ELECTRONICS DEVICE

MANUAL

(NEC-354)

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SYLLABUS

(AS PER PRESCRIBED BY UPTU, LUCKNOW)

NEC-353: ELECTRONICS DEVICE **L T P**

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1. **Study of lab equipments and components:** CRO, Multimeter, Function Generator, Power supply- Active, and Passive Components & Bread Board.
2. **P-N Junction Diode**: Characteristics of PN Junction diode-Static and dynamic resistance measurement from graph.
3. **Applications of PN junction diode**: Half & Full wave rectifier- Measurement of Vrms, Vdc, and ripple factor-use of filter- ripple reduction (RC Filter)-Clipper & Clamper
4. **Properties of junctions** Zener diode characteristics. Heavy doping alters the reverse characteristics. Graphical measurement of forward and reverse resistance.
5. **Application of Zener diode:** Zener diode as voltage regulator. Measurement of percentage regulation by varying load resistor.
6. **Characteristic of BJT**: BJT in CB and CE configuration- Graphical measurement of h parameters from input and output characteristics. Measurement of Av, AI, Ro and Ri of CE amplifier with potential divider biasing.
7. **Characteristic of FET**: FET in common source configuration. Graphical measurement of its parameters gm, rd & m from input and output characteristics.
8. **Characteristic** of silicon-controlled rectifier.
9. **To plot** V-I Characteristics of DIAC.
10. **To draw** V-I characteristics of TRIAC for different values of Gate Currents.

STUDY AND EVALUATION SCHEME

SESSIONAL EVALUATION:-

CLASS TEST	**:**	**10 MARKS**
TEACHER'S ASSESMENT	**:**	**10 MARKS**
EXTERNAL EXAM	**:**	**30 MARKS**
TOTAL	**:**	**50 MARKS**

LIST OF EXPERIMENTS

1. **Study of lab equipments and components:** CRO, Multimeter, Function Generator, Power supply- Active, and Passive Components & Bread Board.

2. **P-N Junction Diode**: Characteristics of PN Junction diode-Static and dynamic resistance measurement from graph.

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5. **Application of Zener diode:** Zener diode as voltage regulator. Measurement of percentage regulation by varying load resistor.

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8. **Characteristic** of silicon-controlled rectifier.

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10. **To draw** V-I characteristics of TRIAC for different values of Gate Currents.

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S.NO.	NAME OF EXPERIMENT	SIGNATURE OF FACULTY/ DATE OF EVALUATION	GRADE

EXPERIMENT NO. 01

1. AIM: To Study of lab equipments and components: CRO, Multimeter, Function Generator, Power supply- Active, and Passive Components & Bread Board.

2. APPARATUS REQUIRED:

S.No.	Apparatus / Software Used	Specification	Quantity
1.	CRO		1
2.	Function Generator		1
3.	Multimeter		1
4.	Resistance & Capacitance		1
5.	Power supply & Bread Board		1

3. THEORY:

CRO (Cathode Ray Oscilloscope)

The oscilloscope is one of the most important electronic instruments available for making circuit measurements. It displays a curve plot of time-varying voltage on the oscilloscope screen. The oscilloscope provided with Multisim Electronics Workbench is a dual trace oscilloscope that looks and acts like a real oscilloscope. A dual trace oscilloscope allows the user to display and compare two time-varying voltages at one time.

The controls on the oscilloscope are as follows:

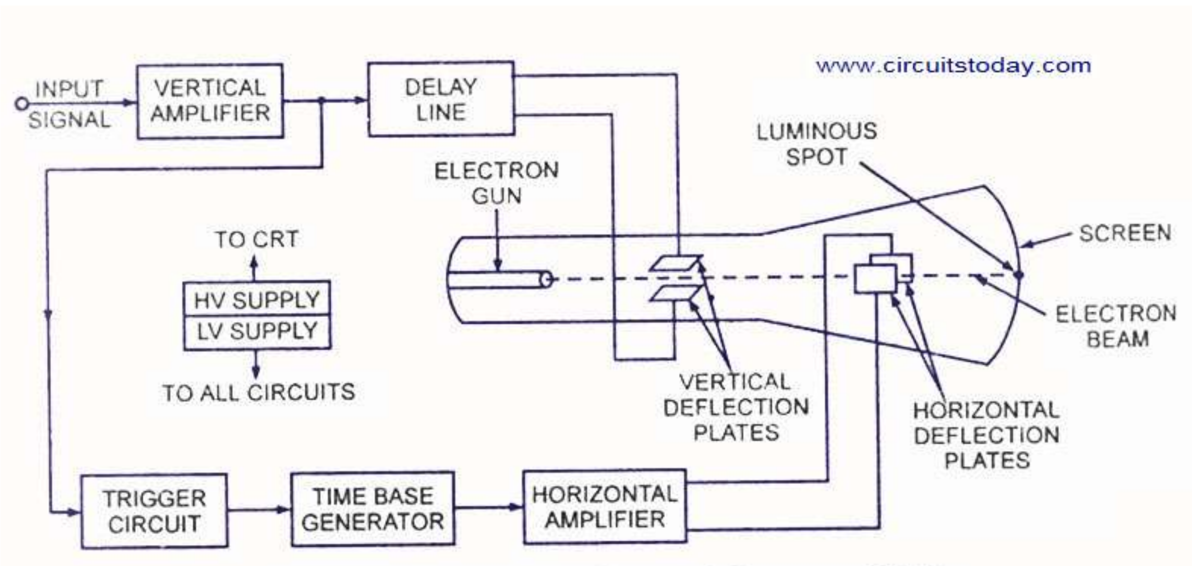
1. The TIME BASE control adjusts the time scale on the horizontal axis in time per division when Y/T is selected. When B/A is selected, the horizontal axis no longer represents time. The horizontal axis now represents the voltage on the channel A input and vertical axis represents the voltage on channel B input. When A/B is selected, the horizontal axis represents the voltage on the channel B input and the vertical axis represents the voltage on the channel A input. The X_POS control determines the horizontal position where the curve plot begins.

2. The CHANNEL A control adjusts the volts per division on the vertical axis for the channel A curve plot. The Y-POS control determines the vertical position of the channel A curve plot

relative to the horizontal axis. Selecting AC places a capacitance between the channel A vertical input and the circuit testing point. Selecting “0” connects channel A vertical input to ground.

3. The CHANNEL B control adjusts the volts per division of the vertical axis for the channel B curve plot. The Y-POS determines the vertical position of the channel B curve plot relative to the horizontal axis. Selecting AC places a capacitance between the channel B vertical input and the circuit test point. Selecting “0” connects the channel B vertical input to ground.

4. The trigger settings control the conditions under which a curve plot is triggered (begins to display). Triggering can be internal (based on one of the input signals) or external (based on a signal applied to the oscilloscope external trigger input). With internal triggering AUTO, A, or B. If A is selected, the curve plot will be triggered by channel A input signal. If |B is selected, the curve plot will be triggered by channel B input signal. If you expect a flat input waveshape or you want the curve plot displayed as soon as possible, select AUTO. The display can be set to start on positive or negative slope of the input by selecting the appropriate EDGE selection. The trigger LEVEL control determines the voltage level of the input signal waveform, in divisions on the vertical axis, before the waveform will begin to display.



Block Diagram of a General Purpose CRO

Function Generator

The function generator is a voltage source that supplies different time-varying voltage functions. The Multisim Electronics Workbench can supply sine wave, square wave, and triangular wave voltage functions. The wave shape, frequency, amplitude, duty cycle, and dc offset can be easily changed. It has three voltage output terminals. Connect the COM terminal to ground symbol. The +ve terminal provides output voltage that is positive with respect to the COM terminal and the –ve terminal proves an output voltage that is negative with respect to the COM terminal.

The controls on the function generator are as follows:

1. You can select a wave shape by clicking the appropriate wave shape on the top of the function generator.

2. The frequency control allows you adjust the frequency of the output voltage up to 999 MHz. Click up or down arrow to adjust the frequency, or click the frequency box and type the desired frequency.

3. The AMPLITUDE control allows you to adjust the amplitude of the output voltage measured from the reference level (common) to **peak** level. The peak to peak value is twice the amplitude setting.

4. The OFFSET control adjusts the dc level of the voltage curve generated by the function generator. An offset of 0 positions the curve plot along the x-axis with an equal positive and negative voltage setting. A positive offset raises the curve plot above the x-axis and a negative offset lowers the curve plot below the x-axis.

Multimeter

A **multimeter** or a **multitester**, also known as a **VOM** (Volt-Ohm meter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter may include features such as the ability to measure voltage, current and resistance. Multimeters may use analog or digital circuits—**analog multimeters** (AMM) and **digital multimeters** (often abbreviated **DMM** or **DVOM**.) Analog instruments are usually based on a microammeter whose pointer moves over a scale calibrated for all the different measurements that can be made; digital instruments usually display digits, but may display a bar of a length proportional to the quantity being measured. A multimeter can be a hand-held device useful for basic fault finding and field service work or a bench instrument which can measure to a very high degree of accuracy. They can be used to troubleshoot electrical problems in a wide array of industrial and household devices such as electronic equipment, motor controls, domestic appliances, power supplies, and wiring systems.

Power Supply

A **power supply** is a device that supplies electric power to one or more electric loads. The term is most commonly applied to devices that convert one form of electrical energy to another, though it may also refer to devices that convert another form of energy (mechanical, chemical, solar) to electrical energy. A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source.

Every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source

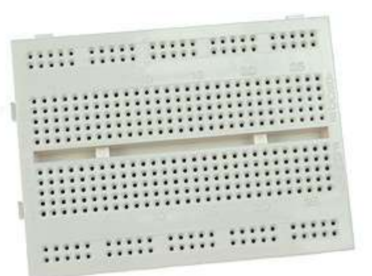
Active Elements & Passive Elements

"The elements within a circuit will either control the flow of electric energy or respond to it. Those elements which control the flow of electric energy are known as active elements and those which dissipate or store the electric energy are passive elements."

"The three linear passive elements are the Resistor, the Capacitor and the Inductor. Examples of non-linear passive devices would be diodes, switches and spark gaps. Examples of active devices are Transistors, Triacs, Varistors, Vacuum Tubes, relays, solenoids and piezo electric devices."

Bread Board

A breadboard (protoboard) is a construction base for prototyping of electronics. The term is commonly used to refer to solderless breadboard (plugboard). Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design.



4. RESULTS AND DISCUSSION:

Study of lab equipments- CRO, Multimeter, Function Generator, Power supply- Active, and Passive Components & Bread Board has been studied successfully.

5. PRE EXPERIMENT Q.B:

Q1. What is CRO?

Ans. The oscilloscope is one of the most important electronic instruments available for making circuit measurements. It displays a curve plot of time-varying voltage on the oscilloscope screen.

Q2. What do you mean by active element and passive element ?

Ans. "The elements within a circuit will either control the flow of electric energy or respond to it. Those elements which control the flow of electric energy are known as active elements and those which dissipate or store the electric energy are passive elements."

6. POST EXPERIMENT Q.B:

Q1. What is multimeter?

Ans. A **multimeter** also known as a **VOM** (Volt-Ohm meter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter may include features such as the ability to measure voltage, current and resistance.

Q2. What is function generator?

Ans. The function generator is a voltage source that supplies different time-varying voltage functions. The Multisim Electronics Workbench can supply sine wave, square wave, and triangular wave voltage functions. The waveshape, frequency, amplitude, duty cycle, and dc offset can be easily changed. It has three voltage output terminals.

