | $I_{L1}$ |
| | | |
| $V_2$ present and $V_1$ replace by internal resistance | $V_{L2}$ | $I_{L2}$ |
| | | |
| Algebraic Sum | $V_L=V_{L1}+V_{L2}$ | $(I_L=I_{L1}+I_{L2})$ |
| | | |

**CALCULATION TABLE:**

| Condition | Load Voltage (volt) | | Error |
|---|---|---|---|
| | Measured Value | Calculated Value | ______ |
| $V_1$ present and $V_2$ replace by internal resistance | $V_{L1m}$ | $V_{L1c}$ | |
| | | | |
| $V_2$ present and $V_1$ replace by internal resistance | $V_{L2m}$ | $V_{L2c}$ | |
| | | | |
| Both $V_1$ and $V_2$ present (Algebraic Sum) | $V_{Lm}=V_L$ | $(V_{Lc}=V_{L1c}+V_{L2c})$ | |
| | | | |

| Condition | Load Current (mA) | | Error |
|---|---|---|---|
| | Measured Value | Calculated Value | ______ |
| $V_1$ present and $V_2$ replace by internal resistance | $I_{L1m}$ | $I_{L1c}$ | |
| | | | |
| $V_2$ present and $V_1$ replace by internal resistance | $I_{L2m}$ | $I_{L2c}$ | |
| | | | |
| Both $V_1$ and $V_2$ present (Algebraic Sum) | $I_{Lm}=I_L$ | $(I_{Lc}=I_{L1c}+I_{L2c})$ | |
| | | | |

**CALCULATION:**

**RESULT:** Thus the Superposition theorem is verified.

**REPORT WRITING:**

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.
Write your final report as per work instruction.

# ANNEXURE – 1

NAME:____________________________________________

ROLL NO.:__________ DEPARTMENT:________________

DATE OF SUBMISSION:_______ DATE OF EXPERIMENT: ______

## CO – WORKER

NAME ROLL NO.

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TITLE:________________________________________________________

OBJECTIVE:____________________________________________

Marks Obtained

Signature of the

Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/06**

**TITLE:** **STUDY THE RLC SERIES CIRCUIT.**

**OBJECTIVE :** To study the RLC series circuit and draw the following characteristics

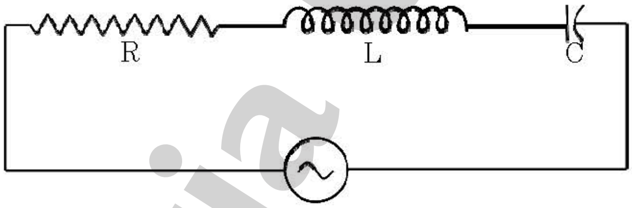
I. Frequency vs. Resistance
II. Frequency vs. Impedance
III. Frequency vs. Inductive reactance
IV. Frequency vs. Capacitive reactance
V. Frequency vs. Current

**APPRATUS :**

| Sl No | Apparatus Name | Apparatus Type | Range |
|---|---|---|---|
| 1 | Resistor | | |
| 2 | Inductor | | |
| 3 | Capacitor | | |
| 4 | Voltmeter | | |
| 5 | Audio Frequency Generator | | |

**THEORY:**

Consider an AC circuit containing resistance R, inductor L and a capacitor C connected in series as shown in figure below




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

Where $X_L = 2\pi fL$ and $X_C = \dfrac{1}{2\pi fC}$.

At resonance $X_L = X_C$ i.e. $X_L - X_C = 0$. Therefore impedance of the circuit is $R$ i.e. $Z = R$. So, current flowing through the circuit is maximum, given by $I = \dfrac{V}{R}$. In that condition voltage drop across the inductor and voltage drop across the capacitor is same and the power factor is unity. When these conditions are exists, the circuit is said to be in resonance. The frequency at which this occurs is called Resonance frequency, $f_r$.

At resonance $X_L = X_C$

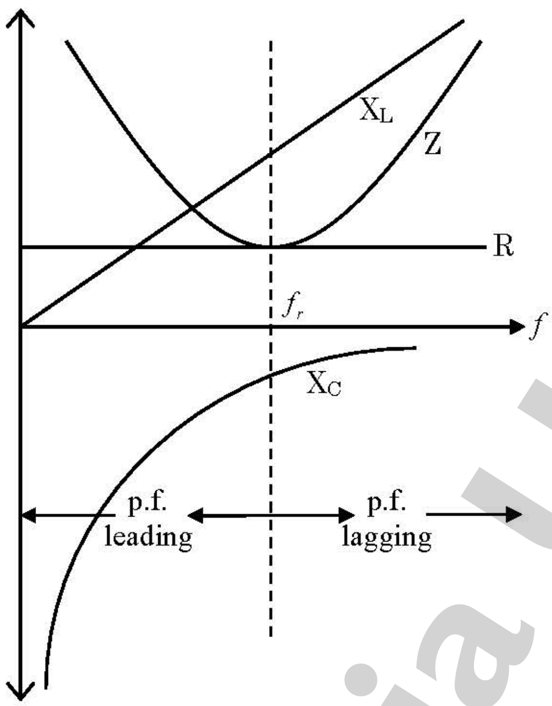
So $\omega_r L = \dfrac{1}{\omega_r C}$

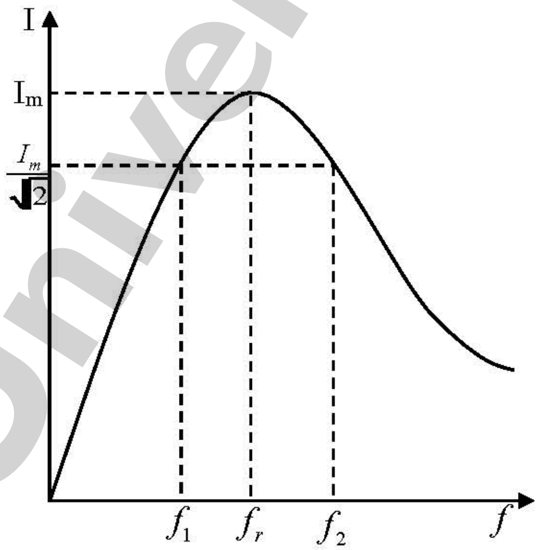
$$\omega_r^2 = \frac{1}{LC}$$

$$\omega_r = \frac{1}{\sqrt{LC}}$$

Therefore resonance frequency, $f_r = \frac{1}{2\pi\sqrt{LC}}$. Hence, the value of resonance frequency depends on the parameter of the two energy storing elements.

The variation of resistance, inductive reactance, capacitive reactance and impedance with respect to frequency are plotted in Fig. 1.



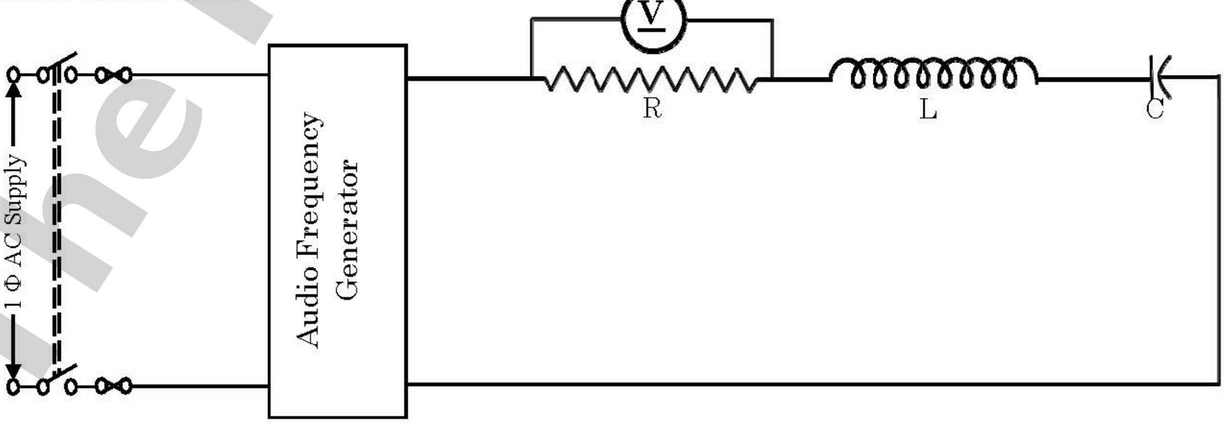

The variation of current $I$ with respect to frequency is also shown in above fig. From the above fig. bandwidth frequency = $f_2 - f_1$. So

$$\text{Q Factor} = \frac{f_r}{f_2 - f_1}$$

The Q Factor is also calculated by the following equation

$$\text{Q Factor} = \frac{\omega_r L}{R} = \frac{2\pi f_r L}{R}$$

**CIRCUIT DIAGRAM:**



**PROCEDURE:**

1) Connect the circuit diagram as shown in Fig.
2) Switch ON the power supply.
3) Vary the frequency step by step in small steps by adjust frequency variation knob.
4) Note down the voltmeter reading which indicate voltage across the resistance.
5) Switch OFF the power supply and disconnect the circuit.

**OBSERVATION TABLE:**

| Sl. No | Frequency *f* (Hz) | Resistance R (Ω) | Inductance L (mH) | Inductive Reactance $X_L$ (Ω) | Capacitance C (μF) | Capacitive Reactance $X_C$ (Ω) | Impedance Z (Ω) | Voltage across R $V_R$ (volt) | Current $I = V_R/R$ (amp) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | | | | | | | | | |
| **2** | | | | | | | | | |
| **3** | | | | | | | | | |
| **4** | | | | | | | | | |
| **5** | | | | | | | | | |
| **6** | | | | | | | | | |
| **7** | | | | | | | | | |
| **8** | | | | | | | | | |
| **9** | | | | | | | | | |
| **10** | | | | | | | | | |
| **11** | | | | | | | | | |
| **12** | | | | | | | | | |
| **13** | | | | | | | | | |
| **14** | | | | | | | | | |
| **15** | | | | | | | | | |
| **16** | | | | | | | | | |
| **17** | | | | | | | | | |
| **18** | | | | | | | | | |
| **19** | | | | | | | | | |
| **20** | | | | | | | | | |

**CALCULATION:**

**RESULT:** Calculate resonance frequency, bandwidth and Q – factor. Also draw the following characteristics

I. Frequency vs. Resistance
II. Frequency vs. Impedance
III. Frequency vs. Inductive reactance IV. Frequency vs. Capacitive reactance V. Frequency vs. Current

**REPORT WRITING:**

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.

Write your final report as per work instruction.

## ANNEXURE – 1

NAME:____________________________________________________________

ROLL NO.:_____________ DEPARTMENT:_____________________

DATE OF SUBMISSION:_________ DATE OF EXPERIMENT: _______

### CO – WORKER

NAME ROLL NO.

1.________________________________ _________________

2.________________________________ _________________

3.________________________________ _________________

4.________________________________ _________________

TITLE:__________________________________________________________________________

OBJECTIVE:__________________________________________________________

Marks Obtained

Signature of the

Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/07**

**TITLE: STUDY THE RLC PARALLEL CIRCUIT.**

**OBJECTIVE :** To study frequency response of parallel R-L-C circuit and determine resonance frequency.

**APPARATUS:** CRO, Audio frequency generator, Multi meters and connecting wires.

**THEORY:** For the parallel R-L-C circuit

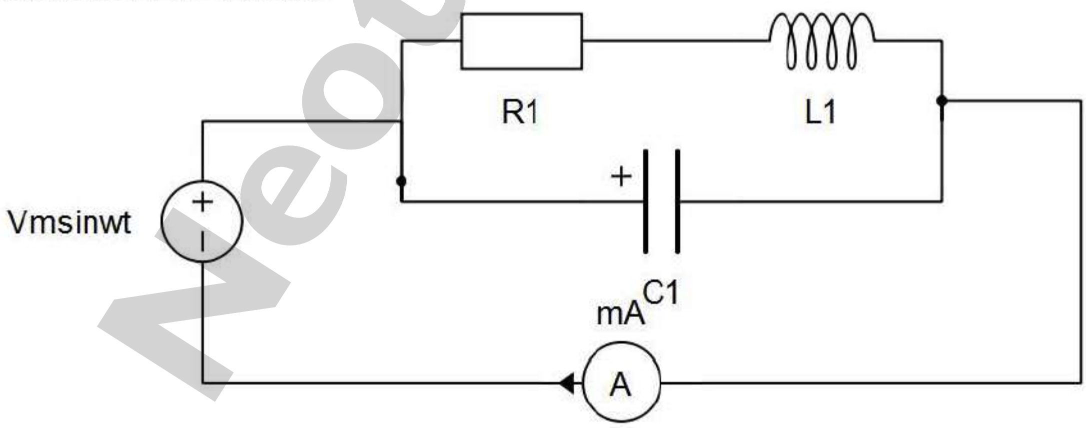
$I_C = I_L \sin\Phi_L$

$I_L = V/Z,$
$\sin \Phi_L = X_L/Z$

$V/Z * X_L / Z = V/X_C$

Or $X_L * X_C = Z^2$
or $L/C = Z^2$
$L/C = R^2 + X_L^2$
$f_o = 1/2\pi * \sqrt{1/LC - R^2/L^2}$

**CIRCUIT DIAGRAM:**



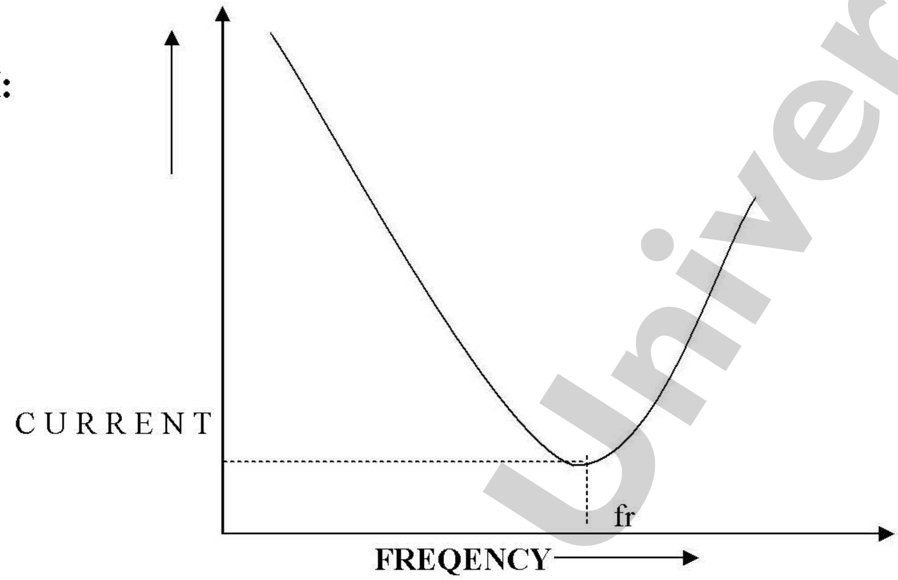

**PROCEDURE :**

- Make the connections shown in fig.
- Frequency is given by audio frequency generator.
- Change the frequency and note the reading carefully
- At certain frequency the voltage becomes minimum after which the voltage increases. This is the resonance frequency
- Plot a graph between frequency and voltage.

