AIM

To draw the characteristic curve of a Zener diode and to determine its reverse breakdown voltage.

APPARATUS AND MATERIAL REQUIRED

A p-n junction Zener diode (IN 758), a variable dc power supply , connecting wires

PRINCIPLE

Zener diodes are essentially p-n junction diodes (both p and n regions are heavily doped) operated in the breakdown region of the reverse voltage characteristic. These diodes are designated with sufficient power dissipation capacities to work in the breakdown region. The following two mechanisms can cause breakdown in a junction diode:

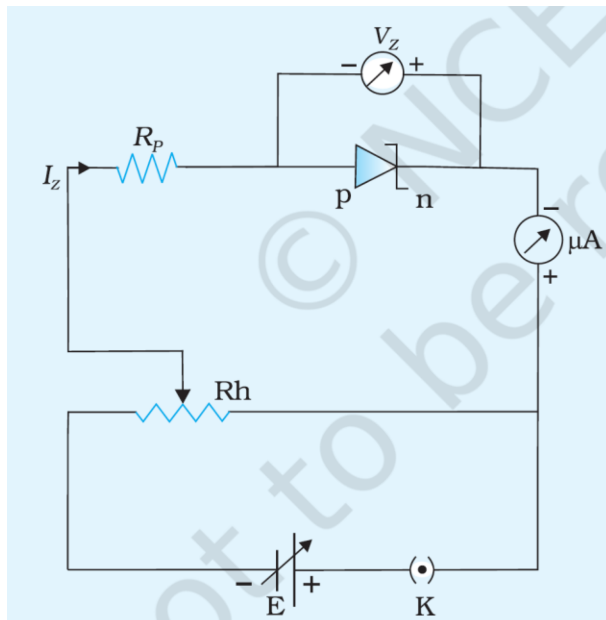
- Avalanche breakdown: With increasing reverse bias voltage, the electric field across the junction of p-n diode increases. At a certain reverse bias, the electric field imparts a sufficiently high energy to a thermally generated carrier crossing the junction. This carrier, on colliding with a crystal ion on its way, disrupts a covalent bond and produces an electron-hole pair. These carriers on gaining sufficient energy from the applied field collide with other crystal ions and generate further electron-hole pairs. This process is cumulative and produces an avalanche of carriers in a very short time. This mechanism is known as avalanche multiplication, causes large reverse current and the diode is said to work in the region of avalanche breakdown.

- Zener breakdown: In a Zener diode, both the p and n-sides are heavily doped. Due to the high dopant densities, the depletion layer junction width is small. Since the junction width is small i.e. less than 10^{-7} m, even a small voltage across it may create a very high field. This high junction field may strip an electron from the valence band which can tunnel to the n-side through the thin depletion layer. Such a mechanism of emission of electrons after applying certain electric field (~ 10^6 V/m) or voltage V_Z is termed as internal field emission which gives rise to a high reverse current or breakdown voltage. This breakdown is termed as *Zener breakdown* and the voltage at which it occurs is called *Zener voltage*.

  The reverse current at Zener voltage is called *Zener current*.

PROCEDURE

1. Note the least count of the given voltmeter and microammeter.
2. The voltmeter and microammeter should read zero with zero applied voltage. If not, then correct the initial reading of the meter suitably.
3. Clean the ends of the connecting wires with the help of sand paper and connect various components by the connecting wires as per the circuit arrangement. Take care that Zener diode is in reverse bias mode and the terminal of the micro-ammeter and voltmeter marked positive are connected to the higher potential side of the power supply.
4. Ensure that the micro-ammeter is connected in series with the Zener diode having a series protective resistance R_P and voltmeter in parallel to the Zener diode.
5. Switch on the power supply.



6. Move the contact point of the potential divider to apply some reverse bias voltage (V_r). For low reverse bias, the current is negligibly small i.e., of the order of 10^{-8} A to 10^{-10} A and hence with milli-ammeter or micro-ammeter, you will observe zero reading.
7. Slowly increase the voltage across the Zener diode in steps and record the value of reverse bias voltage *Vr* and also record the corresponding reverse current I_r from the reading of the micro-ammeter. Take care that the reverse voltage V_r is increased in steps of 0.1 V.

Link: https://youtu.be/6Ha-ePYMyfM

OBSERVATIONS

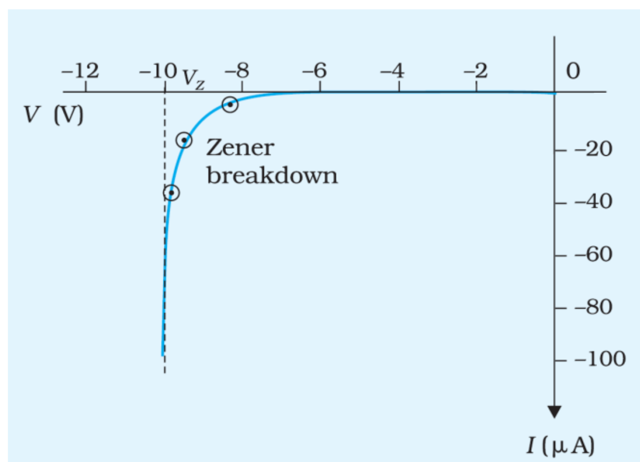
1. Range of voltmeter = ……………………..
2. Least count of voltmeter scale = ……………………..V
3. Range of milliammeter = ………………..
4. Least count of milliammeter scale = ………………..mA

Variation of reverse current I_r with reverse voltage, V_r across the Zener diode

S.No.	Voltmeter V_r (V)	Current I_r (μA)
1.		
2.		
3.		
-		
10.		

CALCULATIONS

1. Plot a graph between forward voltage across the diode (V_f) along the positive x-axis and current flowing through the diode (I) along the positive y-axis. The graph as shown in Fig.3 represents a typical *I-V* characteristic of a silicon diode used.
   Locate the knee and determine the cut-in voltage.



2. Now plot the reverse voltage (V_r) along the negative x-axis and the corresponding current (in μA) along the negative y-axis as shown in Fig.3.
3. Determine the reverse saturation current.

RESULT

The breakdown voltage of the Zener diode obtained from the graph is V_Z = ... V.

PRECAUTIONS

1. Ends of the connecting wires should be cleaned properly with sand paper.
2. Zero reading of voltmeter and microammeter should be checked properly.