EXPERIMENT NO. 02

1. AIM: To study P-N Junction Diode: Characteristics of PN Junction diode-Static and dynamic resistance measurement from graph.

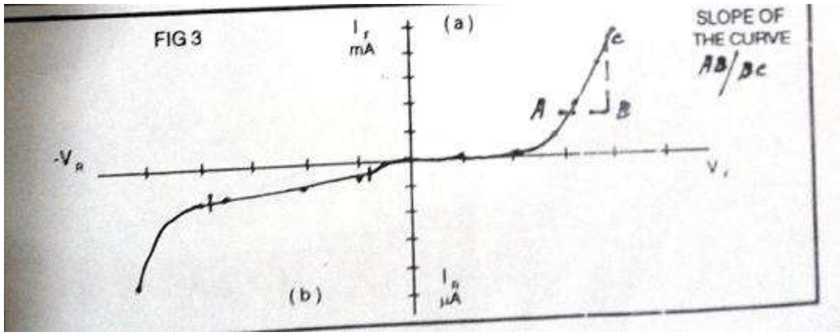
2. APPARATUS REQUIRED:

S.No.	Apparatus / Software Used	Specification	Quantity
1.	Diode Kit		1
2.	Multimeter		1
3.	Connecting leads		

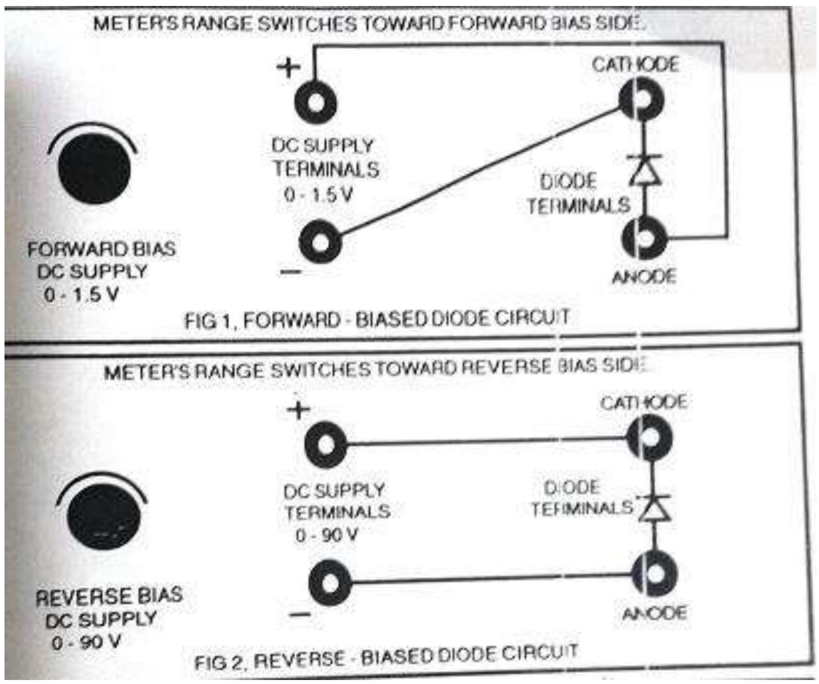
3. THEORY:

A diode is the basic electronic component. It's property is that it can conduct only in one direction. A diode can be made by joining a p type semiconductor and an n type semiconductor. At the junction point there will be a voltage drop due to the migration of carriers. The voltage at this barrier is known as barrier potential. Ideally the barrier potential is zero. But in practical case there will be a drop of 0.7 Volts. When the P side of diode is connected to the positive of power supply and N region is connected to the negative of supply, the diode is said to be in forward biased condition. At this condition, if the applied voltage is greater than the barrier potential of the diode, it starts conduction. After the diode is arrived in the conduction mode, the drop across it remains at 0.7 V. After the conduction starts, if the voltage is increased further, current trough it increases linearly with voltage.

When the supply voltage is reversed the diode is said to be in reverse biased condition. Here there is no conduction at lower voltage values .If we increase the voltage value further ,it is observed that at a voltage the current sharply increases due to the breakdown of the P-N junction. This damages the device. So care is to be taken while connecting diode in a circuit.



4. CIRCUIT DIAGRAM:



5. PROCEDURE

Forward biased diode:

1. Connect the diode with supply terminals as shown in fig.1. The diode's anode should be connected to +terminal of the supply.

2. Select the meter range switches (both) towards forward bias side. Keep both supply control to minimum.

3. Switch on the power. Gradually increase the forward bias supply (0-15V) in small steps. Note the volt and current readings from the panel meters as forward voltage V_F and corresponding current I_F in mA.

4. Take the readings till mA meter approaches near maximum deflection . Switch off the power, turn supply control back to minimum. Prepare the table between V_F and I_F from the observations.

5. Plot the forward biased diode graph taking V_F readings along the x-axis and I_F readings along the y-axis. Find the slope of the line from the linear part of the curve as shown in fig3a. Calculate the dynamic resistance of the diode as

$R_{F} = \delta V_F / \delta I_F$

Reverse biased diode:

1. Keep both meter range select switches towards the reverse bias side. Connect diode as shown in fig2, such that its cathode is connected with the +dc terminal of the supply.

2. Switch on the power. Increase the reverse bias supply (0-90V) in small steps and note reverse voltage as –ve volts and corresponding current from the panel meters.

3. As breakdown appears, the reverse currnet will rise rapidly at this point at small increamnet of reverse bias voltage , note the reading and bring reverse supply back to minimum.

4. Switch off the power and tabulate the results as $-V_R$ and $-I_R$. Plot the graph as shown in fig3b. Calculate the reverse resistance in constant region.

5. Comparing result from both observations, shows that the forward resistance of the diode is very much less than the reverse resistance. This property allows to flow the current in one direction only.

6. OBSERVATION:

For forward bias **For reverse bias**

S.No.	**Voltage (V)**	**Current (mA)**	**S.No.**	**Voltage (V)**	**Current (μA)**

7. CALCULATION:

The dynamic resistance of the diode as

$R_{F\,=}\,\delta\, V_F\,/\,\delta\, I_F$

The static resistance of the diode as

$R_{F\,=}\, V_F\,/\,\, I_F$

8. RESULTS AND DISCUSSION:

The V-I characteristics (forward and reverse biased) is plotted on the graph which is true according to theory.

9. PRE EXPERIMENT Q.B:

Q1. What is diode?

Ans. A diode is the basic electronic component. It's property is that it can conduct only in one direction. A diode can be made by joining a p type semiconductor and an n type semiconductor.

Q2. What do you mean by dynamic forward resistance?

Ans. The resistance offered by the PN junction under a.c. condition is called dynamic forward resistance and given as $R_{F\,=}\,\delta\, V_F\,/\,\delta\, I_F$.

10. POST EXPERIMENT Q.B:

Q1. What is knee voltage for Si and Ge diode respectively?

Ans. Knee voltage for Si= 0.7V and for Ge = 0.3V.

Q.2. What do you mean by PIV?

Ans. It is defined as the maximum value of reverse voltage that a diode can withstand without destroying the junction.

11. PRECAUTIONS:

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

2. Connect the voltmeter and ammeter in correct polarities.

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

EXPERIMENT NO. 03

1. AIM: Applications of PN junction diode: Half & Full wave rectifier- Measurement of V_{RMS}, V_{DC}, and ripple factor.

2. APPARATUS REQUIRED:

S.No.	Apparatus / Software Used	Specification	Quantity
1.	Diode Kit		1
2.	CRO		1
3.	Connecting leads		

3. THEORY:

A diode is using to pass current in a single direction. Alternating current is a current which flows in both directions. In some applications we need dc power supply. A method to obtain dc supply is by using batteries. But it is not economical at all times. It is possible to obtain dc from ac supply .That process is known as rectification. Rectification is of two types: 1.half wave rectification 2.full wave rectification

HALF WAVE RECTIFIERS

In a half wave rectifier only one half cycle of ac voltage is taking. The circuit is given. Here only one diode is using. During the positive half cycle of ac voltage the diode conducts. So current flows through load. During the negative half cycle, the diode is reverse biased .So no current flows through the diode. This type of rectification needs only one diode. But the efficiency is not so good as that of full wave rectifier

FULL WAVE RECTIFIERS

Unlike a half wave rectifier, a full wave rectifier conducts in both half cycles of ac voltage.

A full wave rectifier can be implemented in two ways

a) Full wave bridge rectifier

In full wave bridge rectifiers 4 diodes are using. During positive half cycle, D1 and D4 are in forward biased condition. In the negative half cycle of ac D3 and D2 are in forward biased condition. So in both the half cycles current through the load is in single direction. Thus rectification can be done. This circuit does not need a centre tap rectifier. But it requires more number of diodes than centre tap and half wave rectifiers.

b) Full wave centre tap rectifier

This is another method to obtain full wave rectification. In this method only two diodes are using. But it requires a center tap transformer. During the positive half cycle diode D1 conducts. In the negative half cycle diode D2 conducts. So in both half cycles current flowing through load in same direction. Thus rectification can be obtained.

4. CIRCUIT DIAGRAM:

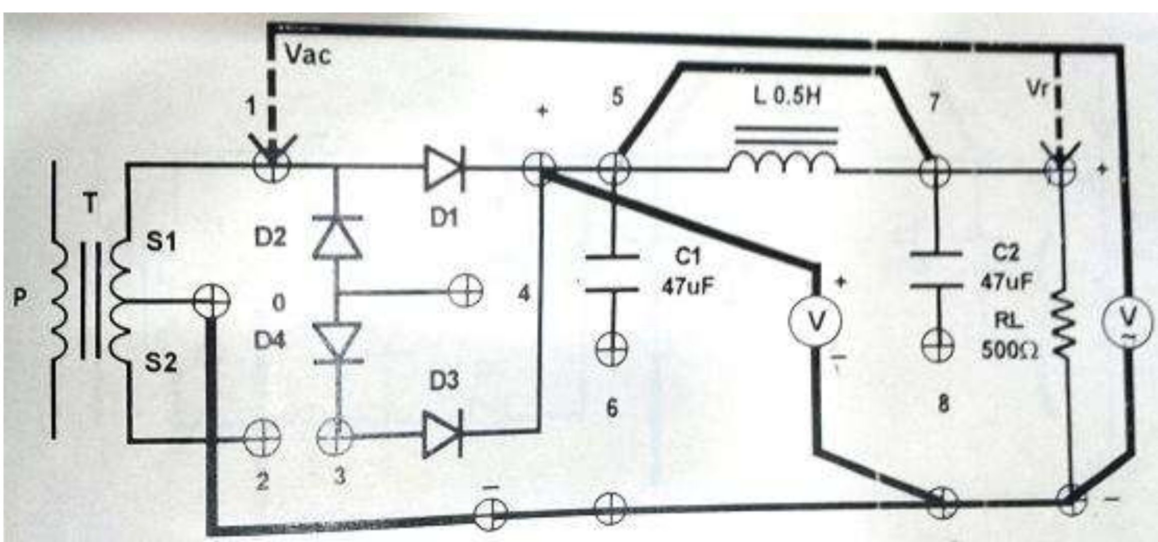


Fig.1 Connection diagram for half wave rectifier.