**OBSERVATION TABLE:**

| SR.NO | FREQUENCY (KHz) | CURRENT (AMP) |
|---|---|---|
| | | |

**GRAPH:**




**RESULT:** The resonance frequency is found to be……kHz.

**CONCLUSION:** Impedance is maximum at resonance frequency

**REPORT WRITING:**

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.
Write your final report as per work instruction.

## ANNEXURE – 1

NAME:_______________________________________________

ROLL NO.:__________ DEPARTMENT:_________________

DATE OF SUBMISSION:________ DATE OF EXPERIMENT: ______

### CO – WORKER

NAME ROLL NO.

1._________________________ _____________

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3._________________________ _____________

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TITLE:__________________________________________________________

OBJECTIVE:______________________________________________

Marks Obtained

Signature of the

Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/08**

**TITLE: FAMILIARISATION WITH PASSIVE AND ACTIVE ELECTRONIC COMPONENTSS.**

**OBJECTIVE :**

Familiarisation with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multimeters etc.

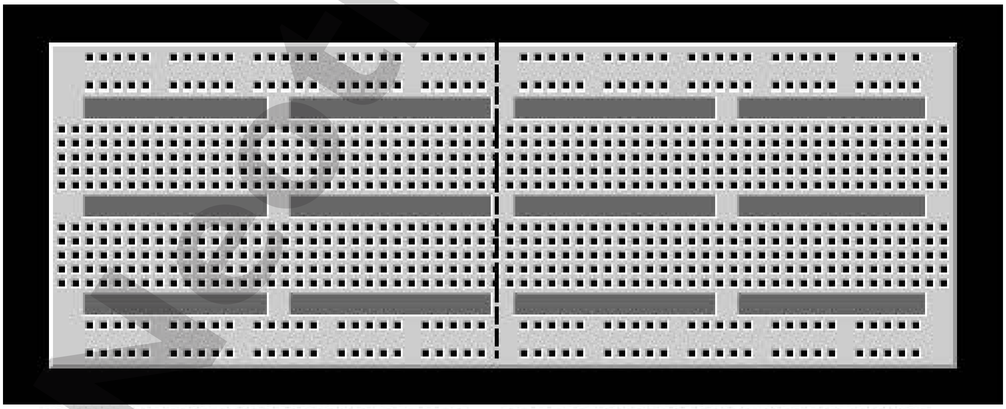
**APPARATUS:** CRO, Audio frequency generator, Multimeters resistor, capacitor, diode, BJTs etc

## THEORY

Breadboards:

In order to temporarily construct a circuit without damaging the components used to build it, we must have some sort of a platform that will both hold the components in place and provide the needed electrical connections. In the early days of electronics, most experimenters were amateur radio operators. They constructed their radio circuits on wooden breadboards. Although more sophisticated techniques and devices have been developed to make the assembly and testing of electronic circuits easier, the concept of the breadboard still remains in assembling components on a temporary platform.

(a)



(b)

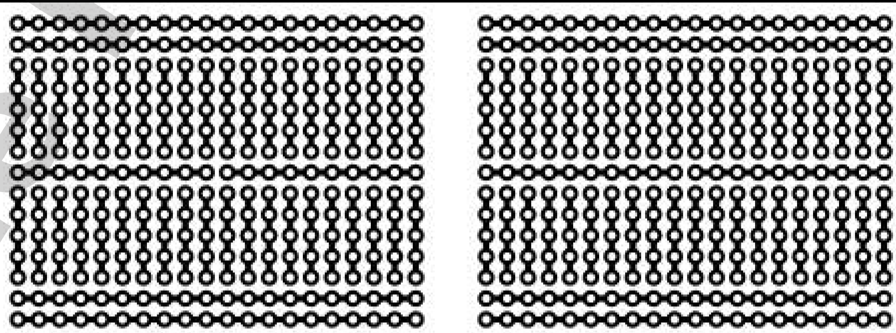


Fig. 1: (a) A typical **Breadboard** and (b) its connection **det**ails

A real breadboard is shown in Fig. 1(a) and the connection details on its rear side are shown in Fig. 1(b). The five holes in each individual column on either side of the central groove are electrically connected to each other, but remain insulated from all other sets of holes. In addition to the main columns of holes, however, you'll note four sets or groups of holes along the top and bottom. Each of these consists of five separate sets of five holes each, for a total of 25 holes. These groups of 25 holes are all connected together on either side of the dotted line indicated on Fig. 1(a) and needs an external connection if one wishes the entire row to be connected. This makes them ideal for distributing power to multiple ICs or other circuits.

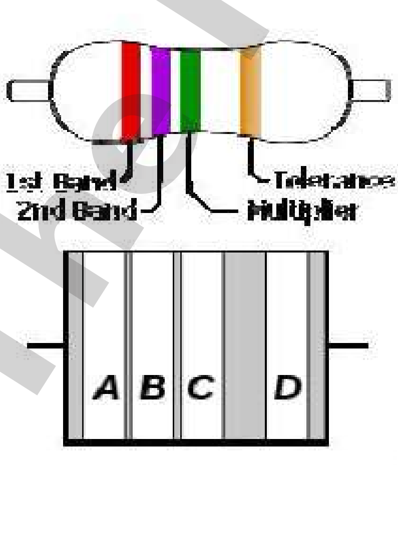
These breadboard sockets are sturdy and rugged, and can take quite a bit of handling. However, there are a few rules you need to observe, in order to extend the useful life of the electrical contacts and to avoid damage to components. These rules are:

- Always make sure power is disconnected when constructing or modifying your experimental circuit. It is possible to damage components or incur an electrical shock if you leave power connected when making changes.
- Never use larger wire as jumpers. #24 wire (used for normal telephone wiring) is an excellent choice for this application. Observe the same limitation with respect to the size of component leads.
- Whenever possible, use ¼ watt resistors in your circuits. ½ watt resistors may be used when necessary; resistors of higher power ratings should never be inserted directly into a breadboard socket.
- Never force component leads into contact holes on the breadboard socket. Doing so can damage the contact and make it useless.
- Do not insert stranded wire or soldered wire into the breadboard socket. If you must have stranded wire (as with an inductor or transformer lead), solder (or use a wire nut to connect) the stranded wire to a short length of solid hookup wire, and insert only the solid wire into the breadboard.

If you follow these basic rules, your breadboard will last indefinitely, and your experimental components will last a long time.

Resistors

Most axial resistors use a pattern of colored stripes to indicate resistance. A 4 band identification is the most commonly used color coding scheme on all resistors. It consists of four colored bands that are painted around the body of the resistor. Resistor values are always coded in ohms (Ω). The color codes are given in the following table in Fig. 1.




| Band Color | Digit | Multiplier | Tolerance |
|---|---|---|---|
| Black | 0 | 1 | — |
| Brown | 1 | 10 | ±1% |
| Red | 2 | 100 | ±2% |
| Orange | 3 | 1,000 | ±3% |
| Yellow | 4 | 10,000 | ±4% |
| Green | 5 | 100,000 | — |
| Blue | 6 | 1,000,000 | — |
| Violet | 7 | 10,000,000 | — |
| Gray | 8 | 100,000,000 | — |
| White | 9 | — | — |
| Gold | — | 0.1 | ±5% |
| Silver | — | 0.01 | ±10% |
| None | — | — | ±20% |

Fig. 1: Color codes of Resistors

- band A is first significant figure of component value
- band B is the second significant figure
- band C is the decimal multiplier
- band D if present, indicates tolerance of value in percent (no color means 20%)

For example, a resistor with bands of yellow, violet, red, and gold will have first digit 4 (yellow in table below), second digit 7 (violet), followed by 2 (red) zeros: 4,700 ohms. Gold signifies that the tolerance is ±5%, so the real resistance could lie anywhere between 4,465 and 4,935 ohms.

Tight tolerance resistors may have three bands for significant figures rather than two, and/or an additional band indicating temperature coefficient, in units of ppm/K. For large power resistors and potentiometers, the value is usually written out implicitly as "10 kΩ", for instance.

Capacitors:

You will mostly use electrolytic and ceramic capacitors for your experiments.

Electrolytic capacitors

An electrolytic capacitor is a type of capacitor that uses an electrolyte, an ionic conducting liquid, as one of its plates, to achieve a larger capacitance per unit volume than other types. They are used in relatively high-current and low-frequency electrical circuits. However, the voltage applied to these capacitors must be polarized; one specified terminal must always have positive potential with respect to the other. These are of two types, axial and radial capacitors as shown in adjacent figure. The arrowed stripe indicates the polarity, with the arrows pointing towards the negative pin.


Fig. 2:Axial and Radial Electrolytic capacitors

Warning: connecting electrolytic capacitors in reverse polarity can easily damage or destroy the capacitor. Most large electrolytic capacitors have the voltage, capacitance, temperature ratings, and company name written on them without having any special color coding schemes.

Axial electrolytic capacitors have connections on both ends. These are most frequently used in devices where there is no space for vertically mounted capacitors.

Radial electrolytic capacitors are like axial electrolytic ones, except both pins come out the same end. Usually that end (the "bottom end") is mounted flat against the PCB and the capacitor rises perpendicular to the PCB it is mounted on. This type of capacitor probably accounts for at least 70% of capacitors in consumer electronics.

Ceramic capacitors are generally non-polarized and almost as common as radial electrolytic capacitors. Generally, they use an alphanumeric marking system. The number part is the same as for resistors, except that the value represented is in pF. They may also be written out directly, for instance, 2n2 = 2.2 nF.

SMT

Fig. 3: Ceramic **capacitors**

Diodes:

A standard specification sheet usually has a brief description of the diode. Included in this description is the type of diode, the major area of application, and any special features. Of particular interest is the specific application for which the diode is suited. The manufacturer also provides a drawing of the diode which gives dimension, weight, and, if appropriate, any identification marks. In addition to the above data, the following information is also provided: a static operating table (giving spot values of parameters under fixed conditions), sometimes a characteristic curve (showing how parameters vary over the full operating range), and diode ratings (which are the limiting values of operating conditions outside which could cause diode damage). Manufacturers specify these various diode operating parameters and characteristics with "letter symbols" in accordance with fixed definitions. The following is a list, by letter symbol, of the major electrical characteristics for the rectifier and signal diodes.

RECTIFIER DIODES

DC BLOCKING VOLTAGE [$V_R$]—the maximum reverse dc voltage that will not cause breakdown.

AVERAGE FORWARD VOLTAGE DROP [$V_{F(AV)}$]—the average forward voltage drop across the rectifier given at a specified forward current and temperature.

AVERAGE RECTIFIER FORWARD CURRENT [$I_{F(AV)}$]—the average rectified forward current at a specified temperature, usually at 60 Hz with a resistive load.

AVERAGE REVERSE CURRENT [$I_{R(AV)}$]—the average reverse current at a specified temperature, usually at 60 Hz.

PEAK SURGE CURRENT [$I_{SURGE}$]—the peak current specified for a given number of cycles or portion of a cycle.

SIGNAL DIODES

PEAK REVERSE VOLTAGE [PRV]—the maximum reverse voltage that can be applied before reaching the breakdown point. (PRV also applies to the rectifier diode.)

REVERSE CURRENT [$I_R$]—the small value of direct current that flows when a semiconductor diode has reverse bias.

MAXIMUM FORWARD VOLTAGE DROP AT INDICATED FORWARD CURRENT [$V_F@I_F$]— the maximum forward voltage drop across the diode at the indicated forward current.

REVERSE RECOVERY TIME [$t_{rr}$]—the maximum time taken for the forward-bias diode to recover its reverse bias.

The ratings of a diode (as stated earlier) are the limiting values of operating conditions, which if exceeded could cause damage to a diode by either voltage breakdown or overheating.

The PN junction diodes are generally rated for: MAXIMUM AVERAGE FORWARD CURRENT, PEAK RECURRENT FORWARD CURRENT, MAXIMUM SURGE CURRENT, and PEAK REVERSE VOLTAGE

Maximum average **forward current** is usually given at a special temperature, usually 25° C, (77° F) and refers to the maximum amount of average current that can be permitted to flow in

the forward direction. If this rating is exceeded, structure breakdown can occur.
Peak recurrent forward current is the maximum peak current that can be permitted to flow in the forward direction in the form of recurring pulses.
Maximum surge current is the maximum current permitted to flow in the forward direction in the form of nonrecurring pulses. Current should not equal this value for more than a few milliseconds.

Peak reverse voltage (PRV) is one of the most important ratings. PRV indicates the maximum reverse-bias voltage that may be applied to a diode without causing junction breakdown. All of the above ratings are subject to change with temperature variations. If, for example, the operating temperature is above that stated for the ratings, the ratings must be decreased.

