



**Ahsanullah University of Science and Technology**  
**Department of Electrical and Electronic Engineering**

**LABORATORY MANUAL**  
**FOR**  
**ELECTRICAL AND ELECTRONIC SESSIONAL COURSES**

Student Name :

Student ID :

Course no : EEE - 2104

Course Title : Electronic Circuits - I Lab



For the students of  
Department of Electrical and Electronic Engineering  
2<sup>nd</sup> Year, 1<sup>st</sup> Semester

Price : Tk. 14.00



## Experiment No: 1

Name of the Experiment : I-V Characteristics of diode.

### Objective :

Study the I-V characteristic of diode.

### Theory :

A diode is a bi-polar device that behaves as the short circuit when it is in forward bias and as an open circuit when it is in reverse bias condition.

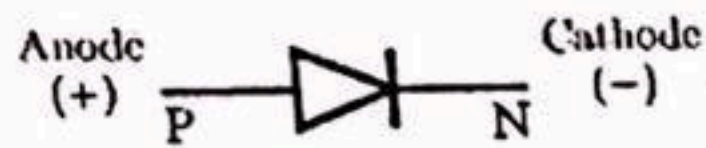


Figure 1.1 : Schematic Diagram of Diode.

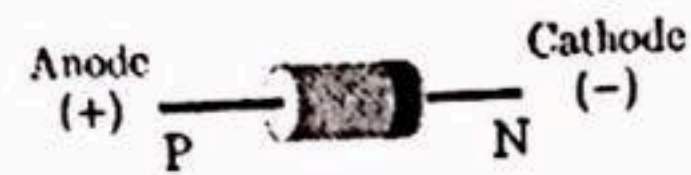


Figure 1.2 : P - N Junction Diode .

There are two types of biasing condition for a diode :

1. When the diode is connected across a voltage source with positive polarity of source connected to p side of diode and negative polarity to n side, then the diode is in forward bias condition.
2. When the diode is connected across a voltage source with positive polarity of source connected to n side of diode and negative polarity to p side, then the diode is in reverse bias condition.

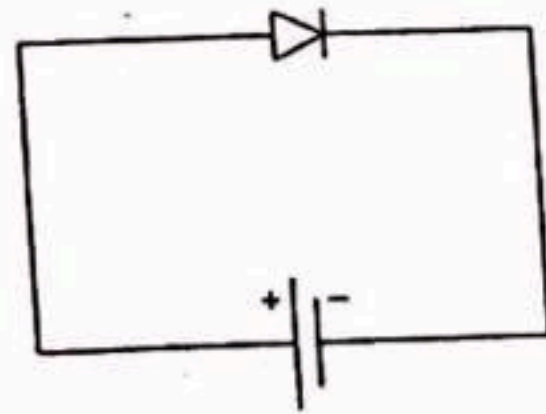


Figure 1.3 : Forward Bias connection.

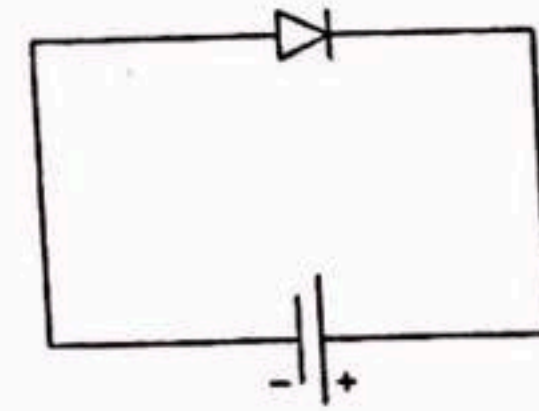


Figure 1.4 : Reverse Bias connection.

If the input voltage is varied and the current through the diode corresponds to each voltage are taken then the plot of diode current ( $I_d$ ) vs diode voltage ( $V_D$ ) will be follows :



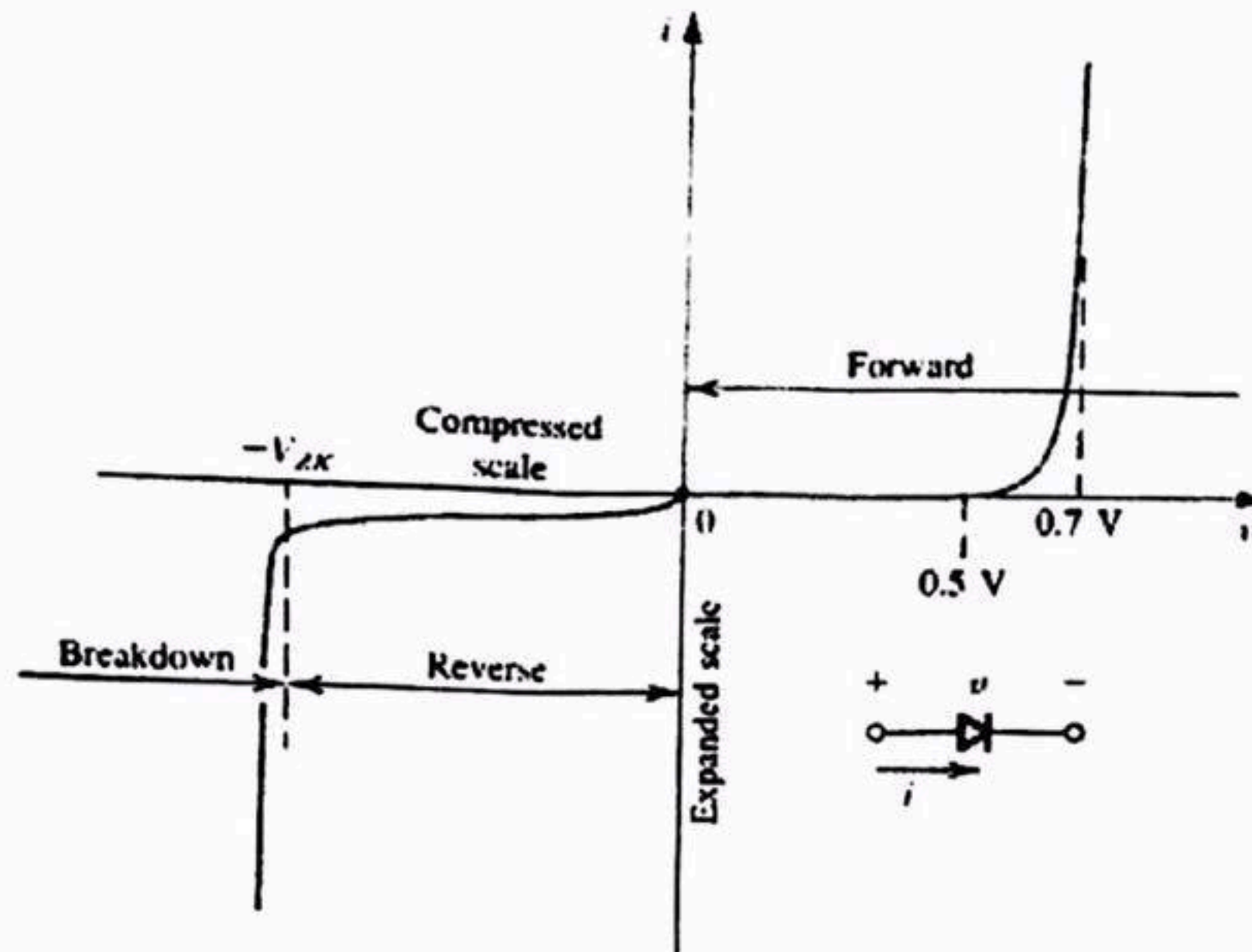


Figure 1.5 : I - V Characteristics of Diode.