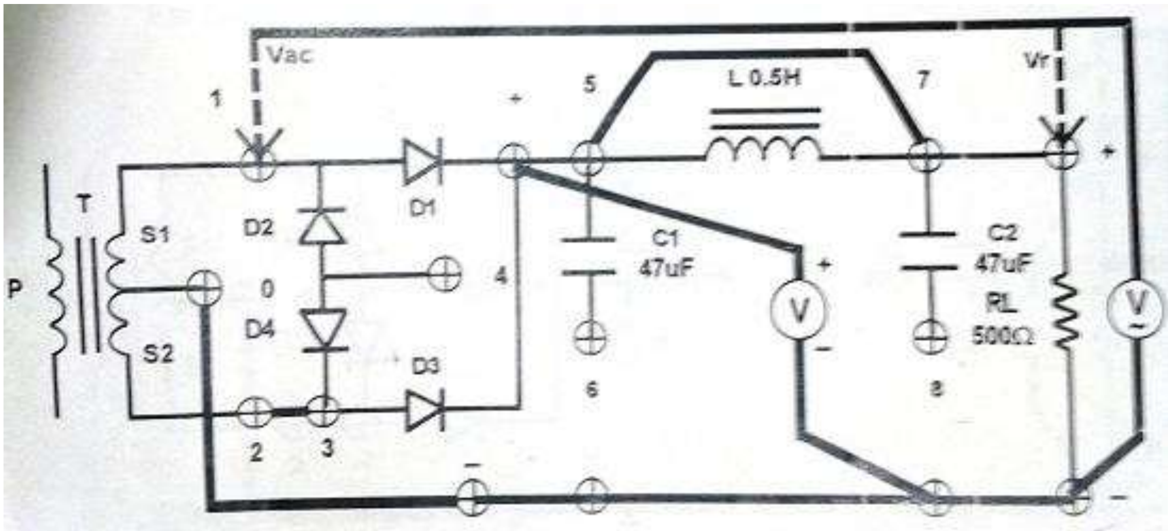


Fig.2. Connection diagram for full wave rectifier.

5. PROCEDURE:

For half wave rectifier circuit:

1. Connect the circuit as shown in fig.1. It becomes a half wave rectifier circuit since only diode D1 is in circuit, note L is short circuited and C open.

2. Switch on the power.

3. Measure AC across the transformer secondary.

4. Note the reading of dc voltage from filter meter as V_{DC} .Calculate the theoretical value and compare it with found value, where theoretical value $V_{DC}=\{ V_{AC(RMS)} * \sqrt{2}/\pi\}$.

5. Connect the AC voltmeter at the dc output socket fitted at +ve of R_L side.

Note the AC ripple voltage as V_R. Calculate the ripple factor as

Ripple factor R= V_R / V_{DC} .

For full wave (centre tapped) rectifier circuit:

1. Connect the circuit as shown in fig2, this will bring diode D3 in the circuit and it becomes a full wave rectifier circuit.

2. Remaining steps as same as before.

6. OBSERVATION:

For half wave and full wave rectifier

S.No.	**Input AC**	**V_{DC} (V)**	**V_{RMS} at dc out (V)**	**Ripple factor**

7. CALCULATION:

DC output voltage, V_{DC}={ $V_{AC(RMS)}$ * √2/π}

Ripple factor, R= V_R / V_{DC} .

8. RESULTS AND DISCUSSION:

Measurement of V_{RMS}, V_{DC}, and ripple factor for half wave and full wave rectifier is done successfully.

9. PRE EXPERIMENT Q.B:

Q1. What is a half wave rectifier?

Ans. In a half wave rectifier only one half cycle of ac voltage is taking. The circuit is given. Here only one diode is using. During the positive half cycle of ac voltage the diode conducts. So current flows through load. During the negative half cycle, the diode is reverse biased .So no current flows through the diode. This type of rectification needs only one diode. But the efficiency is not so good as that of full wave rectifier

Q2. What is a full wave rectifier?

Ans. Unlike a half wave rectifier, a full wave rectifier conducts in both half cycles of ac voltage. So output gets in both the half cycles.

10. POST EXPERIMENT Q.B:

Q1. What are the two schemes of full wave rectifiers?

Ans. 1. Centre tap rectifier

2. Bridge rectifier

Q2. What are the advantages of bridge rectifier over center tap rectifier?

Ans.It does not need a centre tap transformer

Q3. What is the disadvantage of bridge rectifier over centre tap rectifier?

Ans.4 diodes are needed.

11. PRECAUTIONS:

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

2. Connect the voltmeter and ammeter in correct polarities.

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

EXPERIMENT NO. 04

1. AIM: Properties of junctions Zener diode characteristics. Heavy doping alters the reverse characteristics. Graphical measurement of forward and reverse resistance.

2. APPARATUS REQUIRED:

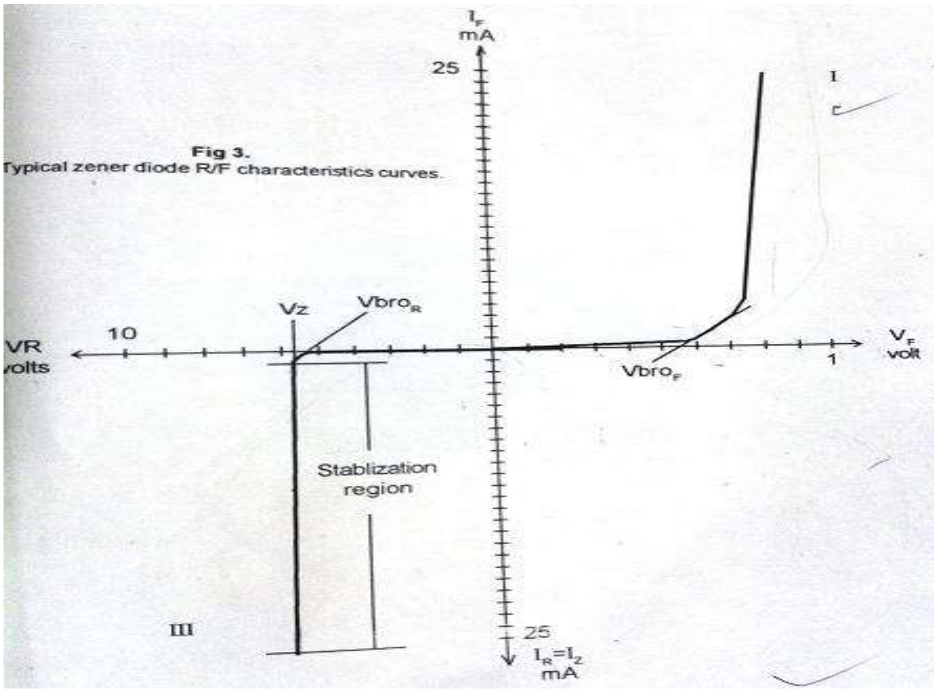
S.No.	Apparatus / Software Used	Specification	Quantity
1.	Zener diode	BZX56	1
2.	Voltmeter		1
3.	Ammeter		1
4.	Connecting wires		

3. THEORY:

Zener diode is a P-N junction diode specially designed to operate in the reverse biased mode. It is acting as normal diode while forward biasing. It has a particular voltage known as break down voltage, at which the diode break downs while reverse biased. In the case of normal diodes the diode damages at the break down voltage. But Zener diode is specially designed to operate in the reverse breakdown region.

The basic principle of Zener diode is the Zener breakdown. When a diode is heavily doped, it's depletion region will be narrow. When a high reverse voltage is applied across the junction, there will be very strong electric field at the junction. And the electron hole pair generation takes place. Thus heavy current flows. This is known as Zener break down.

So a Zener diode, in a forward biased condition acts as a normal diode. In reverse biased mode, after the break down of junction current through diode increases sharply. But the voltage across it remains constant.



4. CIRCUIT DIAGRAM:

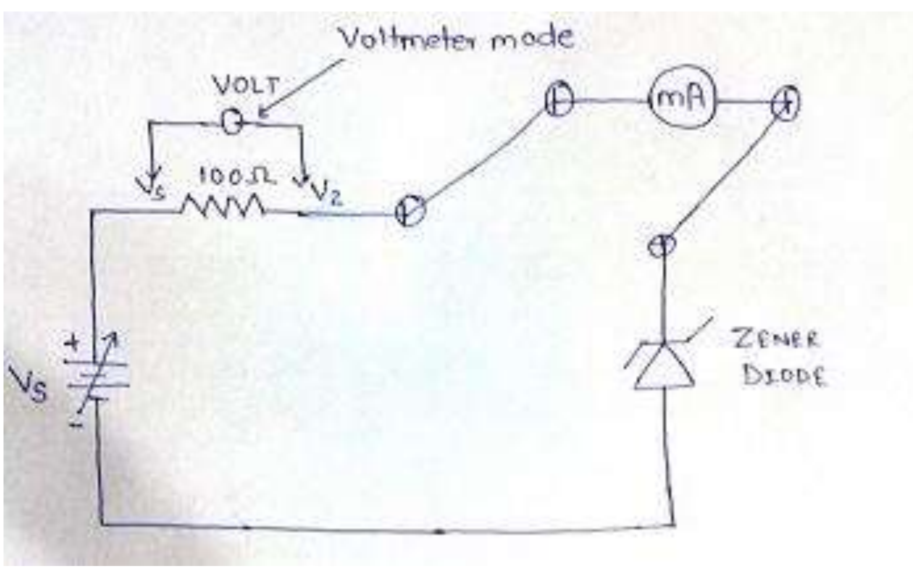


Fig.1a. Connection diagram reverse biased zener diode. Range 10V.

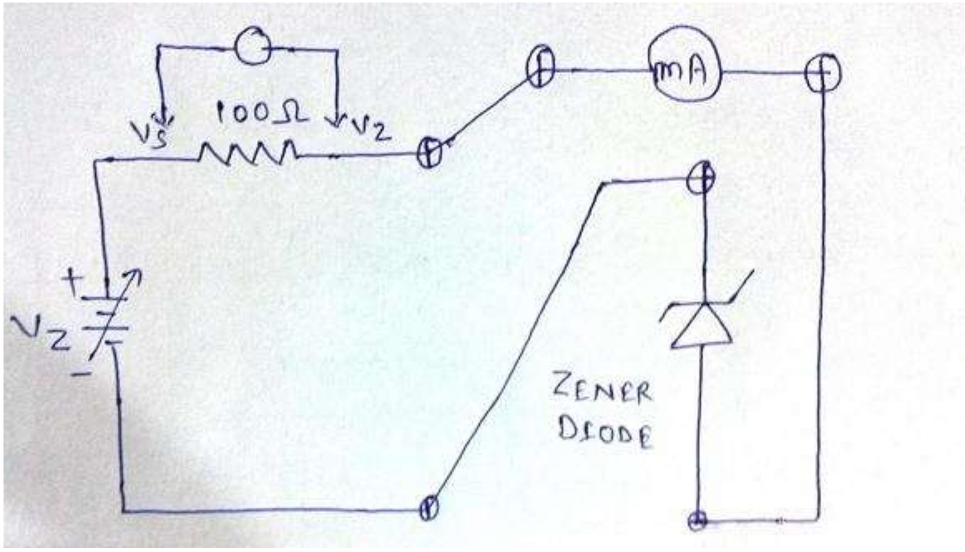


Fig.1b. Connection diagram forward biased zener diode. Range 1V.

5. PROCEDURE:

For zener diode reverse breakdown characteristics of given zener diode BZX56.

1. Connect the given diode as shown in fig.1a. Identify the voltage polarity meter and diode polarity. Select voltmeter range to 10V. Select mode switch towards V_Z mode.