There are many types of diodes varying in size from the size of a pinhead (used in subminiature circuitry) to large 250-ampere diodes (used in high-power circuits). Because there are so many different types of diodes, some system of identification is needed to distinguish one diode from another. This is accomplished with the semiconductor identification system shown in Fig. 4. This system is not only used for diodes but transistors and many other special semiconductor devices as well. As illustrated in this figure, the system uses numbers and letters to identify different types of semiconductor devices. The first number in the system indicates the number of junctions in the semiconductor device and is a number, one less than the number of active elements. Thus 1 designates a diode; 2 designates a transistor (which may be considered as made up of two diodes); and 3 designates a tetrode (a four-element transistor). The letter "N" following the first number indicates a semiconductor. The 2- or 3-digit number following the letter "N" is a serialized identification number. If needed, this number may contain a suffix letter after the last digit. For example, the suffix letter "M" may be used to describe matching pairs of separate semiconductor devices or the letter "R" may be used to indicate reverse polarity. Other letters are used to indicate modified versions of the device which can be substituted for the basic numbered unit. For example, a semiconductor diode designated as type 1N345A signifies a two-element diode (1) of semiconductor material (N) that is an improved version (A) of type 345.

XNYYY

XN YYY

COMPONENT IDENTIFICATION NUMBER

X - NUMBER OF SEMICONDUCTOR JUNCTIONS
N - A SEMICONDUCTOR
YYY - IDENTIFICATION NUMBER (ORDER OR REGISTRATION NUMBER) ALSO INCLUDES SUFFIX LETTER (IF APPLICABLE) TO INDICATE

1. MATCHING DEVICES
2. REVERSE POLARITY
3. MODIFICATION

EXAMPLE - 1N345A (AN IMPROVED VERSION OF THE SEMICONDUCTOR DIODE TYPE 345)

Fig. 4: Identification of Diode

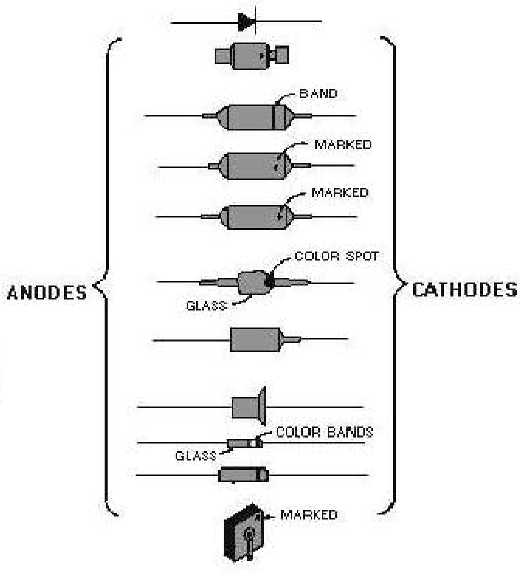



Fig. 5: Identification of Cathode

When working with different types of diodes, it is also necessary to distinguish one end of the diode from the other (anode from cathode). For this reason, manufacturers generally code the cathode end of the diode with a "k," "+," "cath," a color dot or band, or by an unusual shape (raised edge or taper) as shown in Fig. 5. In some cases, standard color code bands are placed on the cathode end of the diode. This serves two purposes: (1) it identifies the cathode end of the diode, and (2) it also serves to identify the diode by number.

Transistors:

Transistors are identified by a Joint Army-Navy (JAN) designation printed directly on the case of the transistor. If in doubt about a transistor's markings, always replace a transistor with one having identical markings, or consult an equipment or transistor manual to ensure that an identical replacement or substitute is used.

Example:

| 2 | N | 130 | A |
|---|---|---|---|
| NUMBER OF JUNCTIONS (TRANSISTOR) | SEMICONDUCTOR | IDENTIFICATION NUMBER | FIRST MODIFICATION |

There are three main series of transistor codes used:

- Codes beginning with B (or A), for example BC108, BC478
  The first letter B is for silicon, A is for germanium (rarely used now). The second letter indicates the type; for example C means low power audio frequency; D means high power audio frequency; F means low power high frequency. The rest of the code identifies the particular transistor. There is no obvious logic to the numbering system. Sometimes a letter is added to the end (eg BC108C) to identify a special version of the main type, for example a higher current gain or a different case style. If a project specifies a higher gain version (BC108C) it must be used, but if the general code is given (BC108) any transistor with that code is suitable.
- Codes beginning with TIP, for example TIP31A
  TIP refers to the manufacturer: Texas Instruments Power transistor. The letter at the end identifies versions with different voltage ratings.
- Codes beginning with 2N, for example 2N3053
  The initial '2N' identifies the part as a transistor and the rest of the code identifies the particular transistor. There is no obvious logic to the numbering system.

TESTING A TRANSISTOR to determine if it is good or bad can be done with an ohmmeter or transistor tester. PRECAUTIONS should be taken when working with transistors since they are susceptible to damage by electrical overloads, heat, humidity, and radiation. TRANSISTOR LEAD IDENTIFICATION plays an important part in transistor maintenance because before a transistor can be tested or replaced, its leads must be identified. Since there is NO standard method of identifying transistor leads, check some typical lead identification schemes or a transistor manual before attempting to replace a transistor. Identification of leads for some common case styles is shown in Fig. 6.

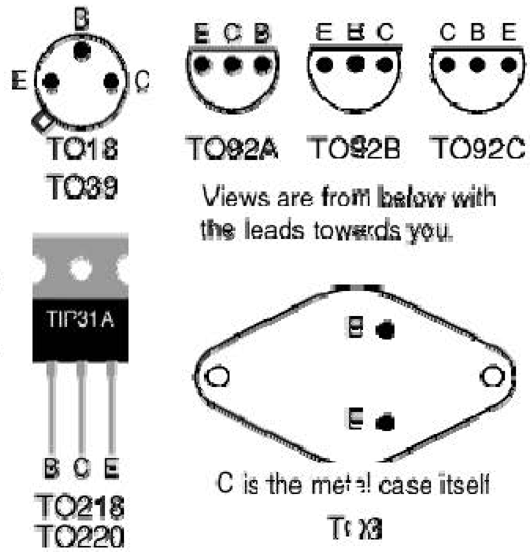


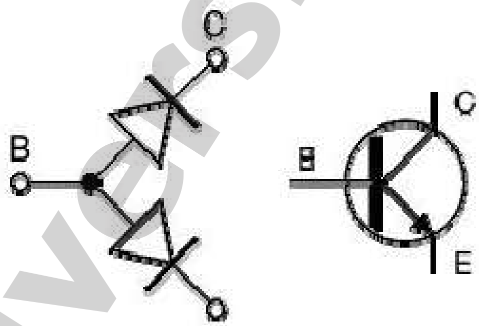

Fig. 6

### Testing a transistor

Transistors are basically made up of two Diodes connected together back-to-back (Fig. 7). We can use this analogy to determine whether a transistor is of the type PNP or NPN by testing its Resistance between the three different leads, Emitter, Base and Collector.

### Testing with a multimeter

Use a multimeter or a simple tester (battery, resistor and LED) to check each pair of leads for conduction. Set a digital multimeter to diode test and an analogue multimeter to a low resistance range.




- The **base-emitter** (BE) junction should behave like a diode and conduct one way only.
- The **base-collector** (BC) junction should behave like a diode and conduct one way only.
- The **collector-emitter** (CE) should not conduct either way.

The diagram shows how the junctions behave in an NPN transistor. The diodes are reversed in a PNP transistor but the same test procedure can be used.

### Transistor Resistance Values for the PNP and NPN transistor types

| Between Transistor Terminals | | PNP | NPN |
|---|---|---|---|
| Collector | Emitter | $R_{HIGH}$ | $R_{HIGH}$ |
| Collector | Base | $R_{LOW}$ | $R_{HIGH}$ |
| Emitter | Collector | $R_{HIGH}$ | $R_{HIGH}$ |
| Emitter | Base | $R_{LOW}$ | $R_{HIGH}$ |
| Base | Collector | $R_{HIGH}$ | $R_{LOW}$ |
| Base | Emitter | $R_{HIGH}$ | $R_{LOW}$ |

## Procedure

1. Measure and record 10 resistors with different value.
2. Find the R max. , R min. then calculate the percentage error.
3. Repeat the steps (1,2) with capacitor value.
4. Repeat the steps (1,2) with inductor.

**REPORT WRITING:**

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.
Write your final report as per work instruction.

## ANNEXURE – 1

NAME:_______________________________________________________

ROLL NO.:____________ DEPARTMENT:____________________

DATE OF SUBMISSION:_________ DATE OF EXPERIMENT: _______

### CO – WORKER

NAME ROLL NO.

1.______________________________ ________________

2.______________________________ ________________

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TITLE:___________________________________________________________________

OBJECTIVE:_____________________________________________________

Marks Obtained

Signature of the
Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/09**

**TILLE: FAMILIARISATION WITH MEASURING INSRUMENTS**

**OBJECTIVE :** To get familiar with working knowledge of the following Instruments: (a) Cathode Ray Oscilloscope(CRO)(b) Function Generator (c) Multimeter (Analog&Digital)(d) Power Supply

(a) CATHODE RAY OSCILLOSCOPE

The cathode-ray oscilloscope (CRO) is a common laboratory instrument that provides accurate time and amplitude measurements of voltage signals over a wide range of frequencies. Its reliability, stability, and ease of operation make it suitable as a general purpose laboratory instrument. The heart of the CRO is a cathode-ray tube shown schematically in Fig. 1.

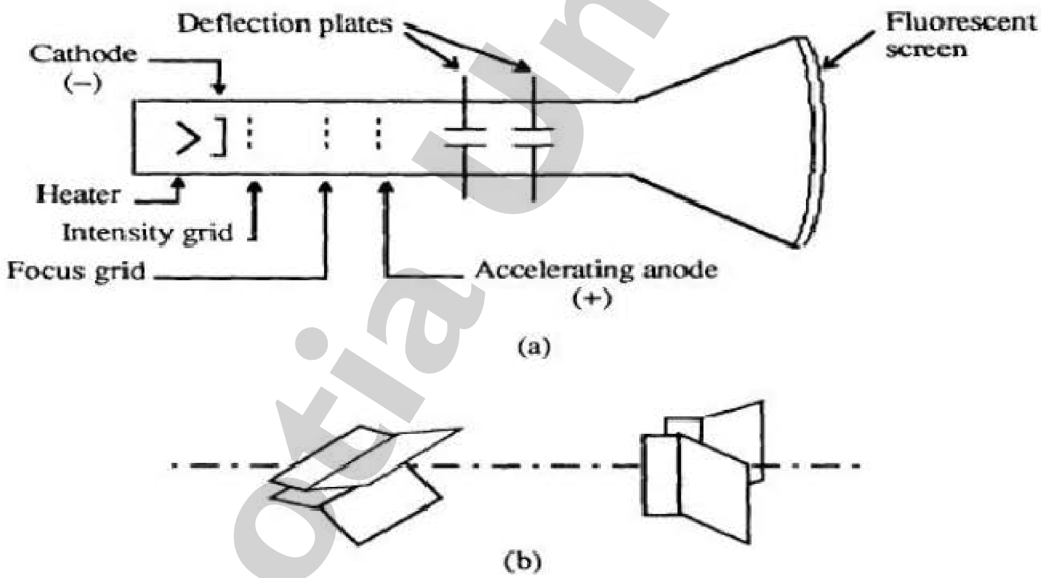



Figure 1. Cathode-ray tube: (a) schematic, (b) detail of the deflection plates.

The cathode ray is a beam of electrons which are emitted by the heated cathode (negative electrode) and accelerated toward the fluorescent screen. The assembly of the cathode, intensity grid, focus grid, and accelerating anode (positive electrode) is called an electron gun. Its purpose is to generate the electron beam and control its intensity and focus. Between the electron gun and the fluorescent screen are two pair of metal plates - one oriented to provide horizontal deflection of the beam and one pair oriented ot give vertical deflection to the beam. These plates are thus referred to as the horizontal and vertical deflection plates. The combination of these two deflections allows the beam to reach any portion of the fluorescent screen. Wherever the electron beam hits the screen, the phosphor is excited and light is emitted from that point. This conversion of electron energy into light allows us to write with points or lines of light on an otherwise darkened screen.

The voltage output of such a generator is that of a sawtooth wave as shown in Fig. 2. Application of one cycle of this voltage difference, which increases linearly with time, to the horizontal plates causes the beam to be deflected linearly with time across the tube face. When the voltage suddenly falls to zero, as at points (a) (b) (c), etc...., the end of each sweep - the beam flies back to its initial position. The horizontal deflection of the beam is repeated periodically, the frequency of this periodicity is adjustable by external controls.

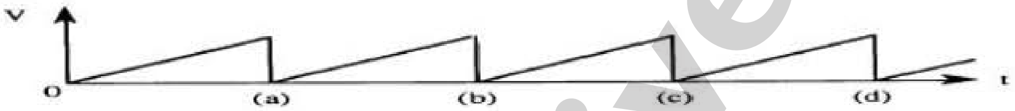
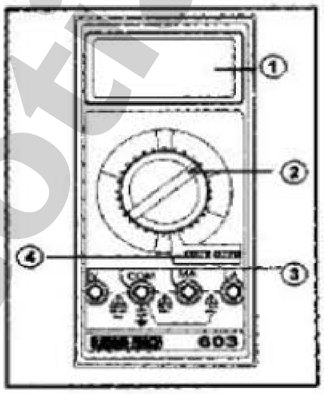



Figure. 2. Voltage difference V between horizontal plates as a function of time t.

D To obtain steady traces on the tube face, an internal number of cycles of the unknown signal that is applied to the vertical plates must be associated with each cycle of the sweep generator. Thus, with such a matching of synchronization of the two deflections, the pattern on the tube face repeats itself and hence appears to remain stationary. The persistence of vision in the human eye and of the glow of the fluorescent screen aids in producing a stationary pattern. In addition, the electron beam is cut off (blanked) during flyback so that the retrace sweep is not observed

(b) MULTIMETER




A multimeter is used to make various electrical measurements, such as AC and DC voltage, AC and DC current, and resistance. It is called a multimeter because it combines the functions of a voltmeter, ammeter, and ohmmeter. Multimeters may also have other functions, such as diode and continuity tests. The descriptions and pictures that follow are specific to the Fluke 73 Series III Multimeter, but other multimeters are similar.