At the reverse bias condition the amount of current flows through the diode is very small (at microampere range). But if the voltage continuously increases in reverse direction, at a certain value the diode will break down and huge amount of current will flow in reverse direction. This is called breakdown of diode. In laboratory the breakdown will not tested because it will damages the diode permanently.

From the characteristics curve it can be seen that, a particular forward bias voltage ( $V_T$ ) is required to reach the region of upward swing. This voltage,  $V_T$  is called the cut-in voltage or threshold voltage of diode. For Si diode the typical value of threshold voltage is 0.7 volt and for Ge diode is 0.3 volt.

### Equipments And Components :

Serial no.	Component Details	Specification	Quantity
1.	p-n junction diode	1N4007	1 piece
2.	Resistor	1 K $\Omega$	1 piece
3.	DC power supply		1 unit
4.	Signal generator		1 unit
5.	Trainer Board		1 unit
6.	Oscilloscope		1 unit
7.	Digital Multimeter		1 unit
8.	Chords and wire		as required



Experimental Setup :

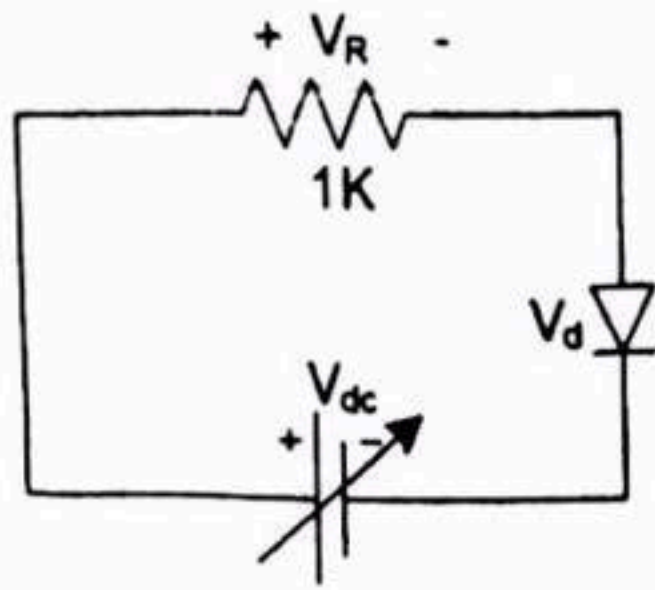


Figure 1.6 : Circuit Diagram for Obtaining Diode Forward Characteristics.

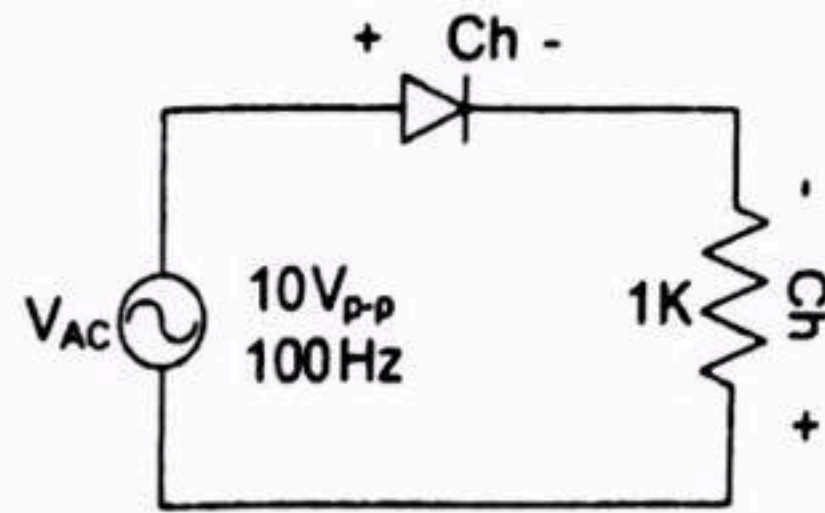


Figure 1.7 : Circuit Diagram for Obtaining Characteristics From Oscilloscope.

Procedure :

1. Measure the resistance accurately using multimeter.
2. Construct the circuit as shown in figure - 1.6.
3. Vary input voltage  $V_{dc}$ . Measure  $V_{dc}$ ,  $V_d$ ,  $V_R$  for the given values of  $V_d$  and record data on data table. Obtain maximum value of  $V_d$  without increasing  $V_{dc}$  beyond 25 volt.
4. Calculate the values of  $I_d$  using the formula,  $I_d = V_R / R$ .
5. Construct the circuit as shown in figure - 1.7.
6. Ste the oscilloscope in X-Y mode. Identify zero record on oscilloscope display. Make proper connection and observe the output.
7. Repeat the step 5 and 6 by increasing the input supply frequency 5 KHz.

Data Table :

$V_{dc}$ (volt)	$V_d$ (volt)	$V_R$ (volt)	$I_d = V_R / R$ (mA)

Report :

1. Draw the I - V characteristics curve of diode from the reading obtain in this experiment.
2. Calculate static resistance for  $I_d = 5$  mA and  $I_d = 10$  mA.
3. Determine the Q- point for the circuit in figure - 6, when  $V_{dc} = 8$  volt.



## Experiment No: 02

Name of the Experiment: Diode rectifier circuits.

### Objective:

Study of different diode rectifier circuits.

### Theory:

A rectifier converts an AC signal into a DC signal. From the characteristic curve of a diode we observe that it allows the current to flow when it is in the forward bias only. In the reverse bias it remains open. So, when an alternating voltage (signal) is applied across a diode it allows only the half cycle (positive half cycle depending on the orientation of diode in the circuit) during its forward bias condition, other half cycle will be clipped off. In the output the load will get DC signal.