2. Keep supply control to minimum (fully counter-clockwise). Switch on the power.

3. Gradually increase the supply voltage in small steps and note the readings V_Z, I_Z with each increament till mA meter approaches to maximum.

4. Bring supply control to minimum.Select mode towards V_S. Now again increase the supply and note the input voltage V_S with current I_Z.

5. Plot the reverse bias curve from the observations. Find out the knee of the curve at minimum current.

For zener diode forward breakdown characteristics of given zener diode BZX56.

1. Connect the given diode as shown in fig.1b. Identify the voltage polarity meter and diode's polarity. Select voltmeter range to 1V. Select mode switch towards V_Z mode.

2. Keep supply control to minimum (fully counter-clockwise). Switch on the power.

3. Gradually increase the supply voltage in small steps and note the forward breakdown voltage .Increase the supply further and note the current I_{ZF} . Increase further supply till current meter approaches to maximum.

4. Plot the forward bias curve with the reverse bias in 1st quadrent. From the curve it is found that the zener diodes exhibit very low resistance after forward breakdown in forward and reverse bias.

6. OBSERVATION:

For circuit 1a.

S.No.	I_z (mA)	V_z (V)	V_s (V)

For circuit 1a.

S.No.	I_{zF} (mA)	V_z (V)

7. RESULTS AND DISCUSSION:

The V-I characteristic of zener diode is plotted in graph which is true according to theory.

8. PRE EXPERIMENT Q.B:

Q1. What is zener diode?

Ans. Zener diode is a P-N junction diode specially designed to operate in the reverse biased mode. It is acting as normal diode while forward biasing. It has a particular voltage known as break down voltage, at which the diode break downs while reverse biased.

9. POST EXPERIMENT Q.B:

Q1. What is zener breakdown?

Ans. When a diode is heavily doped, it’s depletion region will be narrow. When a high reverse voltage is applied across the junction, there will be very strong electric field at the junction. And the electron hole pair generation takes place. Thus heavy current flows. This is known as Zener break down.

10. PRECAUTIONS:

1.Keep your hand away from the main supply.

2. Connect the voltmeter and ammeter in correct polarities.

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

EXPERIMENT NO. 05

1. AIM: **Application of Zener diode:** Zener diode as voltage regulator. Measurement of percentage regulation by varying load resistor.

2. APPARATUS REQUIRED:

S.No.	Apparatus / Software Used	Specification	Quantity
1.	Zener diode kit		1
2.	Ammeter		1
3.	Voltmeter		1
4.	Connecting wires		

3. THEORY:

Zener diode is a P-N junction diode specially designed to operate in the reverse biased mode. It is acting as normal diode while forward biasing. It has a particular voltage known as break down voltage, at which the diode break downs while reverse biased. In the case of normal diodes the diode damages at the break down voltage. But Zener diode is specially designed to operate in the reverse breakdown region.

The basic principle of Zener diode is the Zener breakdown. When a diode is heavily doped, it's depletion region will be narrow. When a high reverse voltage is applied across the junction, there will be very strong electric field at the junction. And the electron hole pair generation takes place. Thus heavy current flows. This is known as Zener break down.

So a Zener diode, in a forward biased condition acts as a normal diode. In reverse biased mode, after the break down of junction current through diode increases sharply. But the voltage across it remains constant. This principle is used in voltage regulator using Zener diodes.

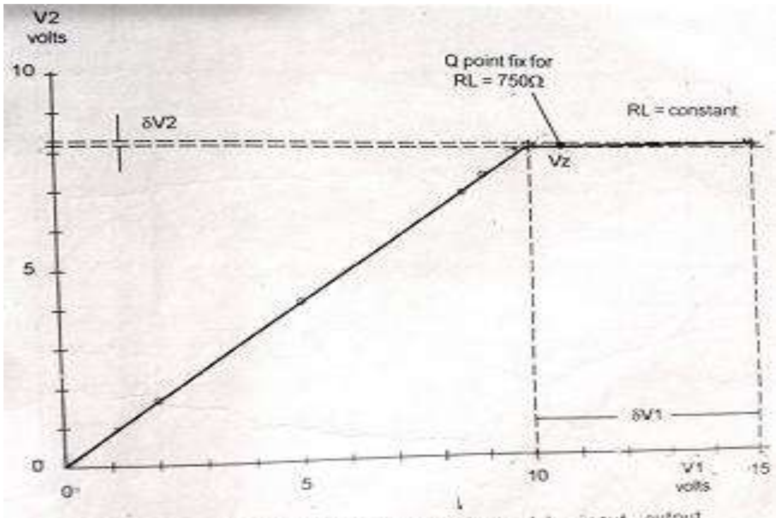
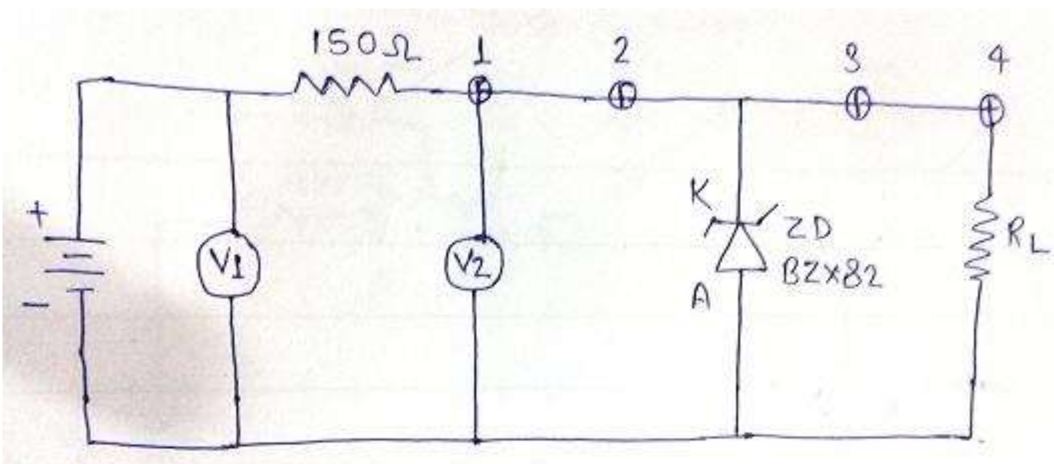


Fig 1 : Characteristic plot for zener diode regulator input - output.

4. CIRCUIT DIAGRAM:



5. PROCEDURE:

Input Characteristics:

1. Varying the input voltage keeping load constant: Connect the circuit as showin in fig.1. Keep supply control at minimum.

2. Keep the load R_L at 750ohms for Q-pont. Increase the input voltage V_S in step of 1Volt and note V1 and V2. Where V1 is the input and V2 is the output voltage across zener.

3. Plot the curves between input –output at load constant. Find out the δV1 and δV2 from the plot and calculate the line regulation.

Output characteristics:

1. Varying the load keeping input voltage constant: Connect the circuit as showin in fig.1. Keep supply control at minimum.

2. Keep load R_L at 3000ohms. Increase the input voltage V1 to 12 $V_{dc.}$

3. Decrease the load and note the voltage V2 with load value.

4.Plot the curves between load and output voltage at input constant. Find out the δV2 and V_Z at Q point at set load value from the input plot and calculate load regulation.

Note: δV2 is zener voltage at minimum and maximum load current in stable region. The Q point is fixed in input characteristic plot. The input voltage held at 12V constant. The δV2 is very small note it carefully.

6. OBSERVATION:

Shunt regulation (Load regulation), Input voltage constant at 10V

S.no.	Output voltage (V)	Load (Ω)

Shunt regulation (Line regulation), load constant at 300Ω

S.no.	Input voltage (V)	Output voltage (V)

7. CALCULATION:

%Line regulation = [δV2/ δV1] * 100 %

Load regulation% = [δV2/ V_Z at Q point] * 100 %.

8. RESULTS AND DISCUSSION:

Realization of zener diode by voltage regulator is verified.

9. PRE EXPERIMENT Q.B:

Q1. What is the basic principle of Zener diode?

Ans. Zener breakdown

Q2. What is Zener break down?

Ans. When a diode is heavily doped, it's depletion region will be narrow. When a high reverse voltage is applied across the junction, there will be very strong electric field at the junction. And the electron hole pair generation takes place. Thus heavy current flows. This is known as Zener break down.

10. POST EXPERIMENT Q.B:

Q1. At what voltage zener breakdown and avalanche breakdown occur?

Ans. Zener breakdown occur before 6V and avalanche breakdown occur after 6V.

11. PRECAUTIONS:

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

2. Connect the voltmeter and ammeter in correct polarities.

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

EXPERIMENT NO. 06

1. AIM: Characteristic of BJT: BJT in CE configuration- Graphical measurement of h parameters from input and output characteristics. Measurement of Av, AI, Ro and Ri of CE amplifier with potential divider biasing.

2. APPARATUS REQUIRED:

S.No.	Apparatus / Software Used	Specification	Quantity
1.	Transistor NPN	BC 147	1
2.	Ammeter		1
3.	Voltmeter		1
4.	Connecting Leads		

3. THEORY:

A transistor is a 3 terminal device. It can be considered as the combination of two diodes. In a transistor there are 3 regions: 1.emitter 2.base 3.Collector. In an npn transistor the emitter and collector are n types, and base is p type. In any transistor emitter is heavily doped, base is lightly doped and collector is moderately doped. For the proper working of transistor the emitter base junction should be forward biased and collector base junction should be reverse biased. In a common emitter configuration, emitter is common to both input and output.

Transistor (bipolar transistor-BJT) is a current controlled device. The input characteristics are a plot between the base current and base emitter voltage. The dynamic input resistance can be calculated by taking the slope of the input characteristics by keeping the output voltage constant. The output characteristics is a plot between collector current and collector emitter voltage by keeping the input current constant..Now the common emitter current gain ß can be calculated as a ratio between collector current and base current at a particular value of output voltage (collector emitter voltage).

The input characteristics:

To draw input characteristic the input supply V_{BE} is varied and corresponding current I_B is noted with each increamental step, while the output supply is kept constant throughout the step.

The input impedance, $Ri = \Delta V_{BE} / \Delta I_B$ at V_{CE} constant (1)

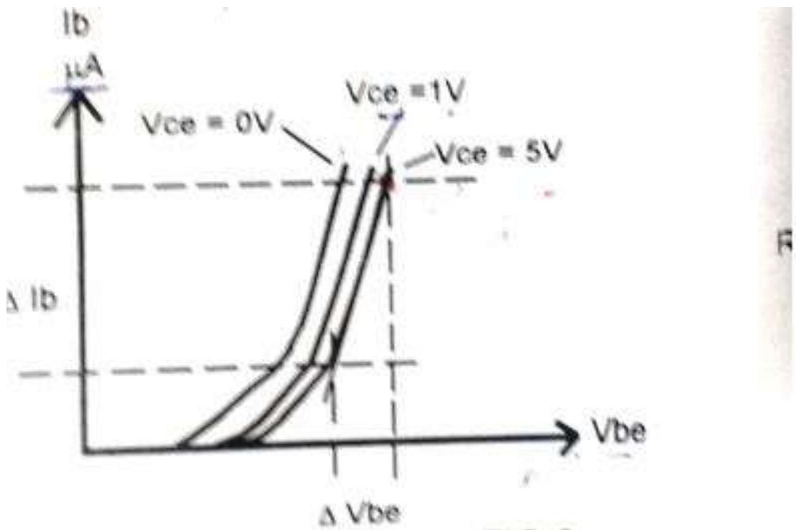


Fig.2 Input characteristic curve

The output characteristics:

To draw output characteristics the output supply V_{CE} is varied and corresponding current I_C is noted with each increamental step, while the input current I_B is kept constant throughout the step.