## (c) FUNCTION GENERATOR

A function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes.

- It is used to test the response of circuits to common input signals. The electrical leads from the device are attached to the ground and signal input terminals of the device under test.

Features and controls

- Most function generators allow the user to choose the shape of the output from a small number of options.
- -Square wave - The signal goes directly from high to low voltage.
  -Sine wave - The signal curves like a sinusoid from high to low voltage.
  -Triangle wave - The signal goes from high to low voltage at a fixed rate.

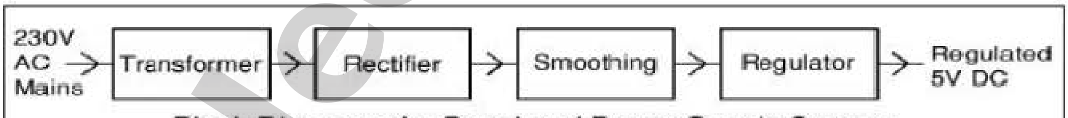
- The amplitude control on a function generator varies the voltage difference between the high and low voltage of the output signal.
- The direct current (DC) offset control on a function generator varies the average voltage of a signal relative to the ground.

- The frequency control of a function generator controls the rate at which output signal oscillates. On some function generators, the frequency control is a combination of different controls.
- One set of controls chooses the broad frequency range (order of magnitude) and the other selects the precise frequency. This allows the function generator to handle the enormous variation in frequency scale needed for signals.

## (d) POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronics circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function.

For example a 5V regulated supply:




Block Diagram of a Regulated Power Supply System

Each of the blocks is described in more detail below:

- Transformer - steps down high voltage AC mains to low voltage AC.
- Rectifier - converts AC to DC, but the DC output is varying.
- Smoothing - smoothes the DC from varying greatly to a small ripple.
  Regulator - eliminates ripple by setting DC output to a fixed voltage.

**REPORT WRITING:**

**Attach the rough note with your final report.**
**The 1st Page of the report shall be as per the format shown in Annexure – 1.**
**Write your final report as per work instruction.**

## ANNEXURE – 1

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OBJECTIVE:__________________________________________________

Marks Obtained

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**EXPERIMENT NO. : ES-EEP101/10**

**TILLE: Volt-Ampere Characteristics of PN junction diode**

## Objective:

1. To plot Volt-Ampere Characteristics of Silicon P-N Junction Diode.
2. To find cut-in Voltage for Silicon P-N Junction diode.
3. To find static and dynamic resistances for P-N Junction diode.

## Apparatus:

| S.No | Apparatus | Type | Range | Quantity |
|---|---|---|---|---|
| 01 | PN Junction diode | 1N4007 | | 01 |
| 02 | Resistance | | 470Ω,1KΩ | 01 |
| 03 | Regulated Power supply | | (0-30V) | 01 |
| 04 | Ammeter | | (0-100mA),(0-100μA) | 01 |
| 05 | Voltmeter | | (0-2V),(0-30V) | 01 |
| 06 | Breadboard and Wires | | | |

## Introduction
:

The semi conductor diode is created by simply joining an n-type and a p-type material together nothing more just the joining of one material with a majority carrier of electrons to one with a majority carrier of holes.

The P-N junction supports uni-directional current flow. If +ve terminal of the input supply is connected to anode (P-side) and –ve terminal of the input supply is connected to cathode (N- side), then diode is said to be forward biased. In this condition the height of the potential barrier at the junction is lowered by an amount equal to given forward biasing voltage. Both the holes from p-side and electrons from n-side cross the junction simultaneously and constitute a forward current( **injected minority current** – due to holes crossing the junction and entering N-side of the diode, due to electrons crossing the junction and entering P-side of the diode).

Assuming current flowing through the diode to be very large, the diode can be approximated as short- circuited switch. If –ve terminal of the input supply is connected to anode (p-side) and +ve terminal of the input supply is connected to cathode (n-side) then the diode is said to be reverse biased. In this condition an amount equal to reverse biasing voltage increases the height of the potential barrier at the junction. Both the holes on p-side and electrons on n-side tend to move away from the junction thereby increasing the depleted region. However the process cannot continue indefinitely, thus a small current called **reverse saturation current** continues to flow in the diode. This small current is due to thermally generated carriers. Assuming current flowing through the diode to be negligible, the diode can be approximated as an open circuited switch. The volt-ampere characteristics of a diode explained by following equation:

$$I = I_0 (e^{\frac{V}{\eta V_T}} - 1)$$

I=current flowing in the diode

$I_0$=reverse saturation current

V=voltage applied to the diode

$V_T$=volt-equivalent of temperature $= \frac{KT}{q} = \frac{T}{11,600} = 26mA$ at room temp

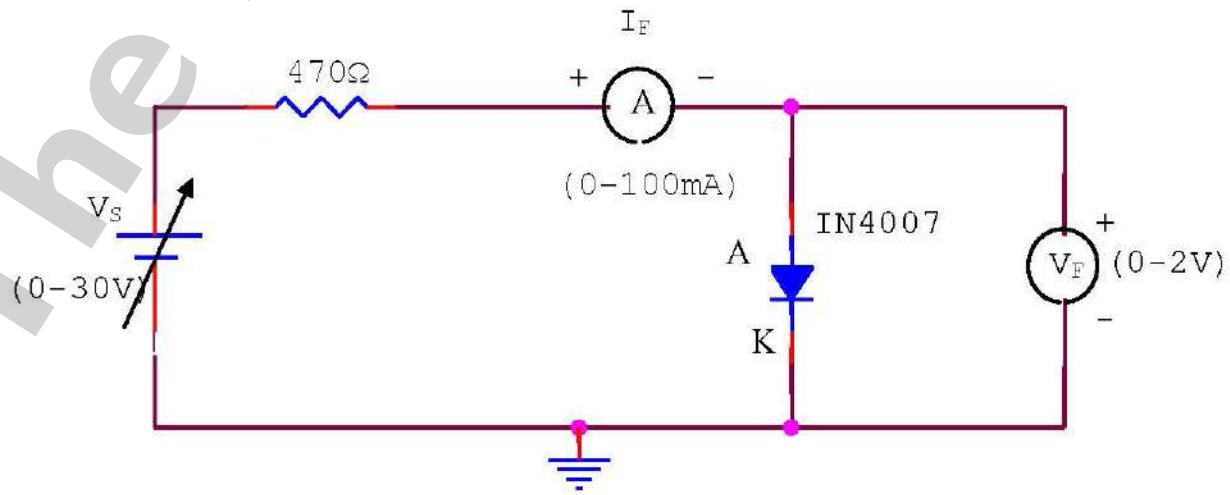
$\eta = 1$ (for Ge)

$\eta = 2$ (for Si)

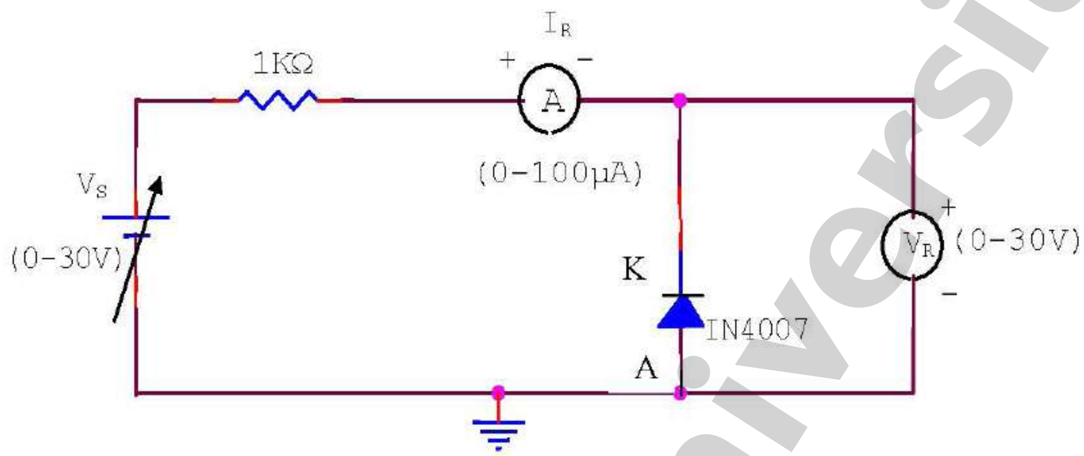
It is observed that Ge diode has smaller cut-in-voltage when compared to Si diode. The reverse saturation current in Ge diode is larger in magnitude when compared to silicon diode.

## Circuit Diagram

## Forward Bias



**Reverse Bias:**




## Experiment

**Forward Biased condition**

1. Connect the PN Junction diode in forward bias i.e Anode is connected to positive of the power supply and cathode is connected to negative of the power supply .

2. Use a Regulated power supply of range (0-30)V and a series resistance of 470Ω

3. By varying the input voltage in steps of 0.1V, note down corresponding Ammeter readings.($I_F$) and voltmeter reading.

4. Plot the graph between forward voltage ($V_F$) and forward current ($I_F$).

**Reverse Biased condition**

1. Connect the PN Junction diode in Reverse bias i.e; anode is connected to negative of the power supply and cathode is connected to positive of the power supply.

2. Use a Regulated power supply of range (0-30)V and a series resistance of 1KΩ

3. By varying the input voltage vary voltage ($V_R$) in steps of 1V and note down corresponding Ammeter readings.($I_R$)

4. Plot the graph between Reverse voltage ($V_R$) and Reverse current ($I_R$).

## Tabular column

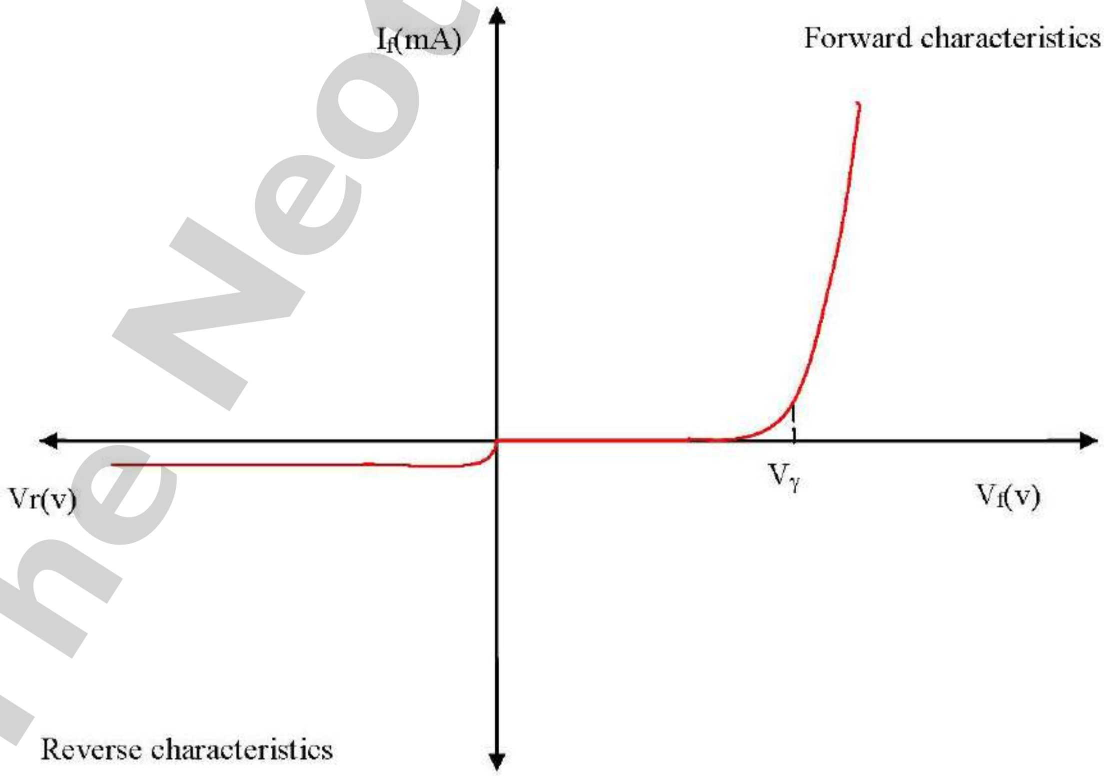
Forward Bias

| S.No | $V_S$ (Volts) | $V_F$ (Volts) | $I_F$ (mA) |
|---|---|---|---|
| | | | |

Reverse Bias

| S.No | $V_S$ (Volts) | $V_R$ (Volts) | $I_R$ (µA) |
|---|---|---|---|
| | | | |

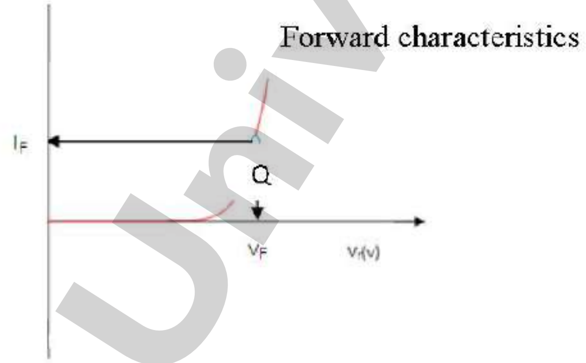
## Model Graph



## Calculations from the Graph

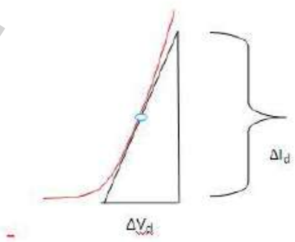
1. **Static Resistance:** To find the forward static resistance locate a point on characteristic curve obtained from the forward bias characteristics which is called operating point Q and draw a line onto the X-axis and Y-axis to obtain $V_F$ and $I_F$ Calculate static forward resistance using the formulae

   Static forward Resistance $R_{DC} = \frac{V_F}{I_F} \Omega$ at Q-point.