Diode rectifier can be categorized in two major types. They are -

1. Half-wave rectifier.
2. Full-wave rectifier.

**Half - Wave Rectifier:** Half-wave rectifier can be built by using a single diode. The circuit diagram and the wave shapes of the input and output voltage of half wave rectifier are shown bellow (figure 2.1) -

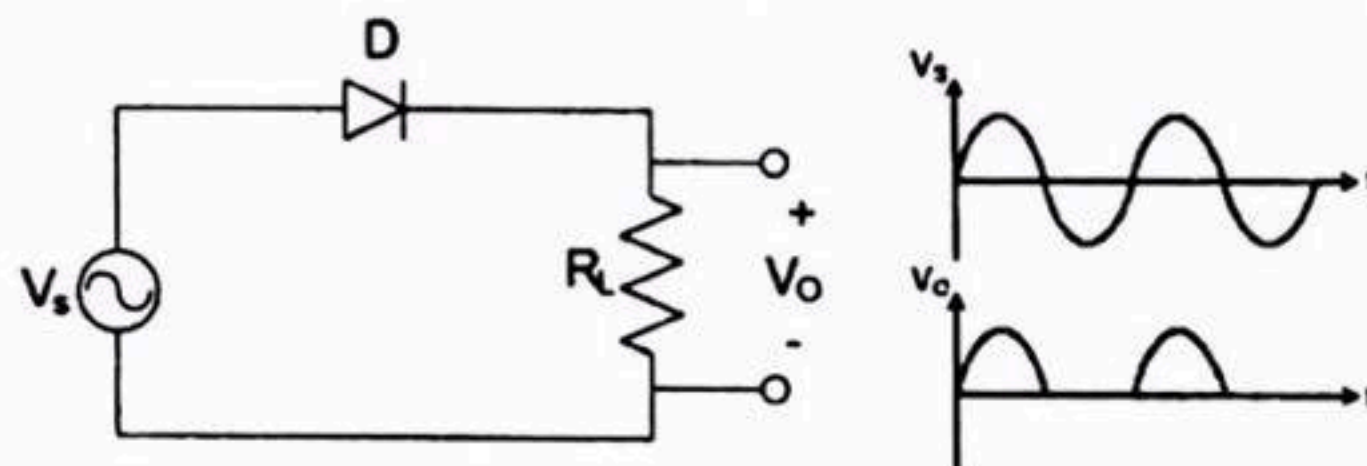


Figure 2.1: Half Wave Rectifier.

The major disadvantages of half wave rectifier are -

- In this circuit the load receives approximately half of input power.
- Average DC voltage is low.
- Due to the presence of ripple output voltage is not smooth one.

**Full Wave Rectifier:** in the full-wave rectifier both the half cycle is present in the output. Two circuits are used as full-wave rectifier are shown bellow -

- a) Full-wave rectifier using center-tapped transformer.
- b) Full-wave bridge rectifier.

Full-wave rectifier using center-tapped transformer: two diodes will be connected to the ends of the transformer and the load will be between the diode and center tap. The circuit diagram and the wave shapes are shown in bellow (figure 2.2) -



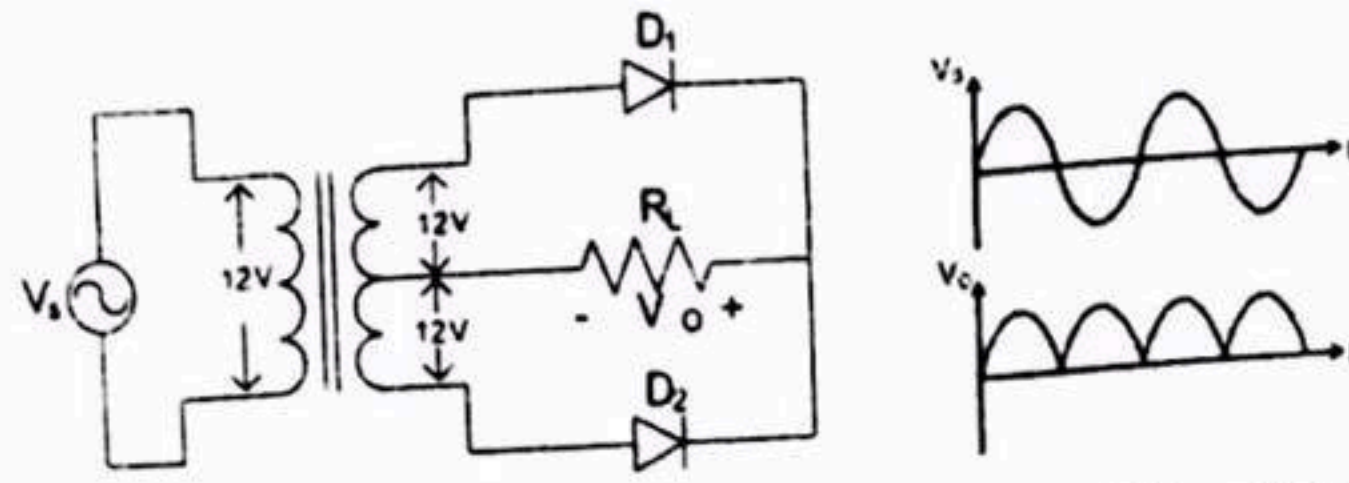


Figure 2.2: Full Wave Rectifier Using Center Tapped Transformer.

Full-wave rectifier using center-tapped transformer circuit has some advantages over full-wave rectifier. Those are -

- Wastage of power is less.
- Average DC output increase significantly.
- Wave shape becomes smoother.

The disadvantages of full-wave rectifier using center-tapped transformer are -

- Require more space and becomes bulky because of the transformer.
- Not cost effective (for using transformer).

**Full-wave bridge rectifier:** a bridge rectifier overcomes all the disadvantages of described above. Here four diodes will be connected as bridge connection. The circuit diagram and the wave shapes are shown in bellow (figure 2.3) -

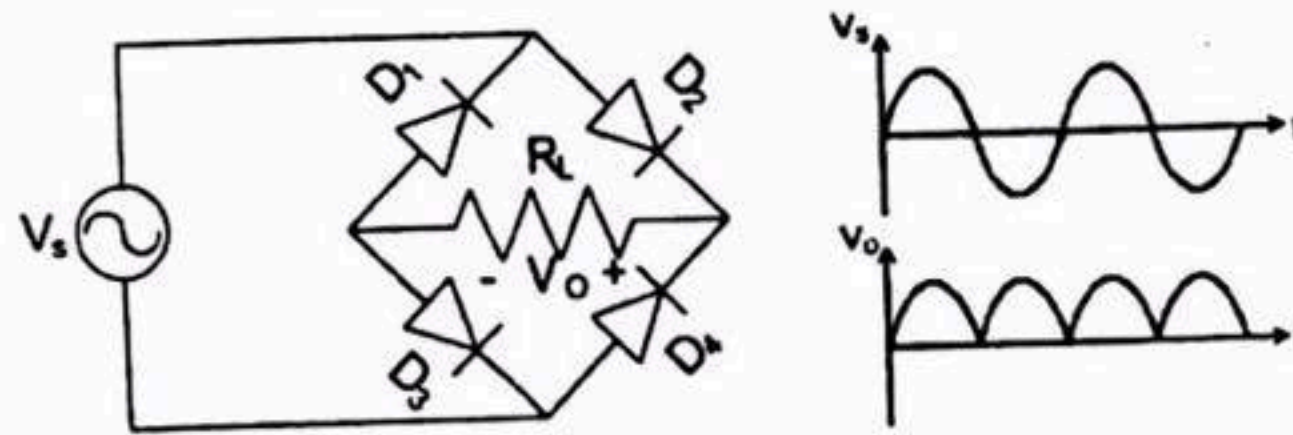


Figure 2.3: Full Wave Bridge Rectifier.