The output impedance, $Ro = \Delta V_{CE} / \Delta I_C$ at I_B constant (2)

The current gain, $\beta = \Delta I_C / \Delta I_B$ at V_{CE} constant (3)

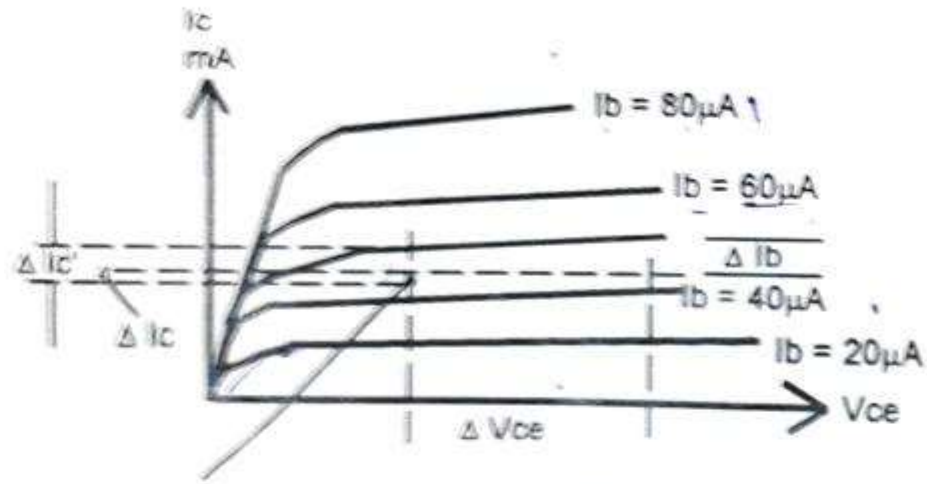


FIG 3
Typical output characteristics curve

4. CIRCUIT DIAGRAM:

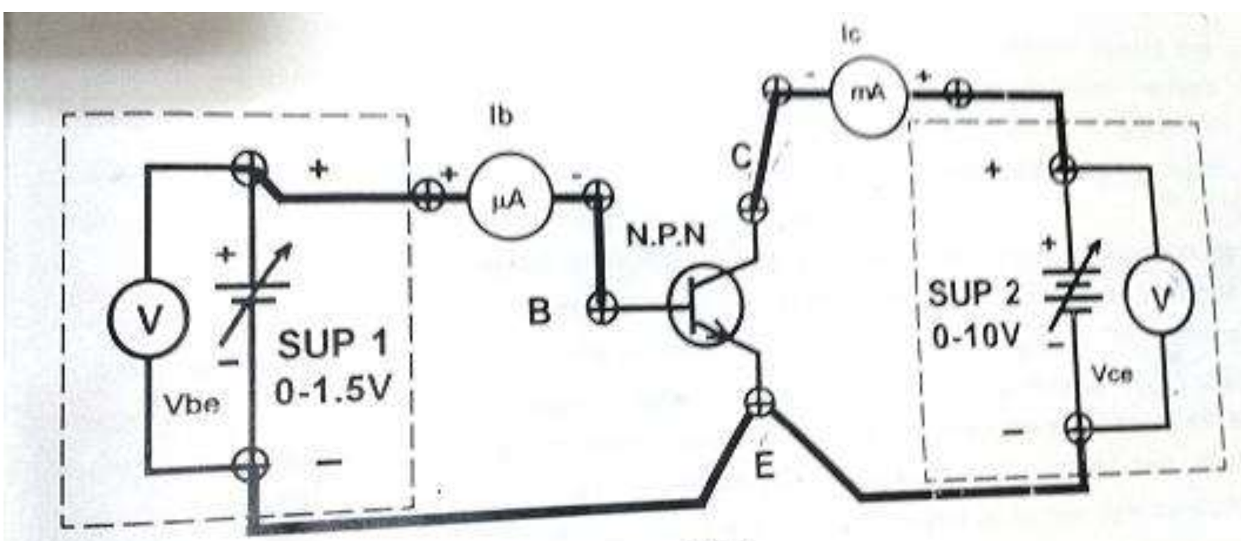


FIG 1
N.P.N Transistor in common - emitter biasing

5. PROCEDURE:

To plot the input and output characteristics of given transistor in common emitter configuration.

(A) For input characteristics.(Fig.1)

1. Keep V_{CE} supply at dc 5volt i.e. V_{CE} =5V.

2. Slowly increase V_{BE} supply in small steps. Note I_B and V_{BE} for each increamental step.

3. Tabulate all observations.

4. Plot the input characteristic curve from the observations between I_B and $V_{BE.}$ Find out the slope of the curves as given in relation see fig2.

(B) For output characteristics.(Fig.1)

1. Keep V_{CE} =0. Adjust I_B =40µA.

2. Slowly increase V_{CE} supply in small steps. The µAmmeter deflects back as the V_{CE} get increased. This is due to reverse saturation current $I_{CEO.}$ Recorrect I_B to determined value 40µA. Note I_C and V_{CE} with each increamental step.

3. Repeat step2 for different values of I_B say 80µA increament for each step. Care should be taken to recorrect I_B through the steps.

4. Tabulate the observations.

5. Plot the output characteristic curves from the observations , between I_C and $V_{CE.}$ Fix an operating point in the middle of the curves, find out the slope of the curve as given in relation (2) and (3). See fig3.

6. OBSERVATION:

At constant, V_{CE} =5V **At constant, I_B =40μA**

S.No.	V_{BE}	I_B	S.No.	V_{BE}	I_B

8. RESULTS AND DISCUSSION:

Thus the input and output characteristic of CE configuration is plotted.

9. PRE EXPERIMENT Q.B:

Q1. What is transistor?

Ans. A transistor is a 3 terminal device. It can be considered as the combination of two diodes. In a transistor there are 3 regions: 1.emitter 2.base 3.Collector. In an npn transistor the emitter and collector are n types, and base is p type. In any transistor emitter is heavily doped, base is lightly doped and collector is moderately doped.

Q2. What are the various configuration of transistor?

Ans. i. Common emitter configuration.

ii. Common base configuration.

iii. Common collector configuration.

10. POST EXPERIMENT Q.B:

Q1. What do you mean by current gain?

Ans. Current gain is defined as the ratio of output current to the input current.

11. PRECAUTIONS:

1. Power supply voltage should be zero before starting the experiment.

2. Connect the voltmeter and ammeter in correct polarities.

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

EXPERIMENT NO. 07

1. AIM: Characteristic of FET: FET in common source configuration. Graphical measurement of its parameters gm, rd & m from input and output characteristics.

2. APPARATUS REQUIRED:

S.No.	Apparatus / Software Used	Specification	Quantity
1.	FET Kit		1
2.	DC power supply	0-30V	1
3.	Patch cords		1
4.	Connecting wire		

3. THEORY:

FET is the Field Effect Transistor. It is 3 terminal voltage controlled device. It’s terminals are drain, source and gate. Gate is the controlling terminal. Consider an n channel device. The gate (p material) is diffused. At zero gate voltage there is no reverse voltage at the channel. So as Vds (drain source voltage) increases current Ids also increases linearly. As the voltage is increased, at a particular voltage, pinch off occurs .This voltage is known as pinch off voltage. After pinch off drain current remains stationary .If we apply a gate voltage (negative voltage) the pinch ff occurs early.

The parameters of FET:

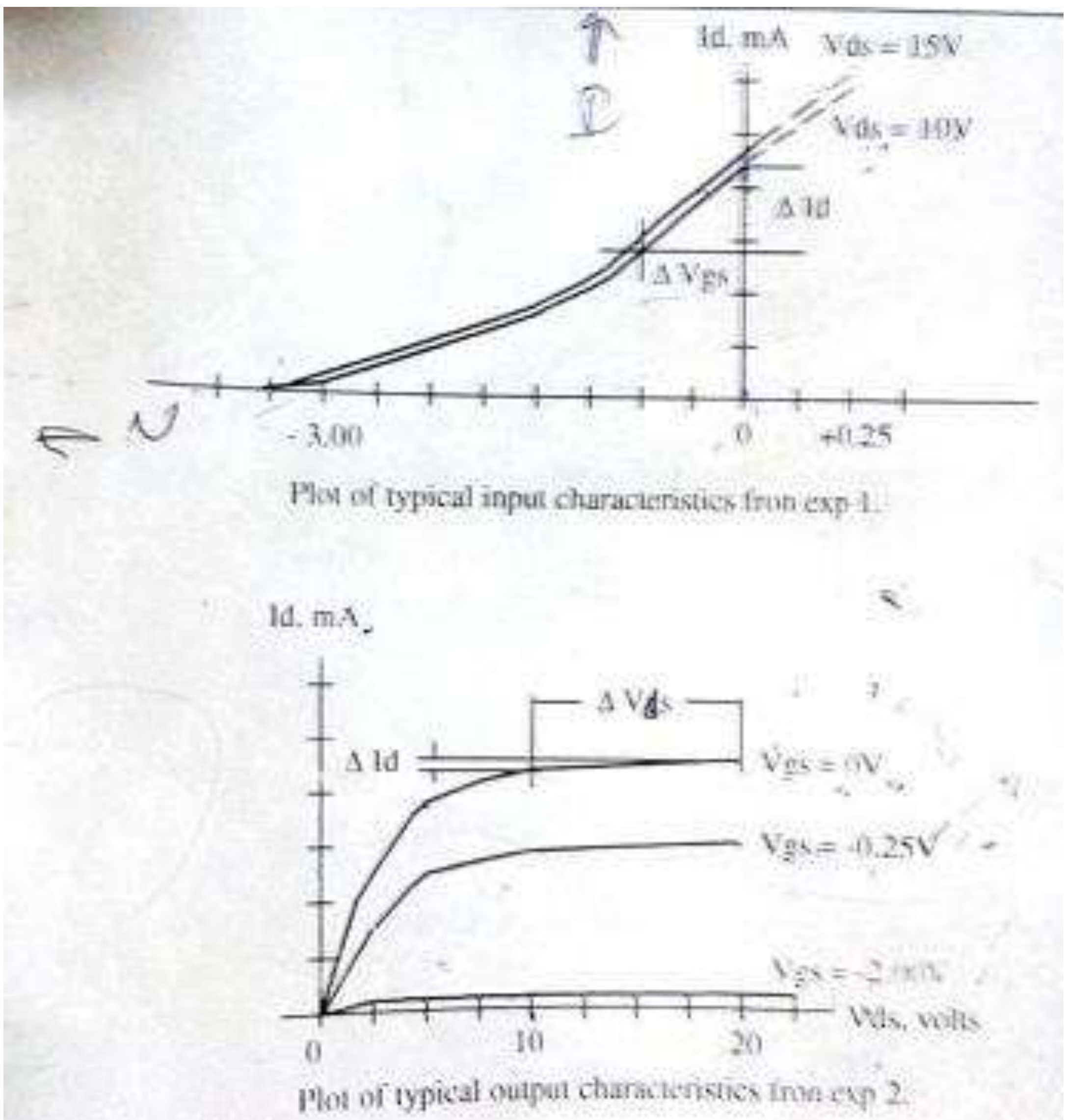
1. Drain resistance, rd:- the drain resistance of MOSFET is defined as follows:

$Rd = \Delta V_{DS} / \Delta I_D$, V_{GS} at constant value (1)

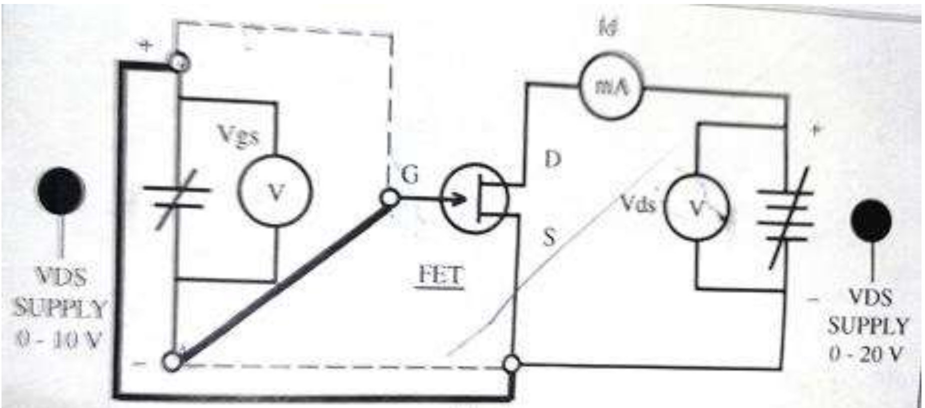
Where V_{DS} is the drain source supply, I_D corresponding drain current and V_{GS} is the voltage between gate and source.