2. **Dynamic Resistance**: The dc resistance of a diode is independent of the shape of the characteristic in the region surrounding the point of interest. If a sinusoidal input is applied rather than a dc input ,the varying input will move the instantaneous operating point up and down a region of the characteristics and thus defines a specific change in current and voltage. To find the ac or dynamic resistance draw a straight line drawn tangent to the curve through the Q-point as shown in the figure will define a particular change in voltage and current that can be used to determine the ac or dynamic resistance for this region of the diode characteristics.

   Dynamic Resistance $r_d = \frac{\Delta V_d}{\Delta I_d}$ $\Omega$ at Q-point



## Precautions:

1. While doing the experiment do not exceed the ratings of the diode. This may lead to damage of the diode.
2. Connect voltmeter and Ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch **ON** the power supply unless you have checked the circuit connections as per the circuit diagram.

## Result:

Thus the VI characteristic of PN junction diode is verified.

1. Cut in voltage = ……… V
2. Static forward resistance = ………. Ω
3. ac or Dynamic resistance = ………. Ω

REPORT WRITING:

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.
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OBJECTIVE:_____________________________________________

Marks Obtained

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**EXPERIMENT NO. : ES-EEP101/11**

**TILLE: Volt-Ampere Characteristics of Zener Diode and Zener Voltage regulator characteristics.**

## Objective:

1. To plot Volt-Ampere Characteristics of Zener Diode in reverse bias.
2. To find Zener Breakdown Voltage in reverse biased condition.
3. To find load regulation characteristics of Zener voltage regulator

## Apparatus:

| S.No | Apparatus | Type | Range | Quantity |
|---|---|---|---|---|
| 01 | Zener diode | IMZ 5.1V | | 01 |
| 02 | Resistance | | 470Ω | 01 |
| 03 | Regulated Power supply | | (0-30V) | 01 |
| 04 | Ammeter | | (0-100mA) | 02 |
| 05 | Voltmeter | | (0-10V) | 01 |
| 06 | Decade Resistance Box | | (0-10K) | 01 |
| 07 | Breadboard and Wires | | | |

## Introduction:

An ideal P-N Junction diode does not conduct in reverse biased condition. A **zener diode** conducts

excellently even in reverse biased condition. These diodes operate at a precise value of voltage called break down voltage. A **zener diode** when forward biased behaves like an ordinary P-N junction diode.

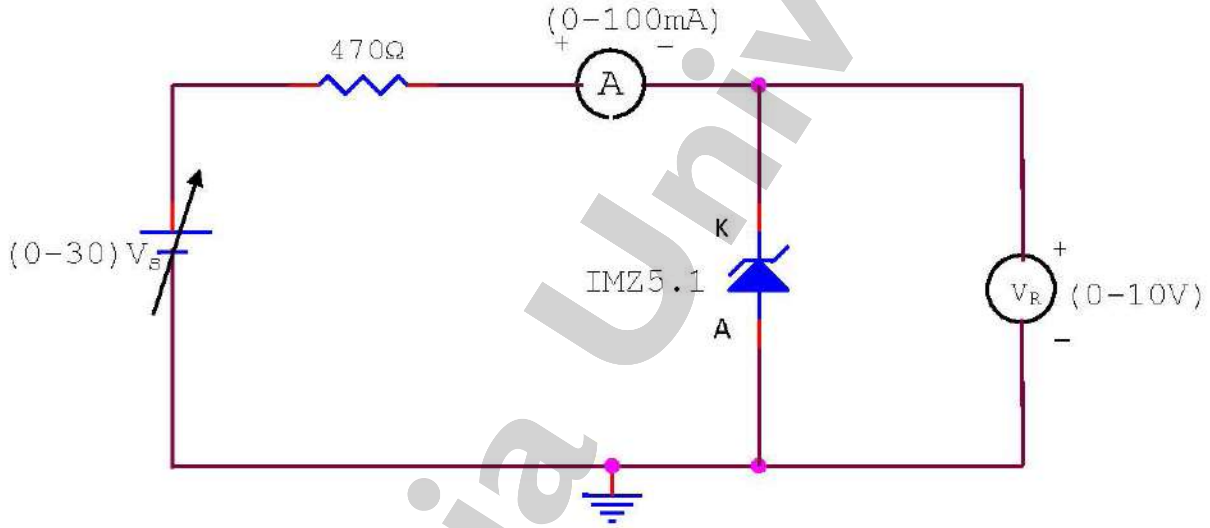
A **zener diode** when reverse biased can either undergo **avalanche break down** or **zener break down**.

**Avalanche break down**:-If both p-side and n-side of the diode are lightly doped, depletion region at the junction widens. Application of a very large electric field at the junction may rupture covalent bonding between electrons. Such rupture leads to the generation of a large number of charge carriers resulting in **avalanche multiplication**.

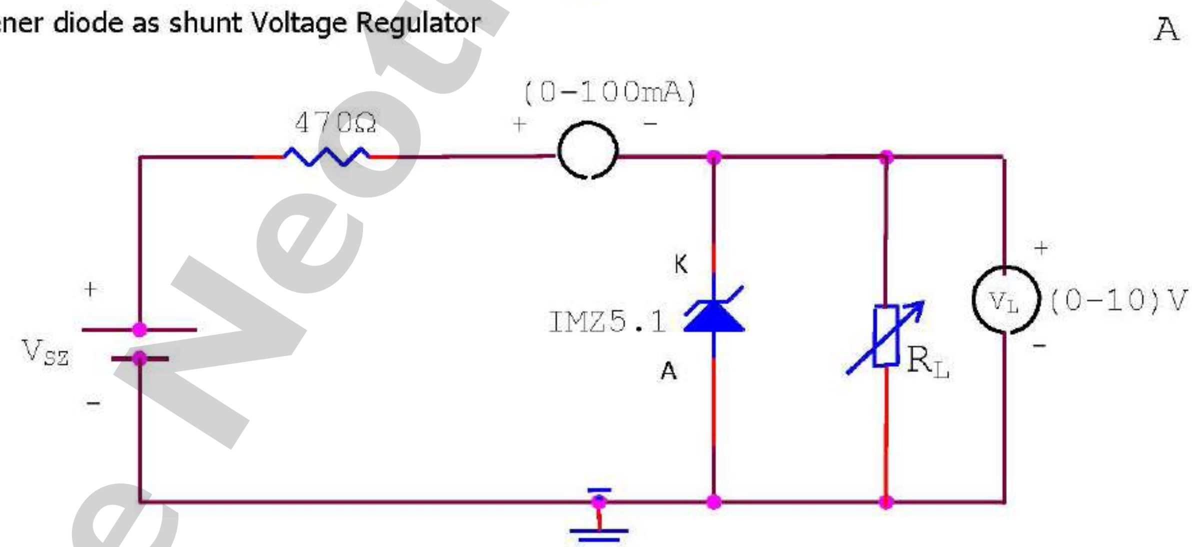
**Zener break down**:-If both p-side and n-side of the diode are heavily doped, depletion region at the junction reduces. Application of even a small voltage at the junction ruptures covalent bonding and generates large number of charge carriers. Such sudden increase in the number of charge carriers results in **zener mechanism**.

## Circuit Diagram

Reverse Biased




Zener diode as shunt Voltage Regulator




## Precautions:

1. While doing the experiment do not exceed the ratings of the diode. This may lead to damage of the diode.

2. Connect voltmeter and Ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch **ON** the power supply unless you have checked the circuit connections as per the circuit diagram.

## Experiment:

**To plot V-I characteristics of Zener diode in reverse bias condition and to find Zener breakdown voltage**

1. Connect the Zener diode in Reverse bias i.e; anode is connected to negative of the power supply and cathode is connected to positive of the power supply as in circuit.
2. Vary the input voltage in steps of 1V and note down reverse voltage($V_R$) and the corresponding values of reverse current ( $I_R$ ).
3. Plot the graph between reverse voltage ($V_R$) and the reverse current ( $I_R$ ).

**To plot the load regulation characteristics of the Zener voltage regulator.**

1. Connect the Zener diode in Reverse bias i.e; anode is connected to negative of the power supply and cathode is connected to positive of the power supply as in circuit.
2. In finding load regulation , input voltage ($V_{sz}$) is kept constant i.e source voltage is chosen as a voltage at which Zener voltage $V_Z$ is remaining constant while the current is increasing($V_{sz}$ from $1^{st}$ circuit characteristics)
3. Measure $V_{NL}$ (No load voltage) by opening the load resistance.
4. Connect the load resistance, and vary the load resistance from 1100Ω to 100Ω in steps of 100Ω and note down the readings of $V_L$ and $I_Z$
5. Calculate % Regulation by using the formula given below.

$$\%\text{Regulation} = \frac{V_{NL} - V_L}{V_L} X100$$

## Tabular column

1. To plot V-I characteristics

| S.No | $V_s$(V) | $V_R$(V) | $I_R$(mA) |
|---|---|---|---|
| | | | |

2. To find load regulation characteristics

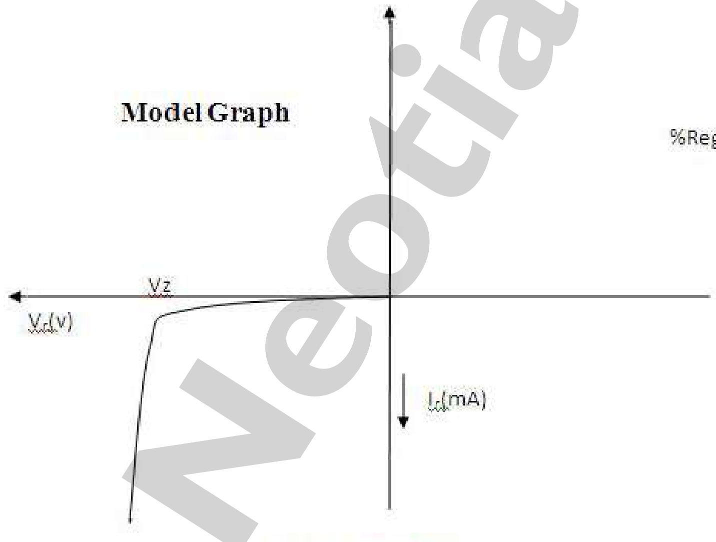
$V_{NL=}$ ---------------

| S.No | $R_L$ | $I_Z$(mA) | $V_L$(V) | % Regulation |
|---|---|---|---|---|
| | **1100** **To** **100** (in steps of 100) | | | |

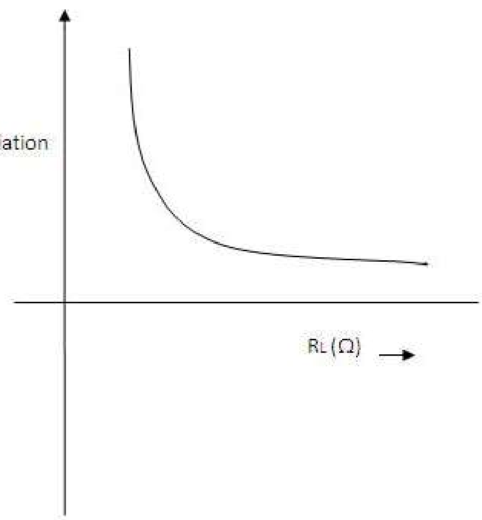
**Precautions:**

Keeping the input voltage constant if the load resistance is increased zener current increases so as to make the load voltage to remain constant.

## Model Graph:




Reverse characteristics




Regulation characteristics

**Calculations from Graph**

To find Zener breakdown voltage

1.In the reverse characteristics of Zener diode observe the voltage at which the reverse current is abnormally increasing while the reverse voltage remain constant.

2.That particular reverse voltage is called the breakdown voltage of the Zener diode

## Result

1.The V-I characteristics of Zener diode were plotted and the Zener breakdown voltage was determined and is given as ----------------------V

2. Load regulation characteristics were plotted.

**REPORT WRITING:**

Attach the rough note with your final report.
The 1st Page of the report shall be as per the format shown in Annexure – 1.
Write your final report as per work instruction.

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OBJECTIVE:____________________________________________________

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## EXPERIMENT NO. : ES-EEP101/12

## TILLE: Half-Wave and Full wave rectifier with regulation and ripple factor

### Objective

1. To plot input and output waveforms of the Half and full Wave Rectifier with and without Filter
2. To find ripple factor of Half and full Wave Rectifier with and without Filter
3. To find percentage regulation of Half and full Wave Rectifier with and without Filter

### Apparatus

| S.No | Apparatus | Type | Range | Quantity |
|---|---|---|---|---|
| 01 | Transformer | Step-down | 0-12V | 01 |
| 02 | Diode | IN4007 | | 02 |
| 03 | Decade Resistance Box | | 10-1KΩ | 01 |
| 04 | Capacitor | | 1000µF/25V | 01 |
| 05 | Digital Multimeter(DMM) | | (0-20V) | 01 |
| 06 | CRO & CRO Probes | | | 01 |
| 07 | Breadboard and Wires | | | |

### INTRODUCTION:

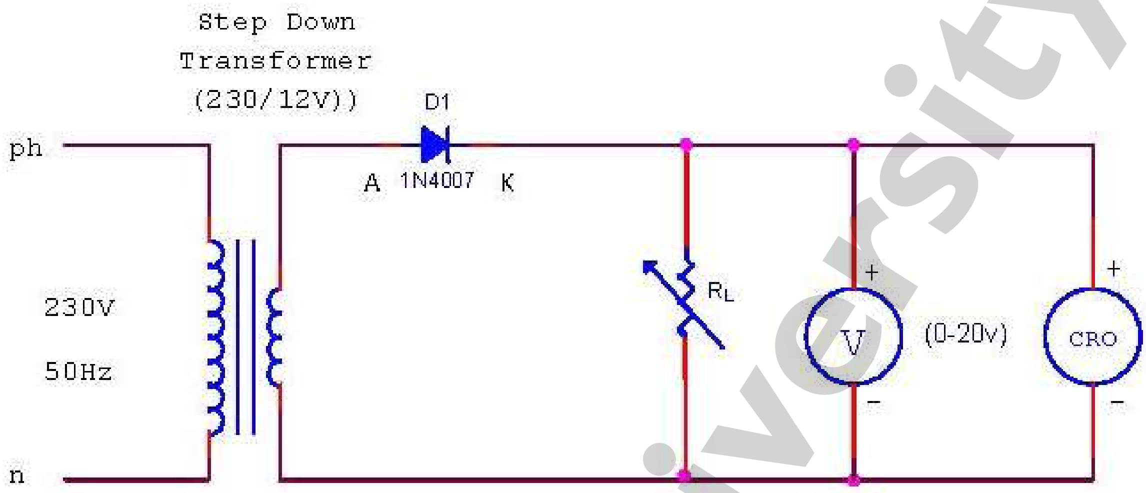
A device is capable of converting a sinusoidal input waveform into a unidirectional waveform with non zero average component is called a rectifier.