This rectifier however cannot produce a smooth DC voltage. It produces some ripple in the output. This ripple can be reducing by using filter capacitor across the load.

Equipments And Components:

Serial no.	Component Details	Specification	Quantity
1.	p-n junction diode	1N4007	4 piece
2.	Resistor	10KΩ	1 piece
3.	Capacitor	0.22μF, 10μF	1 piece each
4.	Signal generator		1 unit
5.	Trainer Board		1 unit
6.	Oscilloscope		1 unit
7.	Digital Multimeter		1 unit
8.	Chords and wire		as required



## Experimental Setup:

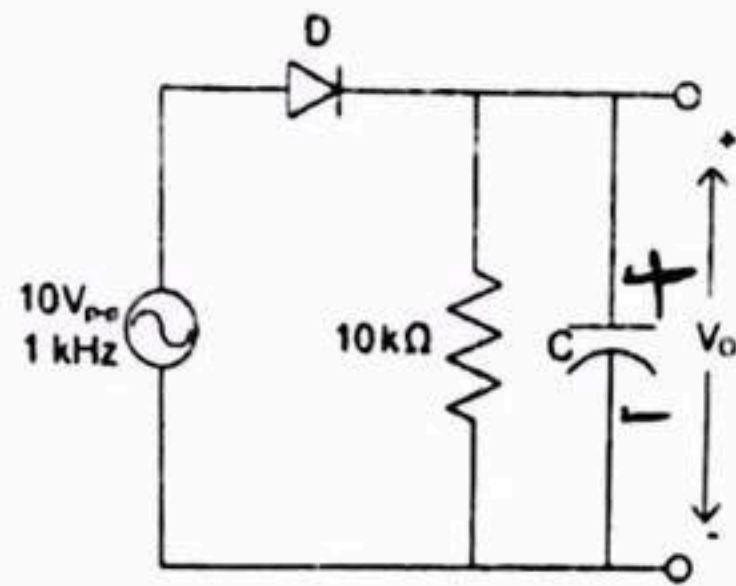


Figure 2.4 : Experimental Circuit 1.

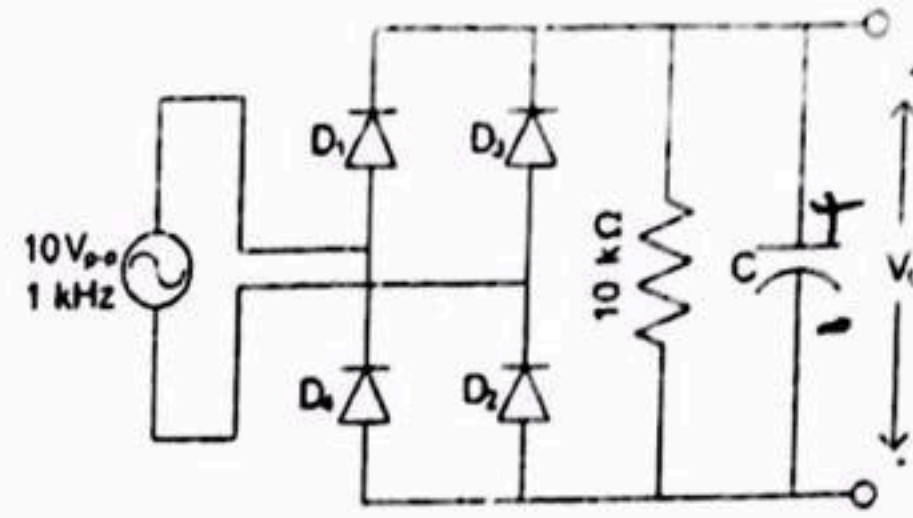


Figure 2.5 : Experimental Circuit 2.

## Procedure:

1. Connect the circuit in breadboard as shown in figure 2.4 without capacitor.
2. Observe the output and input voltages in the oscilloscope and draw them.
3. Connect the  $0.22\mu\text{F}$  capacitor and repeat step 2.
4. Connect the  $10\mu\text{F}$  capacitor and repeat step 2. How does the output wave-shape differ from that in step 3?
5. Vary the frequency from 10 KHz to 100 Hz. What effects do you observe when frequency is changed?
6. Connect the circuit breadboard as shown in figure 2.5 without capacitor.
7. Observe the output and input voltages in the oscilloscope and draw them.
8. Connect the  $0.22\mu\text{F}$  capacitor and repeat step 7.
9. Connect the  $10\mu\text{F}$  capacitor and repeat step 7. How does the output wave-shape differ from that in step 8?
10. Vary the frequency from 10 KHz to 100 Hz. What effects do you observe when frequency is changed?

## Report:

1. Write the answers that were asked during the working procedure.
2. Draw the input wave, output wave (without and with capacitor) for both the circuits.
3. What is the effect in output for changing input signal frequency for both the circuits (without and with capacitor)?
4. What is the function of capacitor in the both circuits? Why a capacitor of higher value is preferable?



Experiment No : 04

Name of the Experiment : Zener Diode applications.

Objective:

Study of the Zener Diode applications.

Theory :

The diodes we have studied before do not operate in the breakdown region because this may damage them. A Zener diode is different; it is a silicon diode that the manufacturer has optimized for operation in the breakdown region. It is used to build voltage regulator circuits that circuits that hold the load voltage almost constant despite large change in line voltage and load resistance. The symbol of Zener diode shows in figure 4.1.



Figure 4.1 : Symbol of Zener Diode.