2. Transconductance, gm:- It is defined as the control of gate voltage over drain current and measured by forward transconductance gfs as

gfs = $\Delta I_D / \Delta V_{GS}$, ΔV_{DS} at constant value (2)



4. CIRCUIT DIAGRAM:



5. PROCEDURE:

(1) To measure drain current I_D at different values of gate source voltage V_{GS}

1.1. Keep both supply controls at minimum position (fully counter- clockwise). Connect gate-source connections with gate supply V_{GS} as shown in fig.1.

1.2. Switch on the power. Adjust drain supply, V_{DS} at 10V and V_{GS} at +0.25V. Note the current I_D , mA at V_{GS} = +0.25V.

1.3. Decrease V_{GS} in small steps and note the corresponding drain current till V_{GS} = 0V.

1.4. Reverse the gate –source connections as shown in fig.1. Now the gate terminal is negative than source.

1.5. Increase the gate voltage in small steps in negative direction and note the drain current for each increament of V_{GS}.

1.6. Repeat the steps at V_{DS} = 15V. Tabulate the readings.

(2) To measure drain current I_D at different values of drain source voltage V_{DS}.

2.1. Remain the setup as step 1.4. Keep V_{GS}=0V. Increase V_{DS} in small steps and note drain current with each increament of V_{DS}.

2.2.Repeat the step 2.1 at -0.5, -1.00, -1.50 and -2.00 Volts of $V_{GS.}$ Tabulate the readings.

2.3. From the table plot the graph between V_{GS} and I_D for constant values of V_{DS}. Plot the another graph between I_D and V_{DS} at constant values of V_{GS}.

6. OBSERVATION:

S.No.	V_{GS} (V)	I_D mA at V_{DS}	S.No.	V_{DS} (V)	I_D mA at V_{GS}
01	+0.25		01	+0.25	
02	-0.50		02	-0.50	
03	-1.00		03	-1.00	
04	-1.50		04	-1.50	
05	-2.00		05	-2.00	

7. RESULTS AND DISCUSSION:

The output characteristics of FET is drawn on the graph from which we obtain that practical observation are true according to theory.

8. PRE EXPERIMENT Q.B:

Q1. What is FET?

Ans. FET is the Field Effect Transistor. It is 3 terminal voltage controlled device. It's terminals are drain, source and gate. Gate is the controlling terminal.

Q2. What do you mean by transconductance?

Ans. Transconductance, gm:- It is defined as the control of gate voltage over drain current and measured by forward transconductance.

9. POST EXPERIMENT Q.B:

Q1. What is advantage of FET over BJT?

Ans. a) No minority carriers

b) High input impedance

c) It is a voltage controlled device

d) Better thermal stability

10. PRECAUTIONS:

1. Keep your hands away from main supply.

2. Use patch cords carefully.

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

EXPERIMENT NO. 08

1. AIM: Characteristic of silicon-controlled rectifier.

2. APPARATUS REQUIRED:

S.No.	Apparatus / Software Used	Specification	Quantity
1. 2. 3.	SCR Kit Multimeter Patch cards		1 2

3. THEORY:

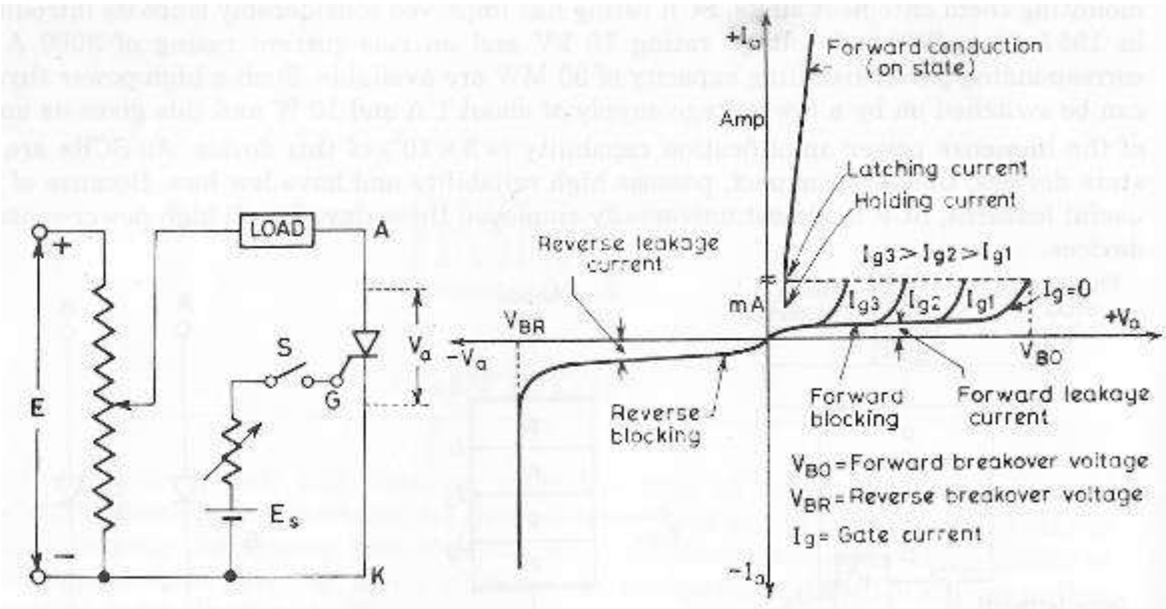


Fig. 4.2. (a) Elementary circuit for obtaining thyristor V-I characteristics
(b) Static V-I characteristics of a thyristor.

An elementary circuit diagram for obtaining static V-I characteristics of a thyristor is shown in Fig. 4.2 (a). The anode and cathode are connected to main source through the load. The gate and cathode are fed from a source E_s which provides positive gate current from gate to cathode.

Fig. 4.2 (b) shows static V-I characteristics of a thyristor. Here V_a is the anode voltage across thyristor terminals A, K and I_a is the anode current. Typical SCR V-I characteristic shown in Fig. 4.2 (b) reveals that a thyristor has three basic modes of operation; namely, reverse blocking mode, forward blocking (off-state) mode and forward conduction (on-state) mode. These three modes of operation are now discussed below:

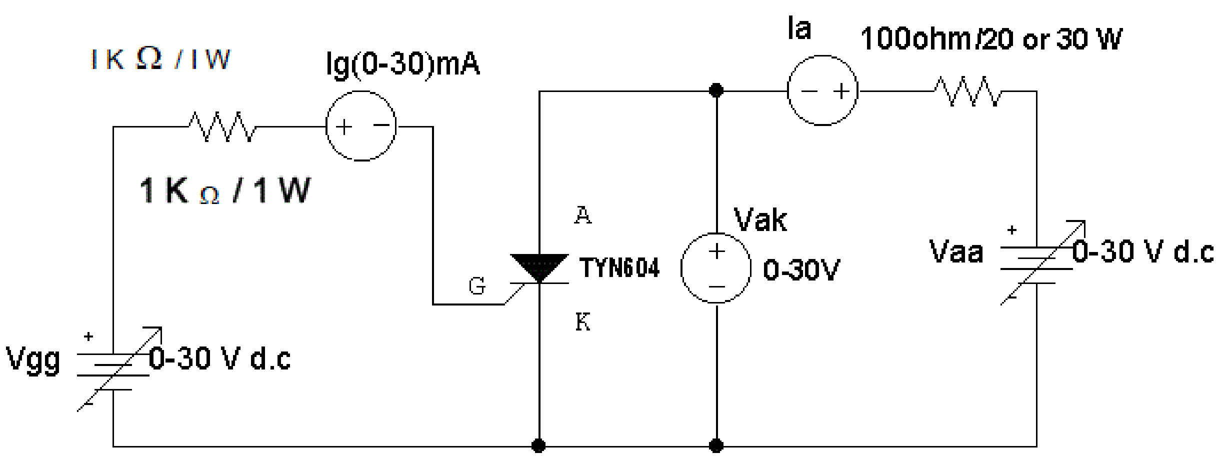
Reverse Blocking Mode: When cathode is made positive with respect to anode with switch S open, Fig. 4.2 (a), thyristor is reverse biased as shown in Fig. 4.3 (a). Junctions J1 J_3 are seen to be reverse biased whereas junction J_2 is forward biased. The device behaves as if two diodes are connected in series with reverse voltage applied across them. A small leakage current of the order of a few milliamperes (or a few microamperes depending upon the SCR rating) flows. This is reverse blocking mode, called the off-state, of the thyristor. If the reverse voltage is increased, then at a critical breakdown level, called reverse breakdown voltage VBR, an avalanche occurs at J1 and J3 and the reverse current increases rapidly. A large current associated with VBR gives rise to more losses in the SCR. This may lead to thyristor damage as the junction temperature may exceed its permissible temperature rise. It should, therefore, be ensured that maximum working reverse voltage across a thyristor does not exceed VBR. When reverse voltage applied across a thyristor is less than VBR, the device offers a high impedance in the reverse direction. The SCR in the reverse blocking mode may therefore be treated as an open switch.

Note that V-I characteristic after avalanche breakdown during reverse blocking mode is applicable only when load resistance is zero, Fig. 4.2 (b). In case load resistance is present, a large anode current associated with avalanche breakdown at V_{BR} would cause substantial voltage drop across load and as a result, V-I characteristic in third quadrant would bend to the right of vertical line drawn at V_{BR}.

Forward Blocking Mode: When anode is positive with respect to the cathode, with gate circuit open, thyristor is said to be forward biased as shown in Fig. 4.3 (b). It is seen from this figure that junctions $J1_,$ J_3 are forward biased but junction J_2 is reverse biased. In this mode, a small current, called forward leakage current, flows as shown in Figs. 4.2 (b) and 4.3 (b). In case the forward voltage is increased, then the reverse biased junction J_2 will have an avalanche breakdown at a voltage called forward break over voltage VB0. When forward voltage is less than VBO, SCR offers high impedance. Therefore, a thyristor can be treated as an open switch even in the forward blocking mode.