A practical half wave rectifier with a resistive load is shown in the circuit diagram. During the positive half cycle of the input the diode conducts and all the input voltage is dropped across $R_L$. During the negative half cycle the diode is reverse biased and it acts as almost open circuit so the output voltage is zero.

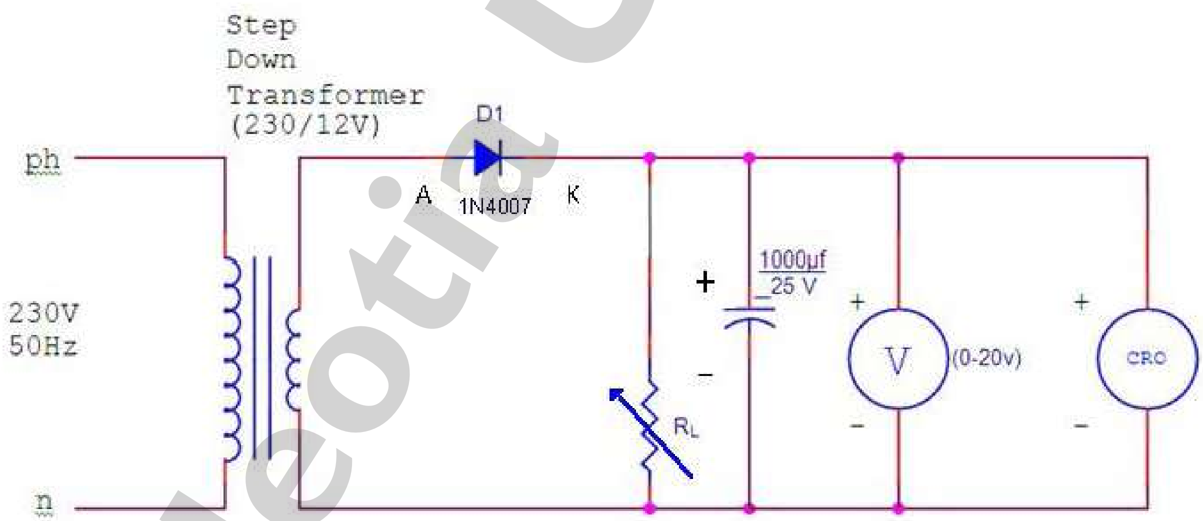
The filter is simply a capacitor connected from the rectifier output to ground. The capacitor quickly charges at the beginning of a cycle and slowly discharges through $R_L$ after the positive peak of the input voltage. The variation in the capacitor voltage due to charging and discharging is called ripple voltage. Generally, ripple is undesirable, thus the smaller the ripple, the better the filtering action.

## Circuit Diagram

**Without Filter**




With Filter




**PRECAUTIONS**

1. The primary and secondary sides of the transformer should be carefully identified.
2. The polarities of the diode should be carefully identified.

**Theoretical calculations for Ripple factor:-**

**Without Filter:-**

$$V_{dc} = \frac{V_m}{\pi}$$

$$V_{rms} = \frac{V_m}{2}$$

$$\text{Ripple factor} = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} \quad = 1.21$$

**With Filter:-**

$$\text{Ripple factor} = \frac{1}{2\sqrt{3} fCR_L} =$$

Where f =50Hz
C =1000μF
$R_L$=1KΩ

**EXPERIMENT (without Filter)**

1. Connections are made as per the circuit diagram of the rectifier without filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3.Note down the no load voltage before applying the load to the Circuit and by using the Multimeter, measure the ac input voltage of the rectifier and its frequency.

4.Now Vary the $R_L$ in steps of 100Ω by varying the DRB from 1100Ω to 100Ω and note down the load voltage ($V_L$) using the multimeter for each value of $R_L$ and calculate the percentage regulation.

5.Measure the AC and DC voltage at the output of the rectifier for each value of $R_L$ using Multimeter.

6.Now Observe the output waveform on CRO across $R_L$ and find out value of $V_m$.

7. Now calculate $V_{dc}$, $V_{rms}$, Ripple Factor and other parameters of half wave rectifier according to the given formulae.

8.Measure the amplitude and timeperiod of the transformer secondary(input waveform) by connecting CRO.

9.Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.

**EXPERIMENT (with Filter)**

1. Connections are made as per the circuit diagram of the rectifier with filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the rectifier.

4.Measure the amplitude and timeperiod of the transformer secondary(input waveform) by connecting CRO.

5.Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.

**Tabular Column:** **Without Filter**

**Using DMM:**

| $V_{ac}$ | $V_{dc}$ | Ripple Factor(γ)= $V_{ac}/V_{dc}$ |
|---|---|---|
| | | |

**Using CRO :**

| $R_L$ (Ω) | $V_L$ (V) | $V_m$ (V) | $Vdc=\frac{Vm}{\pi}$ (V) | $Vrms=\frac{Vm}{2}$ (V) | $Vr(rms) = \sqrt{Vrms^2 - Vdc^2}$ (V) | R.F= $\frac{Vr(rms)}{Vdc}$ | % Regulation $=\frac{V(NL)-V(L)}{VL}$ |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

**With Filter**

**Using DMM:**

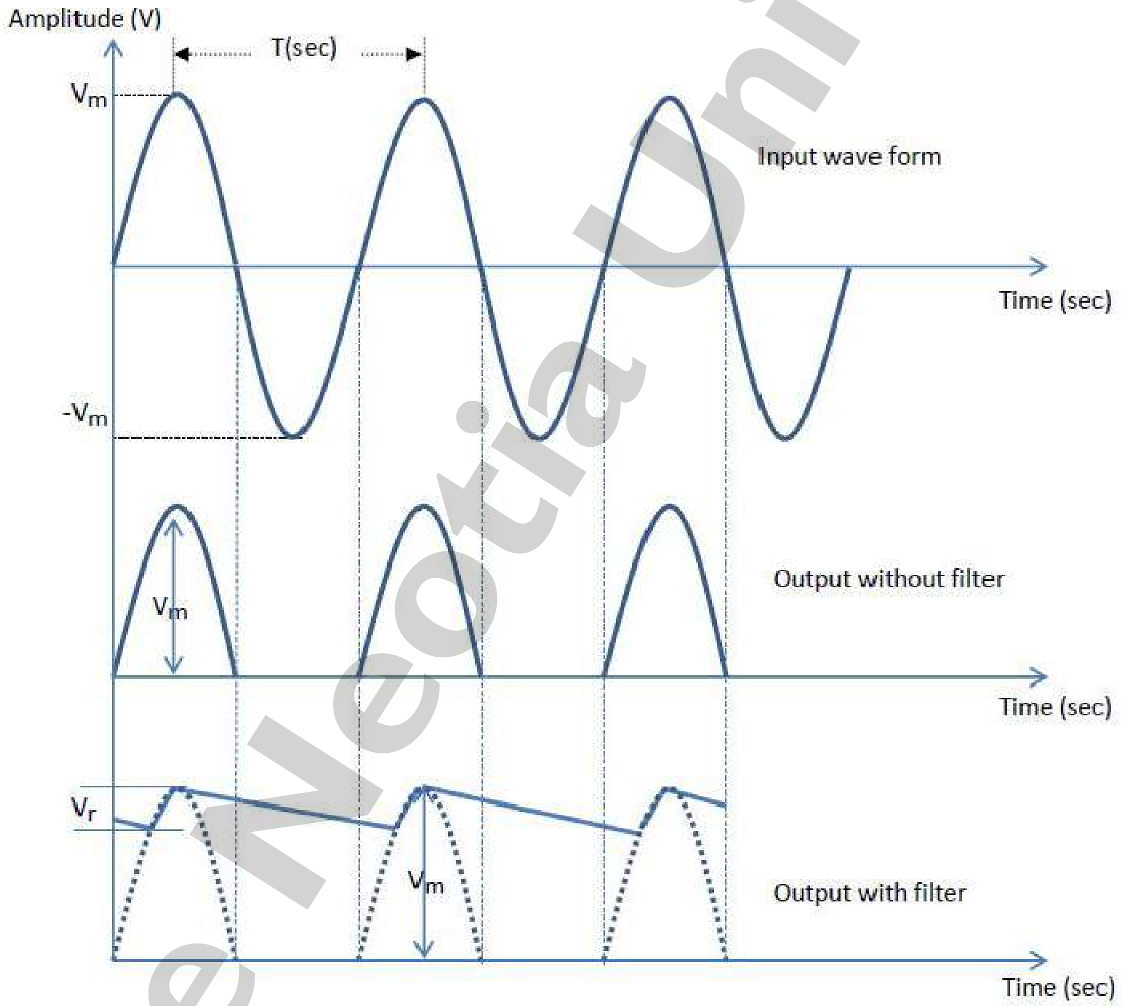
| $V_{ac}$ | $V_{dc}$ | Ripple Factor(γ)= $V_{ac}/V_{dc}$ |
|---|---|---|
| | | |

**Using CRO :**

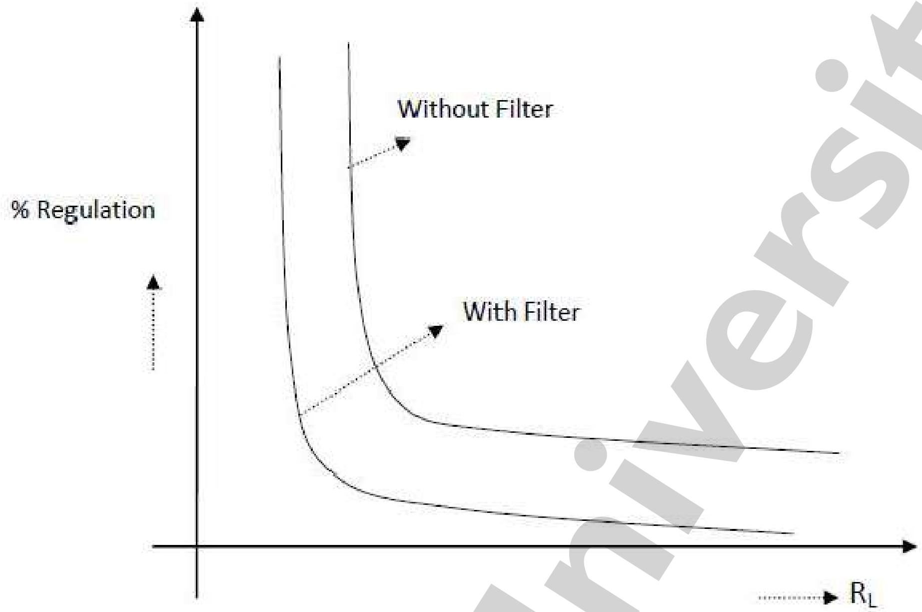
$V_{NL}$=

| $R_L$ (Ω) | $V_L$ (V) | $V_m$ (V) | $V_r$ (V) | $Vdc = Vm - \frac{Vr}{2}$ (V) | $Vr(rms) = \frac{Vr}{2\sqrt{3}}$ | $R.F = \frac{Vr(rms)}{Vdc}$ | % Regulation $= \frac{V(NL)-V(L)}{VL}$ |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

## OUTPUT WAVEFORMS:



**REGULATION GRAPH:**




**Result:** The input and output waveforms of half wave rectifier is plotted and the ripple factor and regulation at 1100Ω are

Ripple factor with out Filter =

Ripple factor with Filter =

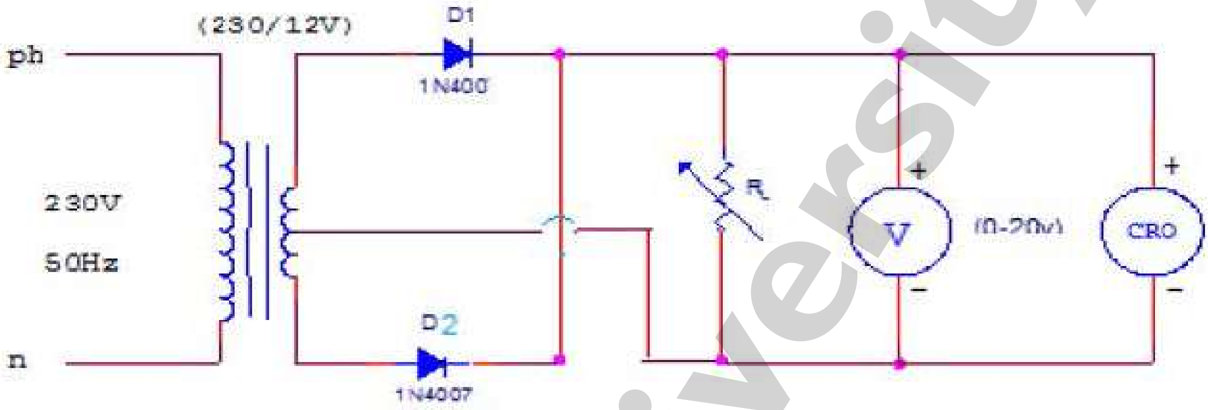
%Regulation=

**Full Wave rectifier**

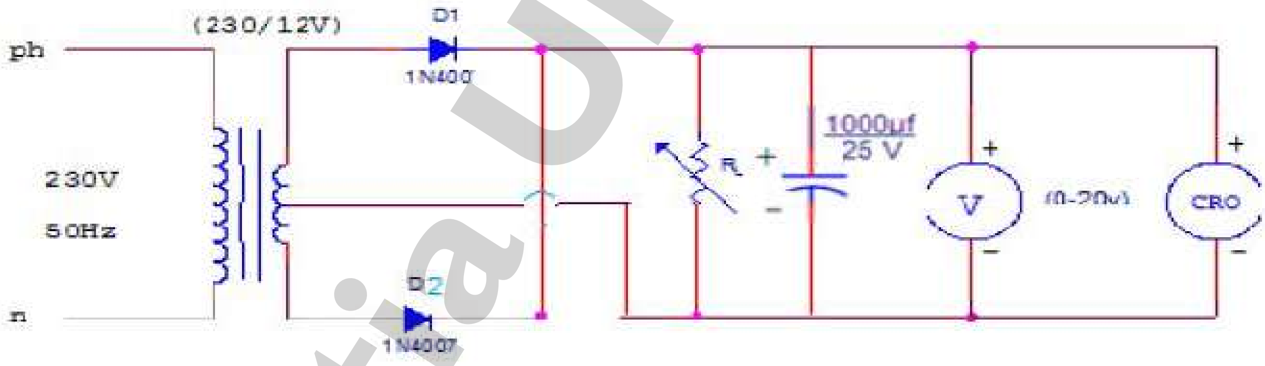
A device is capable of converting a sinusoidal input waveform into a unidirectional waveform with non zero average component is called a rectifier. A practical half wave rectifier with a resistive load is shown in the circuit diagram. It consists of two half wave rectifiers connected to a common load. One rectifies during positive half cycle of the input and the other rectifying the negative half cycle. The transformer supplies the two diodes (D1 and D2) with sinusoidal input voltages that are equal in magnitude but opposite in phase. During input positive half cycle, diode D1 is ON and diode D2 is OFF. During negative half cycle D1 is OFF and diode D2 is ON. Generally, ripple is undesirable, thus the smaller the ripple, the better the filtering action.