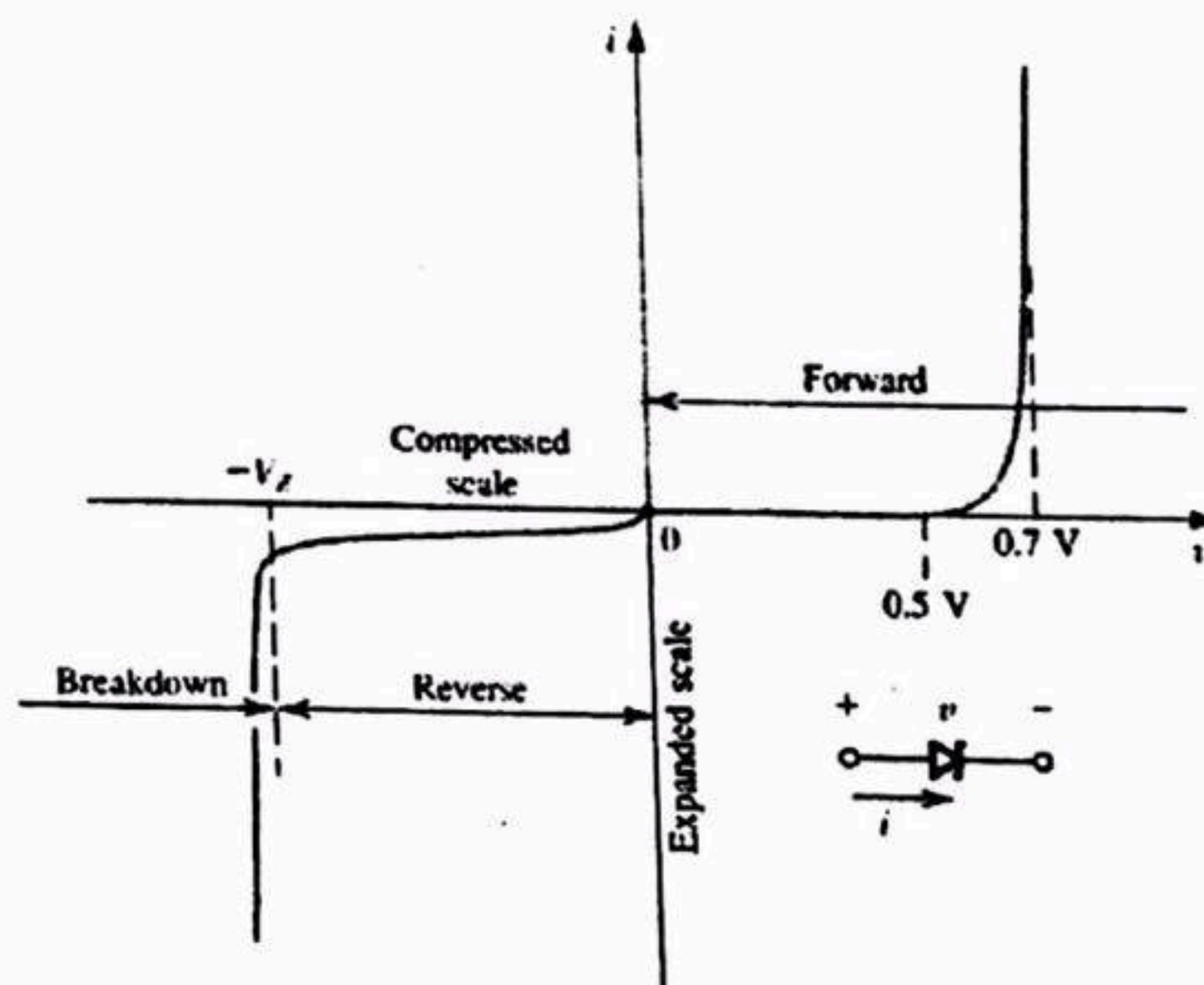


Figure 4.2 : I - V Characteristics of Zener Diode.

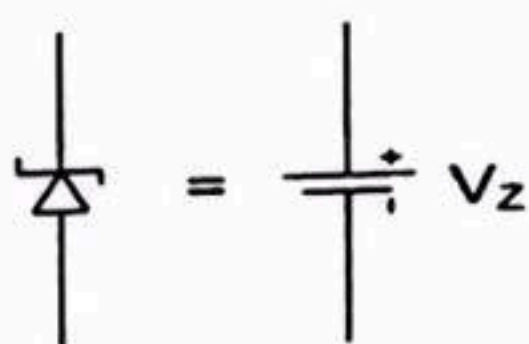
The Zener diode may have a breakdown voltage from about 2 to 200 volts. These diodes can operate in any of three regions – forward, leakage and breakdown. Figure 4.2 shows the I-V characteristics curve of Zener diode.



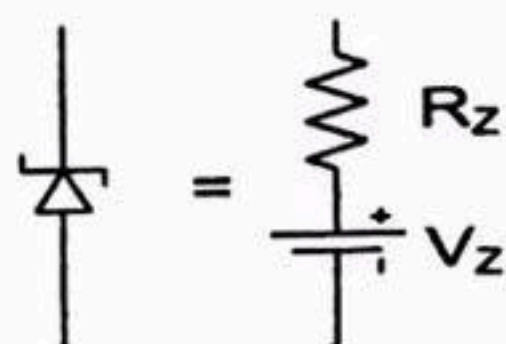
- In the forward region it works as an ordinary diode.
- In the leakage region (between zero and breakdown) it has only a small reverse saturation current.
- In the breakdown it has a sharp knee, followed by an almost vertical increase in current without changing the voltage.
- The voltage is almost constant, approximately equal to  $V_Z$  over most of the breakdown region.

Equivalent circuits of Zener Diode : Two approximation are used for Zener Diode equivalent circuit.

**First Approximation :** As the voltage remains constant across the Zener diode though the current changes through it, it is considered as a constant voltage source according to the first approximation.



**Second Approximation :** A Zener resistance is in series with the ideal voltage source is approximated.



### Equipments and Components:

Serial no.	Component Details	Specification	Quantity
1.	Zener diode	5 volts	1 piece
2.	Resistor	220 $\Omega$ , 470 $\Omega$ , 1K $\Omega$	1 piece each
3.	POT	10K $\Omega$	1 unit
4.	Trainer Board		1 unit
5.	DC Power Supply		1 unit
6.	Digital Multimeter		1 unit
7.	Chords and wire		as required



Experimental Setup:

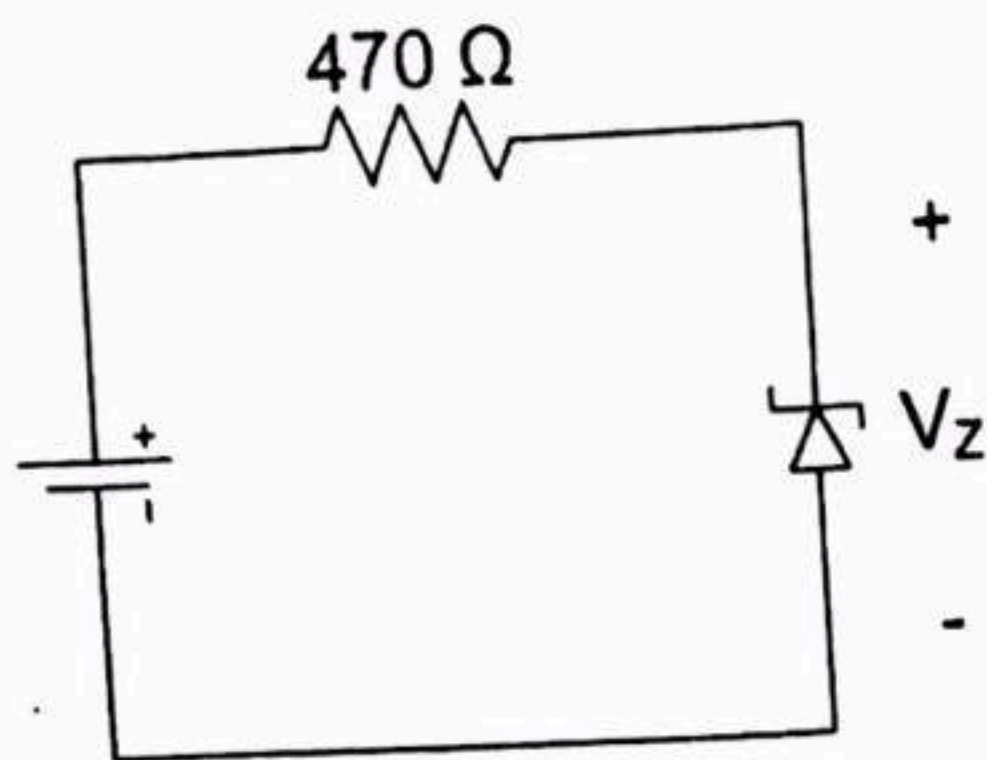


Figure 4.3 : Experimental Circuit 1.

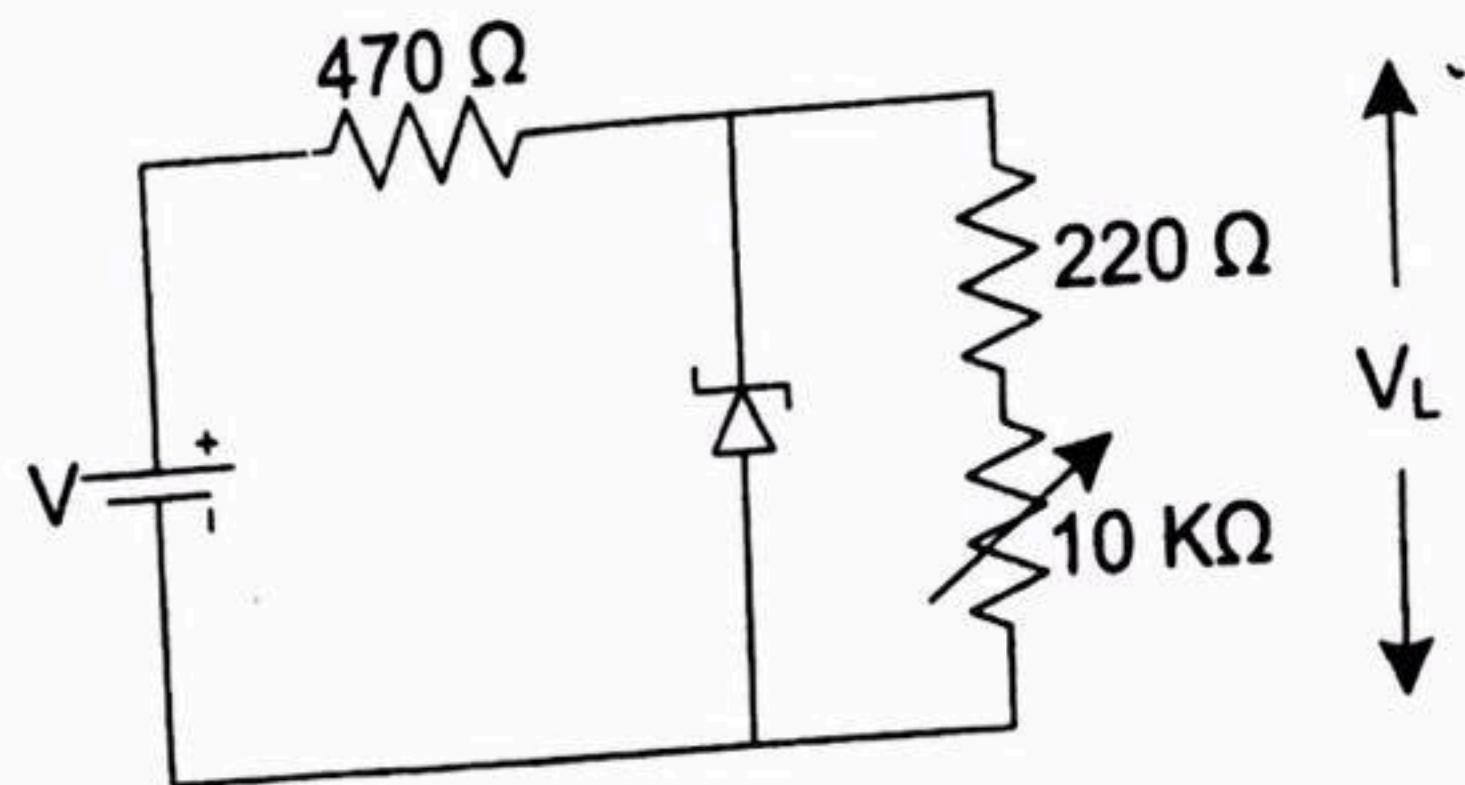


Figure 4.4 : Experimental Circuit 2.

Procedure :

1. Connect the circuit as shown in the figure 4.3
2. Vary the supply voltage from zero volt, complete the Table 4.1.
3. Connect the circuit as shown in the figure 4.4
4. Keep the POT at maximum position and power up the circuit. Apply 10 as V.
5. Gradually decrease the POT resistance and complete the Table 4.2.
6. Replace load with 1KΩ resistance, vary the supply voltage and take reading for Table 4.3.

Table 4.1 : Data for I - V characteristics.

V (volts)	$V_R$ (volts)	$V_z$ (volts)	$I_z = V_R / R$ (mA)
1.0			
2.0			
3.0			
4.0			
5.0			
6.0			
7.0			
8.0			
9.0			
10.0			
11.0			
12.0			



Table 4.2 : Data for regulation due to load variation.

$V_{220}$ (mV)	$V_L$ (volts)	$I_L$ (Amp)

Table 4.3 : Data for regulation due supply voltage variation.

$V$ (volts)	$V_L$ (volts)
5.0	
6.0	
7.0	
8.0	
9.0	
10.0	
11.0	
12.0	

Report :

1. Plot the I - V characteristics of Zener diode. Determine the Zener breakdown voltage from the plot.
2. Plot  $I_L$  vs  $V_L$  for the data table 4.2. Find the voltage regulation.
3. Plot  $V_L$  vs  $V$  for the data table 4.3. Find the voltage regulation.