Forward Conduction Mode: In this mode, thyristor conducts currents from anode to cathode with a very small voltage drop across it. A thyristor is brought from forward blocking mode to forward conduction mode by turning it on by exceeding the forward breakover voltage or by applying a gate pulse between gate and cathode. In this mode, thyristor is in on-state and behaves like a closed switch. Voltage drop across thyristor in the on state is of the order of 1 to 2 V depending on the rating of SCR. It may be seen from Fig. 4.2 (b) that this voltage drop increases slightly with an increase in anode current. In conduction mode, anode current is limited by load impedance alone as voltage drop across SCR is quite small. This small voltage drop v_T across the device is due to ohmic drop in the four layers.

4. CIRCUIT DIAGRAM:



5. PROCEDURE:

1. Connections are made as shown in the circuit diagram.

2. The value of gate current $I_{G,}$ is set to convenient value by adjusting $V_{GG.}$

3. By varying the anode cathode voltage V_{AA} gradually in step by step, note down the corresponding values of V_{AK} and I_A . Note down V_{AK} and I_A at the instant of firing of SCR and after firing (by reducing the voltmeter ranges and ammeter ranges) then increase the supply voltage V_{AA} . Note down corresponding values of V_{AK} and $I_{A.}$

4. The point at which SCR fires, gives the value of break over voltage V_{BO}.

5. Agraph of V_{AK} V/S I_A is to be plotted.

6. The on state resistance can be calculated from the graph by using a formula.

7. The gate supply voltage V_{GG} is to be switched off.

8. Observe the ammeter reading by reducing the anode cathode supply voltage V_{AA} .The point at which ammeter reading suddenly goes to zero gives the value of holding current I_H .

9. Steps no.2, 3, 4, 5, 6, 7, 8 are repeated for another value of gate current I_G .

6. OBSERVATION:

For forward bias **For reverse bias**

S.No.	**Voltage (V)**	**Current (mA)**	**S.No.**	**Voltage (V)**	**Current (µA)**

7. RESULTS AND DISCUSSION:

The V-I characteristics of silicon controlled rectifier is plotted on the graph which is true according to theory.

8. PRE EXPERIMENT Q.B:

Q1. What is SCR?

Ans. A silicon-controlled rectifier (or semiconductor-controlled rectifier) is a four-layer solid state current. The name "silicon controlled rectifier" or SCR is General Electric's trade name for a type of thyristor. SCRs are mainly used in devices where the control of high power, possibly coupled with high voltage, is demanded. Their operation makes them suitable for use in medium to high-voltage AC power control applications, such as lamp dimming, regulators and motor control.

9. POST EXPERIMENT Q.B:

Q1. What are various turn on method for thyristor?

Ans. i) Forward voltage triggering.

ii) gate triggering

iii) dv/dt triggering

iv) temperature triggering

v) light triggering

10. PRECAUTIONS:

1. Keep your hand away from main supply.

2. Do not switch on the power supply unless you have checked the circuit connections as per the circuit diagram.

EXPERIMENT NO. 09

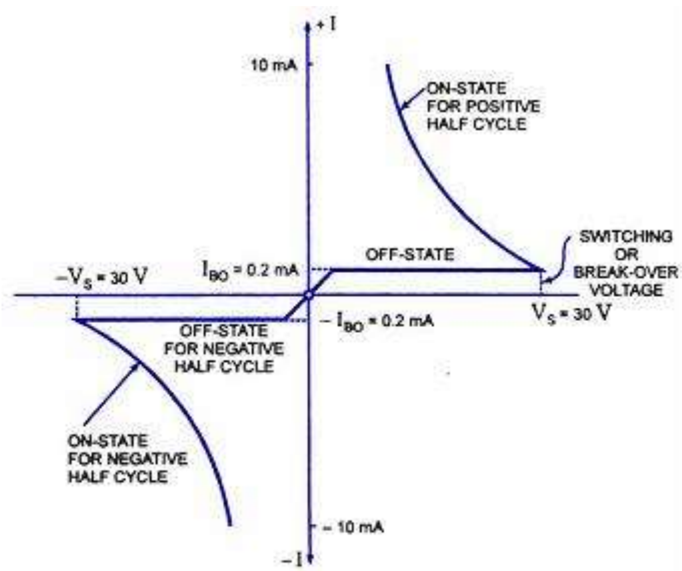
1. AIM: **To plot** V-I Characteristics of DIAC.

2. APPARATUS REQUIRED:

S.No.	Apparatus / Software Used	Specification	Quantity
1. 2. 3.	DIAC Kit Multimeter Connecting Leads		1 2

3. THEORY:

A diac is an important member of the thyristor family and is usually employed for triggering triacs. A diac is a two-electrode bidirectional avalanche diode which can be switched from off-state to the on-state for either polarity of the applied voltage. This is just like **a triac** without gate terminal, as shown in figure. Its equivalent circuit is a pair of inverted four layer diodes. Two schematic symbols are shown in figure. Again the terminal designations are arbitrary since the diac, like triac, is also a bilateral device. The switching from off-state to on-state is achieved by simply exceeding the avalanche break down voltage in either direction.

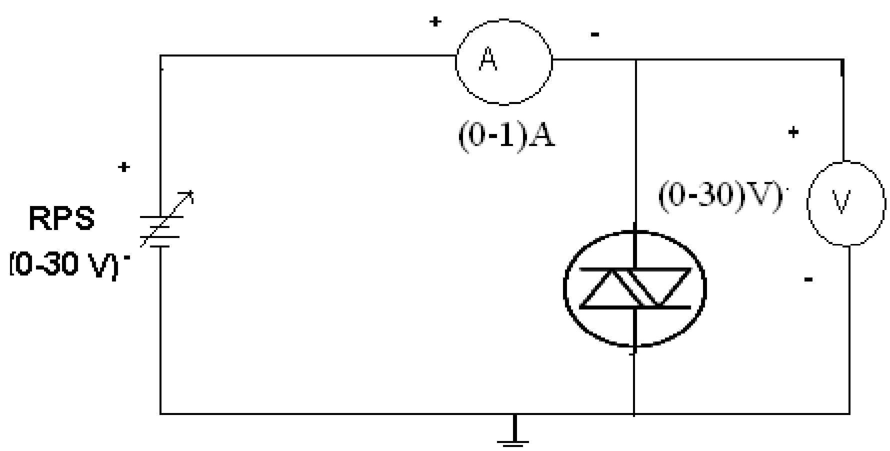


V-I Characteristic of a Diac

Volt-ampere characteristic of a diac is shown in figure. It resembles the English letter Z because of the symmetrical switching characteristics for either polarity of the applied voltage.

The diac acts like an open-circuit until its switching or breakover voltage is exceeded. At that point the diac conducts until its current reduces toward zero (below the level of the holding current of the device). The diac, because of its peculiar construction, does not switch sharply into a low voltage condition at a low current level like the SCR or triac. Instead, once it goes into conduction, the diac maintains an almost continuous negative resistance characteristic, that is, voltage decreases with the increase in current. This means that, unlike the SCR and the triac, the diac cannot be expected to maintain a low (on) voltage drop until its current falls below a holding current level.

4. CIRCUIT DIAGRAM:



5. PROCEDURE:

1. Connect the millimetre, DIAC, Voltmeter to the circuit.
2. Switch on the power supply.
3. Increase the supply voltage in steps; note the corresponding currents and voltages for each step.
4. Plot the graph of VI characteristics.

5. Reverse the terminal of DIAC. Increase the supply voltage in steps, note the corresponding currents and voltages for each step

6. Plot the graph of VI characteristics.

6. OBSERVATION:

For forward bias **For reverse bias**

S.No.	Voltage (V)	Current (mA)	S.No.	Voltage (V)	Current (μA)

7. RESULTS AND DISCUSSION:

The V-I characteristics of DIAC is plotted on the graph which is true according to theory.

8. PRE EXPERIMENT Q.B:

Q1. What is DIAC?

Ans. DIAC is a three layer; two terminal semiconductor devices.MT1 and MT2 are the two main terminals which are interchangeable .It acts as a bidirectional avalanche diode. It does not have any control terminal. It has two junctions J1 and J2 resembles a bipolar transistor, the central layer is free from any connection with the terminals. It acts as a switch in both directions.

9. POST EXPERIMENT Q.B:

Q1. What are the applications of DIAC?

Ans. DIACS are widely used in AC applications and it is found that the device is "reset" to its non-conducting state, each time the voltage on the cycle falls so that the current falls below the holding current. As the behaviour of the device is approximately equal in both directions, it can provide a method of providing equal switching for both halves of an AC cycle, e.g for triacs.

10. PRECAUTIONS:

1. Keep your hand away from the main supply.

2. Do not switch on the power supply unless you have checked the circuit connections as per the circuit diagram.

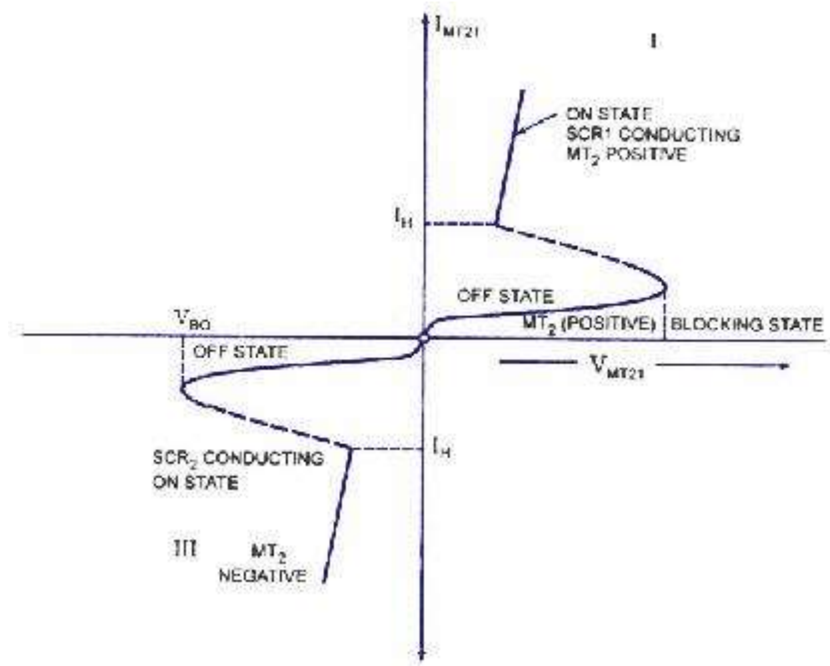
EXPERIMENT NO. 10

1. AIM: **To draw** V-I characteristics of TRIAC for different values of Gate Currents.

2. APPARATUS REQUIRED:

S.No.	Apparatus / Software Used	Specification	Quantity
1. 2. 3.	TRIAC Kit Multimeter Connecting Leads		1 2

3. THEORY:



V-I Characteristic of a Triac

Typical V-I characteristics of a **triac** are shown in figure. The triac has on and off state characteristics similar to SCR but now the char acteristic is applicable to both positive and negative voltages. This is expected because triac consists of two SCRs connected in parallel but opposite in direc tions.

MT_2 is positive with respect to MT_X in the first quadrant and it is negative in the third quad rant. As already said in previous blog posts, the gate triggering may occur in any of the following four modes.