**Circuit Diagram**

**Without Filter**




**With Filter**




**PRECAUTIONS**

1. The primary and secondary sides of the transformer should be carefully identified.
2. The polarities of the diode should be carefully identified.

**Theoretical calculations for Ripple factor:-**

**Without Filter:-**

$$V_{dc} = \frac{2V_m}{\pi}$$

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

$$\text{Ripple factor} = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} \quad =0.482$$

**With Filter:-**

$$\text{Ripple factor} = \frac{1}{4\sqrt{3}fCR_L} =$$

Where f=50Hz

**Experiment(without filter)**

1. Connections are made as per the circuit diagram of the rectifier without filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the rectifier.

4. Measure the amplitude and time period of the transformer secondary(input waveform) by connecting CRO.

5. Feed the rectified output voltage to the CRO and measure the time period and amplitude of the Waveform.

**Experiment (With filter)**

1. Connections are made as per the circuit diagram of the rectifier with filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the rectifier.

4. Measure the amplitude and time period of the transformer secondary(input waveform) by connecting CRO.

5. Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.

**Tabular Column Without Filter**

**Using DMM:**

| $V_{ac}$ | $V_{dc}$ | Ripple Factor(γ)= $V_{ac}$/ $V_{dc}$ |
|---|---|---|
| | | |

**Using CRO :**

$V_{NL}$=

| $R_L$ (Ω) | $V_L$ (V) | $V_m$ (V) | $Vdc = \frac{2Vm}{\pi}$ (V) | $Vrms = \frac{Vm}{\sqrt{2}}$ (V) | $Vr(rms) = \sqrt{Vrms^2 - Vdc^2}$ (V) | R.F=$\frac{Vr(rms)}{Vdc}$ | % Regulation $=\frac{V(NL)-V(L)}{VL}$ |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

**With Filter**

**Using DMM:**

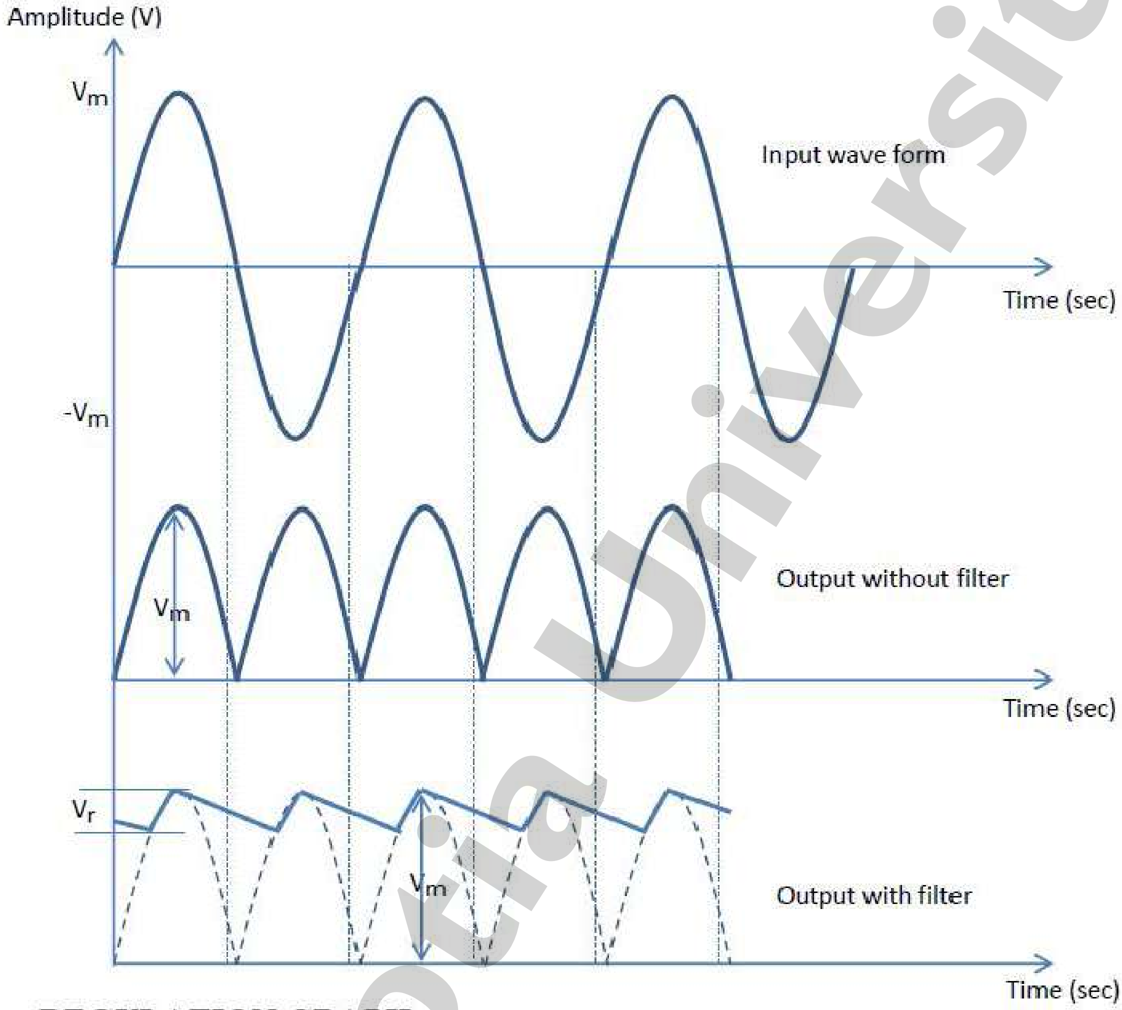
| $V_{ac}$ | $V_{dc}$ | Ripple Factor($\gamma$)= $V_{ac}$/ $V_{dc}$ |
|---|---|---|
| | | |

**Using CRO :**

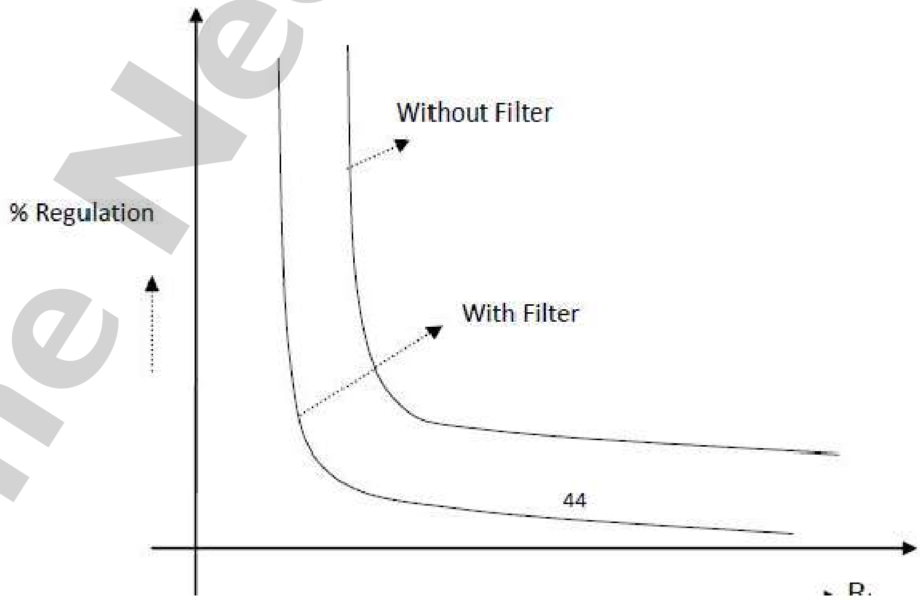
$V_{NL}$=

| $R_L$ (Ω) | $V_L$ (V) | $V_m$ (V) | $V_r$ (V) | $Vdc = Vm - \frac{Vr}{2}$ (V) | $Vr(rms) = \frac{Vr}{4\sqrt{3}}$ | R.F=$\frac{Vr(rms)}{Vdc}$ | % Regulation $=\frac{V(NL)-V(L)}{VL}$ |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

**Model Graph**




## REGULATION GRAPH:



**Result:** The input and output waveforms of Full wave rectifier is plotted and the ripple factor and regulation at 1100Ω are

Ripple factor with out Filter =

Ripple factor with Filter =

%Regulation=

**REPORT WRITING:**

Attach the rough note with your final report.

The 1st Page of the report shall be as per the format shown in Annexure – 1.

Write your final report as per work instruction.

ANNEXURE – 1

NAME:________________________________________________

ROLL NO.:__________ DEPARTMENT:________________

DATE OF SUBMISSION:________ DATE OF EXPERIMENT: ______

CO – WORKER

NAME ROLL NO.

1.__________________________ ______________

2.__________________________ ______________

3.__________________________ ______________

4.__________________________ ______________

TITLE:____________________________________________________________

OBJECTIVE:_______________________________________________

Marks Obtained

Signature of the

Sessional in - charge

**EXPERIMENT NO. : ES-EEP101/13**

**TITLE: Study of I-V characteristics of BJTs**

**Objective :**

To plot the input and output characteristics of a transistor in CB, CE Configuration and to compute the h –parameters.

### Apparatus

| S.No | Apparatus | Type | Range | Quantity |
|---|---|---|---|---|
| 01 | Transistor | BC107 | | 01 |
| 02 | Resistance | | 1KΩ | 02 |
| 03 | Regulated Power supply | | (0-30V) | 02 |
| 04 | Ammeter | | (0-100mA) | 02 |
| 05 | Voltmeter | | (0-2V),(0-20V) | 01 |
| 06 | Breadboard and Wires | | | |

## Common Base configuration

### Introduction:

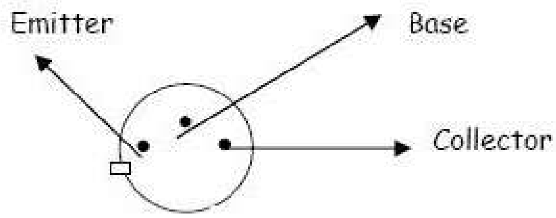
Bipolar junction transistor (BJT) is a 3 terminal (emitter, base, collector) semiconductor device. There are two types of transistors namely NPN and PNP. It consists of two P-N junctions namely emitter junction and collector junction.

In Common Base configuration the input is applied between emitter and base and the output is taken from collector and base. Here base is common to both input and output and hence the name common base configuration.

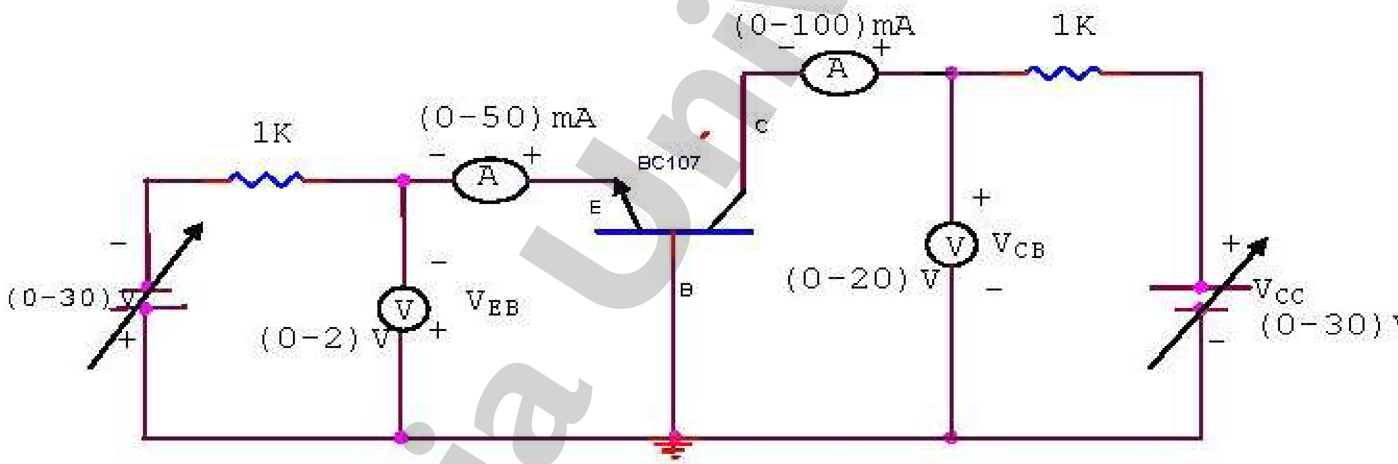
Input characteristics are obtained between the input current and input voltage taking output voltage as parameter. It is plotted between $V_{EB}$ and $I_E$ at constant $V_{CB}$ in CB configuration.