## Experiment No: 05

Name of the Experiment : The output characteristics of CE (common emitter) configuration of BJT.

### Objective:

Study of the output characteristics of CE (common emitter) configuration of BJT.

### Theory :

Unlike the diode, which has two doped region, a transistor has three doped region. They are as follows –

- a) Emitter,
- b) Base and
- c) Collector.

These three doped regions form two junctions: One between the emitter and base and other between the collector and the base. Because of these it can be thought as combination of two diodes, the emitter and the base form one diode and the collector and base form another diode. The emitter is heavily doped. Its job is to emit or inject free majority carrier (electron for NPN and hole for PNP) into the base. The base is lightly doped and very thin. It passes the most of the emitter-injected electron (for NPN) into the collector. The doping level of the collector is between emitter and base. Figure 5.1 shows the biased NPN transistor.

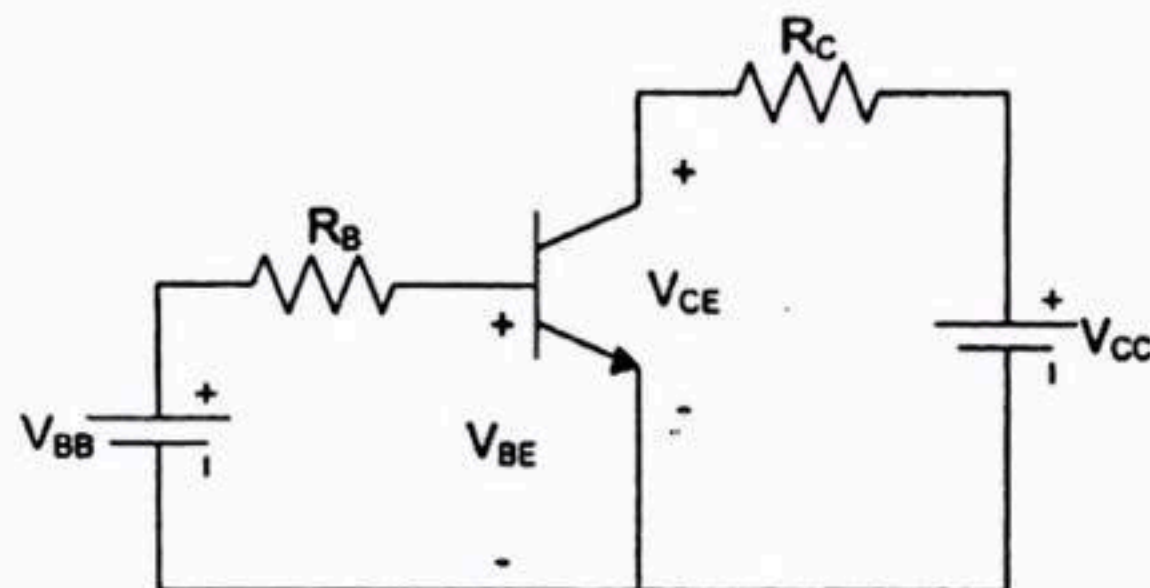


Figure 5.1 : Biasing of an NPN transistor.

If the  $V_{BE}$  is greater than the barrier potential, emitter electron will enter base region. The free electron can flow either into the base or into the collector. As base lightly doped and thin, most of the free electron will enter into the collector.

There are three different current in a transistor. They are emitter current ( $I_E$ ), collector current ( $I_C$ ) and the base current ( $I_B$ ) are shows in figure 5.2.

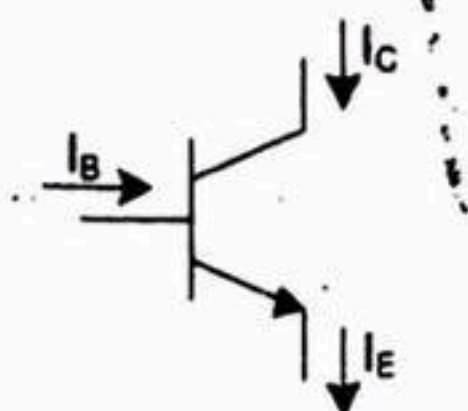


Figure 5.2 : Different current in transistor.



Here,  $I_E = I_C + I_B$ , and the current gain  $\beta = \frac{I_C}{I_B}$

Characteristics Curve : The characteristics of a transistor is measured by two characteristics curve. They are as follows –

- Input characteristics curve.
- Output characteristics curve.

Input Characteristics Curve : Input characteristics is defined as the set of curves between input current ( $I_B$ ) vs. input voltage ( $V_{BE}$ ) for the constant output voltage ( $V_{CE}$ ). It is the same curve that is found for a forward biased diode.

Output Characteristics Curve : Output characteristics is defined by the set of curves between output current ( $I_C$ ) vs. output voltage ( $V_{CE}$ ) for the constant input current ( $I_B$ ). The curve has the following features –

- It has three regions namely Saturation, Active and Cutoff region.
- The rising part of the curve, where  $V_{CE}$  is between 0 and approximately 1 volt is called saturation region. In this region the collector diode is not reversed biased.
- When the collector diode of the transistor becomes reverse biased, the graph becomes horizontal. In this region the collector remains almost constant. This region is known as the active region. In applications where the transistor amplifies weak radio and TV signal, it will always be operation in the active region.
- When the base current is zero, but there is some collector current. This region of the transistor curve is known as the cutoff region. The small collector current is called collector cutoff current.
- For different value of base current ( $I_B$ ) an individual curve can be obtained.