Quadrant I operation : V_{MT2}, positive; V_{G1} positive

Quadrant II operation : V_{MT21} positive; V_{Gl} negative

Quadrant III operation : V_{MT21} negative; V_{Gl} negative

Quadrant IV operation : V_{MT21} negative; V_{G1} positive

where V_{MT21} and V_{Gl} are the voltages of terminal MT_2 and gate with respect to terminal MT_1.

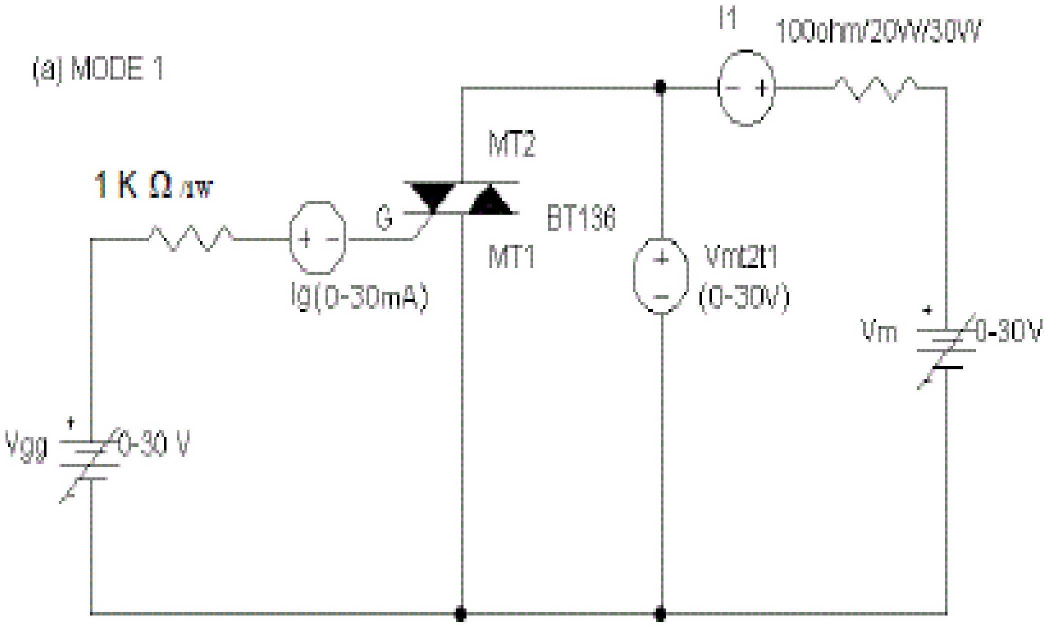
The device, when starts conduction permits a very heavy amount of current to flow through it. This large inrush of current must be restricted by employing external resist ance, otherwise the device may get damaged.

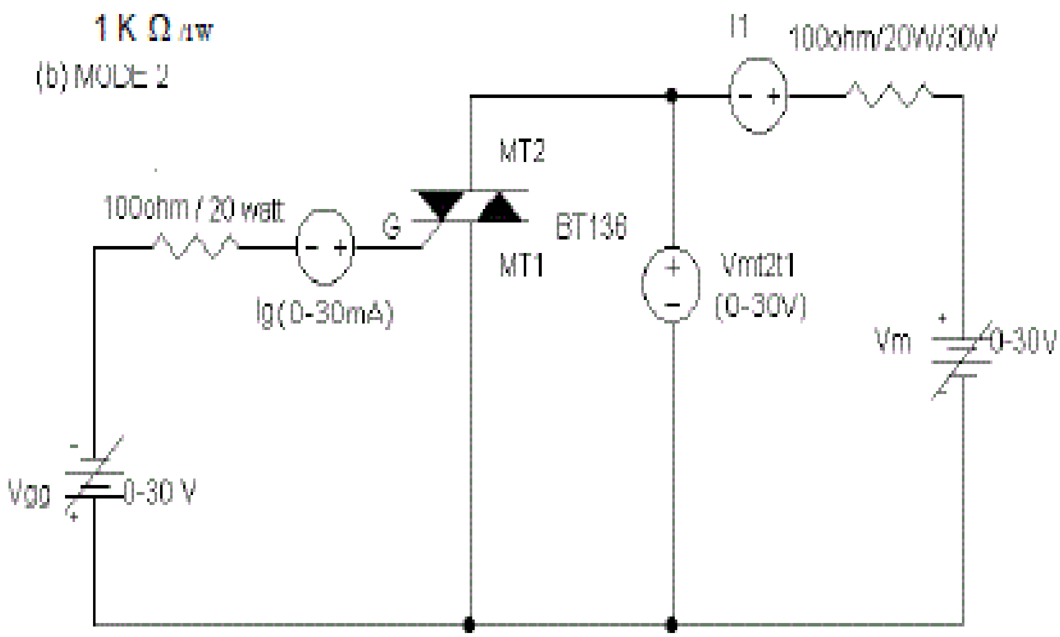
The gate is the control terminal of the device. By applying proper signal to the gate, the firing angle of the device can be controlled. The circuits used in the gate for triggering the device are called the gate-triggering circuits. The gate-triggering circuits for the triac are almost same like those used for SCRs. These triggering circuits usually generate trigger pulses for firing the device. The trigger pulse should be of sufficient magnitude and duration so that firing of the device is assured. Usually, a duration of 35 us is sufficient for sustaining the firing of the device.

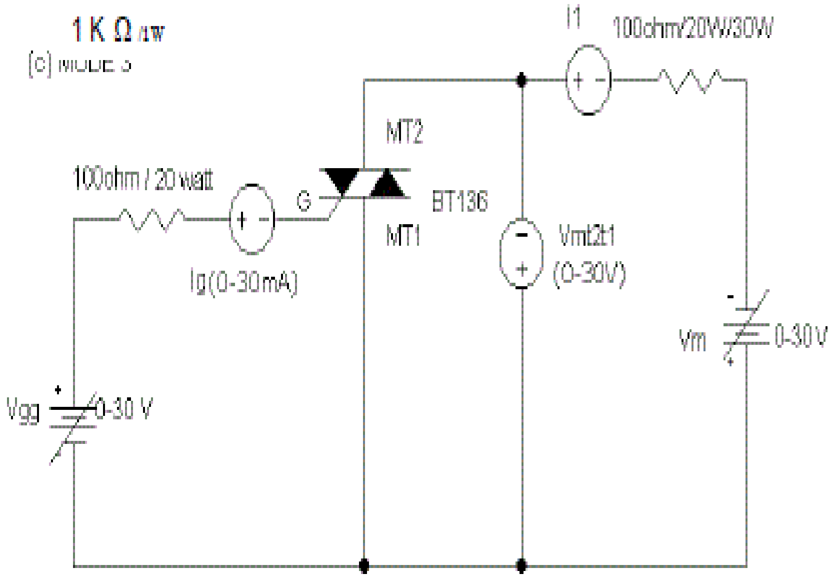
A typical triac has the following voltage/current values:

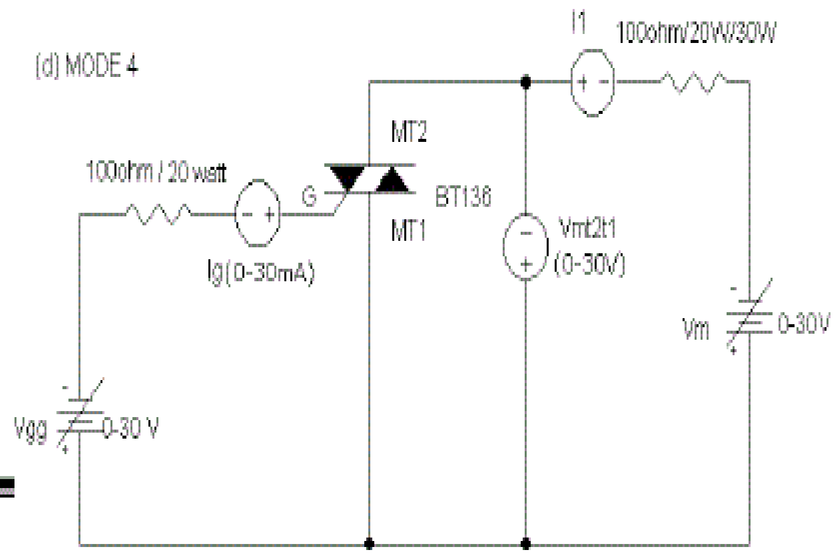
- Instantaneous on-state voltage – 1.5 Volts
- On-state current – 25 Amperes
- Holding current, I_H - 75 Milli Amperes
- Average triggering current, I_G – 5 Milli Amperes

4. CIRCUIT DIAGRAM:






1 K Ω /1W
(c) MODE 3
I1
100ohm/20W/30W
MT2
100ohm / 20 watt
G
BT136
MT1
Vmt2t1
(0-30V)
Ig(0-30mA)
Vm
0-30 V
Vgg
0-30 V


I1
100ohm/20W/30W
(d) MODE 4
MT2
100ohm / 20 watt
G
BT136
MT1
Vmt2t1
(0-30V)
Ig(0-30mA)
Vm
0-30V
Vgg
0-30 V

5. PROCEDURE:

1. Connections are made as shown in the circuit diagram
2. Adjust the value of I_g to zero or some minimum value
3. By varying the voltage V_{mt2mt1} from 0 to 10 volts with a step of 2 volts, note down corresponding values of I_1
4. Now apply the gate voltage gradually, until SCR fires, then note down the values of I_g and also the values of I_1 and V_{mt2mt1}.
5. Increase V_m to some value and note down I_1 and V_{mt2mt1}.
6. Reduce gate voltage to zero, observe ammeter reading by reducing V_m which gives the values of I_h (holding current) at the point at which, current suddenly drops to zero
7. Repeat the steps 2, 3, 4, 5 & 6 for different values of break over voltages
8. Plot a graph of V_{mt1mt2} v/s I_1
9. Repeat the steps 1, 2, 3, 4, 5, 6 & 7 for different modes
10. Compare sensitivity of TRIAC and comment on sensitivities.
11. Refer same design procedure for selection of R_L and R_g as that of SCR.
12. Follow the same procedure as that of SCR experiment to find latching current.

6. OBSERVATION:

For forward bias **For reverse bias**

S.No.	Voltage (V)	Current (mA)	S.No.	Voltage (V)	Current (μA)

7. RESULTS AND DISCUSSION:

The V-I characteristics of TRIAC is plotted on the graph which is true according to theory.

8. PRE EXPERIMENT Q.B:

Q1. What is TRIAC?

Ans. TRIAC, from Triode for Alternating Current, is a generalized trade name for an electronic component that can conduct current in either direction when it is triggered (turned on), and is formally called a bidirectional triode thyristor or bilateral triode thyristor. TRIACs belong to the thyristor family and are closely related to Silicon-controlled rectifiers (SCR). However, unlike SCRs, which are unidirectional devices (i.e. can conduct current only in one direction), TRIACs are bidirectional and so current can flow through them in either direction.

9. POST EXPERIMENT Q.B:

Q1. What do you mean by gate threshold current?

Ans. A TRIAC starts conducting when a current flowing into or out of its gate is sufficient to turn on the relevant junctions in the quadrant of operation. The minimum current able to do this is called gate threshold current and is generally indicated by I_{GT}

Q2. What are the applications of TRIAC?

Ans. Low power TRIACs are used in many applications such as light dimmers, speed controls for electric fans and other electric motors, and in the modern computerized control circuits of many household small and major appliances.

10. PRECAUTIONS:

1. Keep your hand away from main supply.

2. Do not switch on the power supply unless you have checked the circuit connections as per the circuit diagram.