Output characteristics are obtained between the output voltage and output current taking input current as parameter. It is plotted between $V_{CB}$ and $I_C$ at constant $I_E$ in CB configuration.

**PIN Assingnment**




**Circuit Diagram**




**Precautions:**

1. While doing the experiment do not exceed the ratings of the transistor. This may lead to damage the transistor.
2. Connect voltmeter and Ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch **ON** the power supply unless you have checked the circuit connections as per the circuit diagram.
4. Make sure while selecting the emitter, base and collector terminals of the transistor.

**Experiment**

**Input Characteristics**

1. Connect the transistor in CB configuration as per circuit diagram
2. Keep output voltage $V_{CB} = 0V$ by varying $V_{CC}$.
3. By varying $V_{EE}$ , vary $V_{EB}$ in steps of 0.1V and note down emitter current $I_E$.
4. Repeat above procedure (step 3) for various values of $V_{CB}$ ($V_{CB}$=5V and $V_{CB}$=10V)

**Output Characteristics**

1. Make the connections as per circuit diagram.
2. By varying $V_{EE}$ keep the base current $I_E$ =10mA.
3. By varying $V_{CC}$ ,vary $V_{CB}$ in steps of 1V and note down the readings of collector-current ($I_C$).
4. Repeat above procedure (step 3) for different values of $I_E$ ($I_E$=15mA & $I_E$=20mA)

## Tabular column

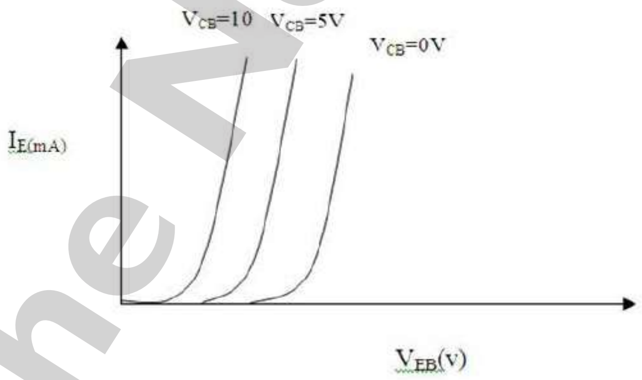
**Input Characteristics**

| $V_{CB}$= 0 V | | $V_{CB}$= 5V | | $V_{CB}$ = 10 V | |
|---|---|---|---|---|---|
| $V_{EB}$ (V) | $I_E$(mA) | $V_{EB}$ (V) | $I_E$ (mA) | $V_{EB}$ (V) | $I_E$ (mA) |
| | | | | | |

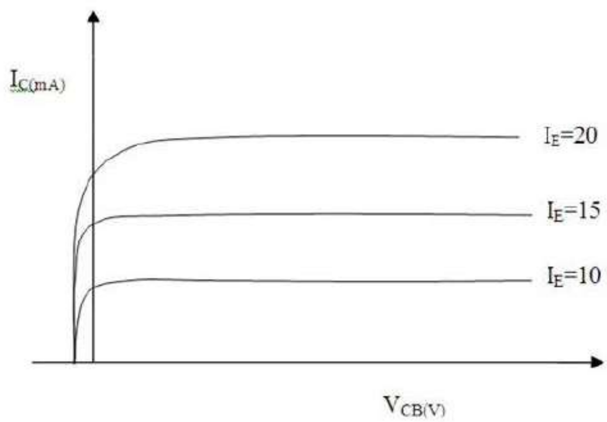
**Output Characteristics**

| $I_E$ = 10 mA | | $I_E$ = 15 mA | | $I_E$ = 20 mA | |
|---|---|---|---|---|---|
| $V_{CB}$ (V) | $I_C$ (mA) | $V_{CB}$ (V) | $I_C$ (mA) | $V_{CB}$ (V) | $I_C$ (mA) |
| | | | | | |

## Model Graph




Input characteristics




Output characteristics

## Calculations from the Graph

**Input characteristics**

a) Input impedance($h_{ib}$)= $\Delta V_{EB}$ / $\Delta I_E$ , $V_{CB}$ constant.

b) Reverse voltage gain($h_{rb}$)= $\Delta V_{EB}$/$\Delta$ $V_{CB}$ , $I_E$ constant

**Output characteristics**

a) Output admittance($h_{ob}$)= $\Delta Ic$ / $\Delta$ $V_{CB}$ , $I_E$ constant

b) Forward current gain($h_{fb}$)= $\Delta Ic$ / $\Delta I_E$ , $V_{CB}$ constant

## Result:

Thus the input and output characteristics of CB configuration are plotted and h parameters are found.

a) Input impedance($h_{ib}$)=

b) Forward current gain($h_{fb}$)=

c) Output admittance($h_{ob}$)=

d) Reverse voltage gain($h_{rb}$)=

## Common Emitter Configuration

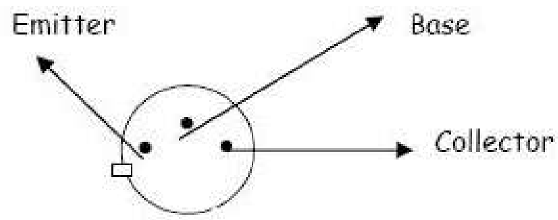
Bipolar junction transistor (BJT) is a 3 terminal (emitter, base, collector) semiconductor device. There are two types of transistors namely NPN and PNP. It consists of two P-N junctions namely emitter junction and collector junction.

In Common Emitter configuration the input is applied between base and emitter and the output is taken from collector and emitter. Here emitter is common to both input and output and hence the name common emitter configuration.

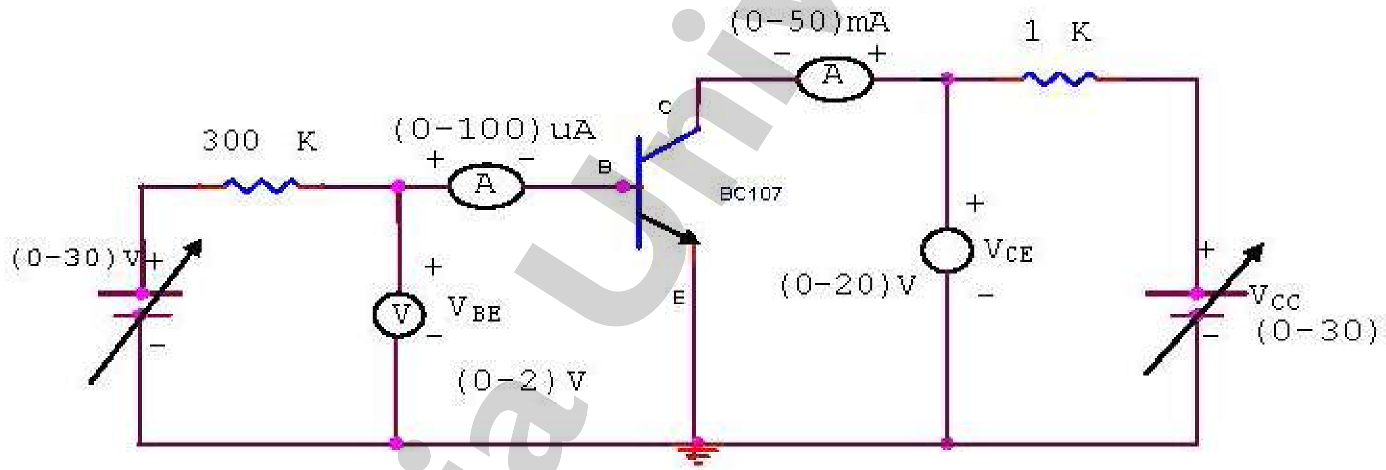
Input characteristics are obtained between the input current and input voltage taking output voltage as parameter. It is plotted between $V_{BE}$ and $I_B$ at constant $V_{CE}$ in CE configuration.

Output characteristics are obtained between the output voltage and output current taking input current as parameter. It is plotted between $V_{CE}$ and $I_C$ at constant $I_B$ in CE configuration.

**PIN Assingnment**




**Circuit Diagram**




**Precautions:**

1. While doing the experiment do not exceed the ratings of the transistor. This may lead to damage the transistor.

2. Connect voltmeter and Ammeter in correct polarities as shown in the circuit diagram.

3. Do not switch **ON** the power supply unless you have checked the circuit connections as per the circuit diagram.

4. Make sure while selecting the emitter, base and collector terminals of the transistor.

**Experiment**

**Input Characteristics**

1. Connect the transistor in CE configuration as per circuit diagram

2. Keep output voltage $V_{CE} = 0V$ by varying $V_{CC}$.

3. By varying $V_{BB}$ ,vary $V_{BE}$ in steps of 0.1V and note down base current $I_B$ .

4. Repeat above procedure (step 3) for various values of $V_{CE}$ ($V_{CE}$=5V and $V_{CE}$=10V)

5. Plot the input characteristics by taking $V_{BE}$ on X-axis and $I_B$ on Y-axis at constant $V_{CE}$.

**Output Characteristics**

1. Make the connections as per circuit diagram.

2. By varying $V_{BB}$ keep the base current $I_B = 0\mu A$.

3.By varying $V_{CC}$ , vary $V_{CE}$ in steps of 1V and note down the readings of collector-current ($I_C$)

4. Repeat above procedure (step 3) for different values of $I_B$

5.Plot the output characteristics by taking $V_{CE}$ on x-axis and $I_C$ on y-axis by taking $I_B$ as a constant parameter.

## Tabular column

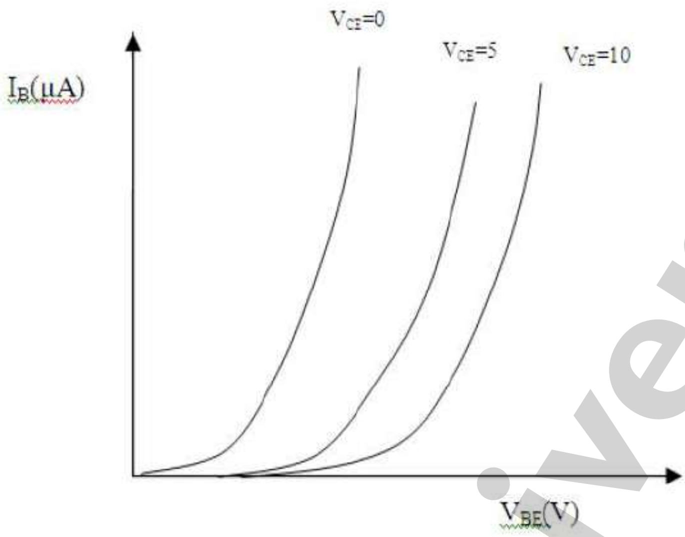
**Input Characteristics**

| $V_{CE}$= 0 V | | $V_{CE}$= 5 V | | $V_{CE}$ = 10 V | |
|---|---|---|---|---|---|
| $V_{BE}$ (V) | $I_B$ (μA) | $V_{BE}$ (V) | $I_B$ (μA) | $V_{BE}$ (V) | $I_B$ (μA) |
| | | | | | |

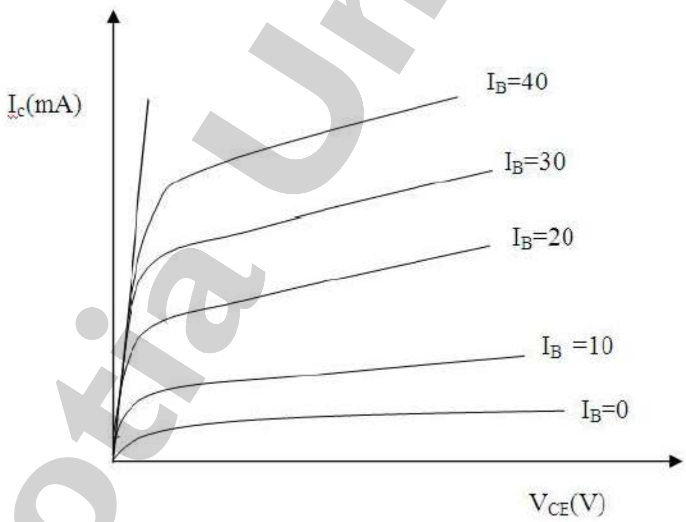
**Output Characteristics**

| $I_B$ = 0 μA | | $I_B$ = 10 μA | | $I_B$ = 20 μA | |
|---|---|---|---|---|---|
| $V_{CE}$ (V) | $I_C$ (mA) | $V_{CE}$ (V) | $I_C$ (mA) | $V_{CE}$ (V) | $I_C$ (mA) |
| | | | | | |

## Model Graph




Input characteristics




Output characteristics

## Calculations from graph:

**Input characteristics**

a) Input impedance($h_{ie}$)= $\Delta V_{BE} / \Delta I_B$ , $V_{CE}$ constant.

b) Reverse voltage gain($h_{re}$)= $\Delta V_{BE}/\Delta V_{CE}$ , $I_B$ constant

**Output characteristics**

a) Output admittance($h_{oe}$)= $\Delta Ic / \Delta V_{CE}$ , $I_B$ constant

b) Forward current gain($h_{fe}$)= $\Delta Ic / \Delta I_B$ , $V_{CE}$ constant

**Result:**

Thus the input and output characteristics of CE configuration is plotted. a) Input impedance($h_{ie}$)=

b) Forward current gain($h_{fe}$)=

c) Output admittance($h_{oe}$)=

d) Reverse voltage gain($h_{re}$)=

**REPORT WRITING:**

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OBJECTIVE:_____________________________________________________

Marks Obtained

Signature of the

Sessional in - charge