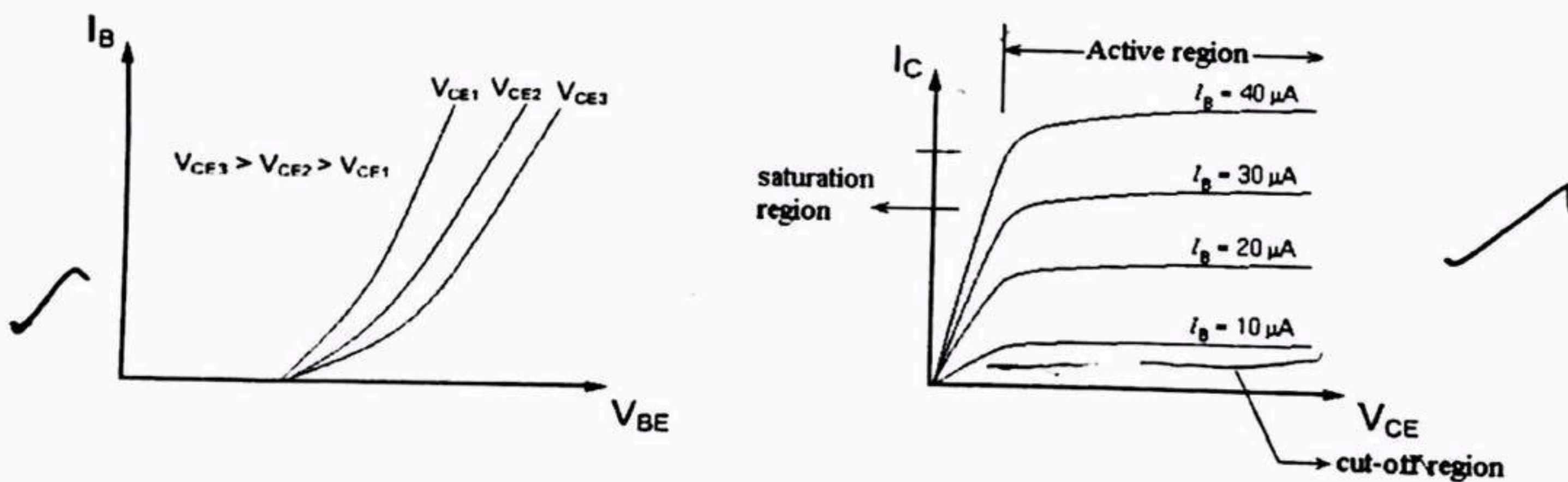


Figure 5.3 : (a) Input Characteristic, (b) Output Characteristic of NPN transistor.



### Equipments And Components:

Serial no.	Component Details	Specification	Quantity
1.	Transistor	C828	1 piece
2.	Resistor	470Ω, 2.2KΩ, 3.3KΩ, 4.7KΩ, 10KΩ, 470KΩ	1 piece each
3.	POT	100KΩ	1 unit
4.	Trainer Board		1 unit
5.	DC Power Supply		1 unit
6.	Digital Multimeter		1 unit
7.	Chords and wire		as required

### Experimental Setup:

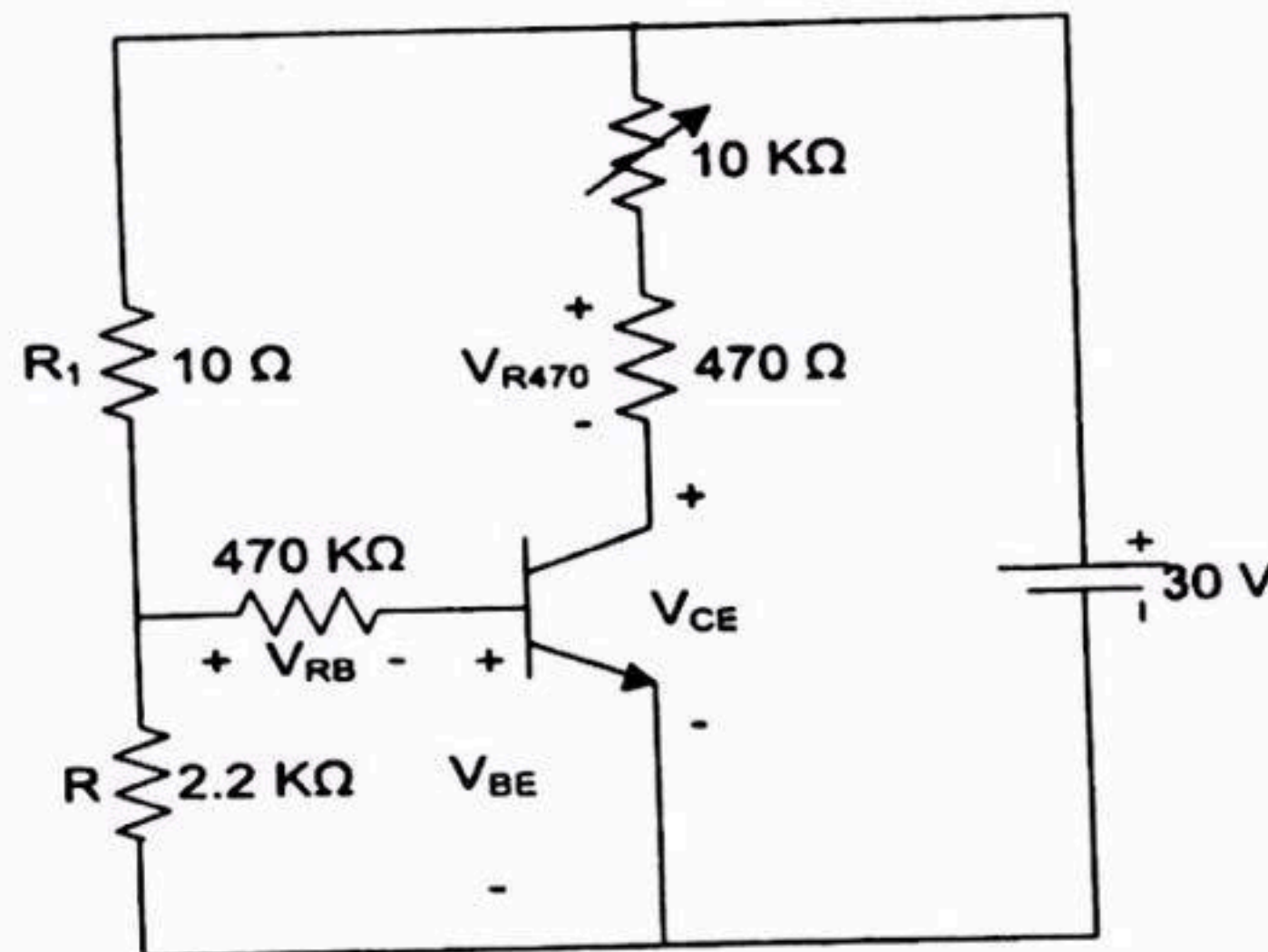


Figure 5.4: Experimental Circuit.

### Procedure:

1. Connect the circuit as shown in the figure 5.4. Use 2.2 KΩ as R.
2. Measure  $V_{RB}$  and calculate  $I_B$  using  $I_B = V_{RB} / R_B$ . (We will assume that  $I_B$  to be constant for a particular setup at input.)
3. Measure the voltages of  $V_{CE}$  and  $V_{R470}$ . And calculate  $I_C$  using  $I_C = V_{R470} / R_{470}$ .



4. Take at least 10 reading by varying the POT.
5. Repeat step 1 to 4 with resistance R as 3.3 K $\Omega$  and 4.7 K $\Omega$ .

Table 5.1 : Data for I - V characteristics of transistor.

R (K $\Omega$ )	$I_B = V_{RB} / R_B$ ( $\mu$ A)	$V_{CE}$ (volts)	$V_{R470}$ (volts)	$I_C = V_{R470} / R_{470}$ (mA)
2.2				
3.3				
4.7				

Report:

1. Plot the graph of  $I_C$  vs.  $V_{CE}$  with necessary details. Show the different regions of operation.
2. Plot a hypothetical output characteristic using PNP transistor.
3. Find  $\beta$  for the three different condition.