Experiment Number -05

PEC-101/201 Fundamental of Electronics Engineering Lab
Er. Yadvendra Sharan
Assistant Professor
Department of Electrical & Electronics Engineering
Phonics Group of Institutions, Roorkee
Phone: +91-8273990016
yadvendra.sharan@yahoo.com
www.yadvendrasharan.wordpress.com

OBJECT

To Study of characteristics of zener diode as constant voltage.

APPRATUS REQUIRED

1. Zener Diode Characteristics Kit.
2. Connecting Probes (Leads).
3. DC Ammeter (0-20 mA)
4. DC Voltmeter (0-20 V)
5. Power Supply

THEORY

Zener diodes are a special kind of diode which permits current to flow in the forward direction. What makes them different from other diodes is that Zener diodes will also allow current to flow in the reverse direction when the voltage is above a certain value. This breakdown voltage is known as the Zener voltage. In a standard diode, the Zener voltage is high, and the diode is permanently damaged if a reverse current above that value is allowed to pass through it. Zener diodes are designed in a way where the Zener voltage is a much lower value. There is a controlled breakdown which does not damage the diode when a reverse current above the Zener voltage passes through a Zener diode.

The most common values for nominal working voltage are 5.1 V, 5.6 V, 6.2 V, 12 V and 15 V. We also carry Zener diodes with nominal working voltage up to 1 kV. Forward (drive) current can have a range from 200 uA to 200 A, with the most common forward (drive) current being 10 mA or 200 mA.

In the forward bias direction, the zener diode behaves like an ordinary silicon diode.

In the reverse bias direction, there is practically no reverse current flow until the breakdown voltage is reached. When this occurs there is a sharp increase in reverse current. Varying amount of reverse current can pass through the diode without damaging it. The breakdown voltage or zener voltage (V_Z) across the diode remains relatively constant. The maximum reverse current is limited, however, by the wattage rating of the diode.

Avalanche Break down:

When the diode is in the reverse bias condition, the width of the depletion region is more. If both p-side and n-side of the diode are lightly doped, depletion region at the junction widens. In reverse bias, the minority charge carrier current flows through junction. As the applied reverse voltage increases the minority carriers acquire sufficient energy to collide with the carriers in the covalent bonds inside the depletion region. As a result, the bond breaks and electron hole pairs are generated. The process becomes cumulative and leads to the generation of a large number of charge carriers resulting in Avalanche Breakdown.

Zener Break down:

If both p-side and n-side of the diode are heavily doped, depletion region at the junction reduces compared to the width in normal doping. Applying a reverse bias causes a strong electric field get applied across the device. As the reverse bias is increased, the Electric field becomes strong enough to rupture covalent bonds and generate large number of charge carriers. Such sudden increase in the number of charge carriers due to rupture of covalent bonds under the influence of strong electric field is termed as Zener breakdown.

PROCEDURE

a) Forward Bias Condition:

1. Connect the circuit as shown in figure (1).
2. Initially vary V_s in steps of 0.1V. Once the current starts increasing vary V_s in steps of 1V up to 12V. Note down the corresponding readings of V_{zf} and I_{zf}.

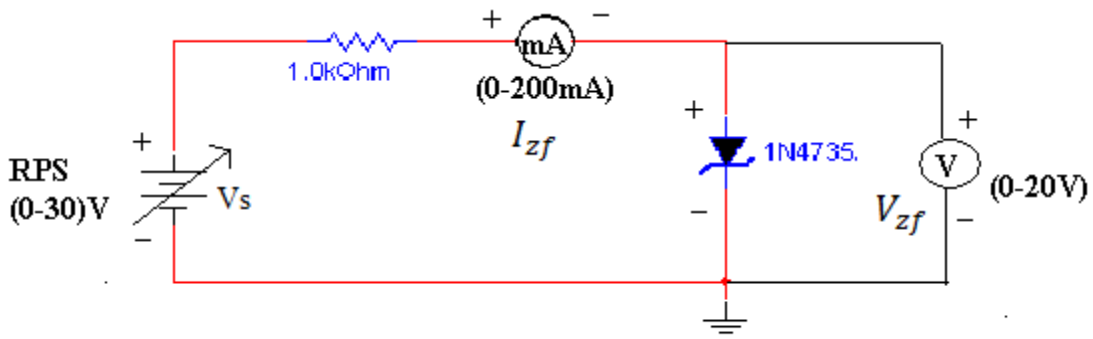
b) Reverse Bias Condition:

1. Connect the circuit as shown in figure (2).

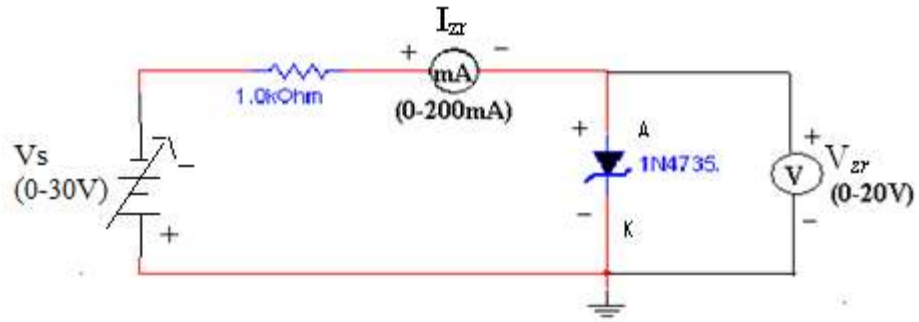
2. Vary V_s gradually in steps of 1V up to 12V and note down the corresponding readings of V_{zr} and I_{zr}.
3. Tabulate different reverse currents obtained for different reverse voltages.

CIRCUIT DIAGRAM

Case I – When Diode is Forward Bias



Case II – When Diode is Reverse Bias



OBSERVATION TABLE

S.No.	When Zener Diode if Forward Bias		When Zener Diode is Reverse Bias	
	V_D	I_D	V_D	I_D
1				
2				
3				
4				
5				

6				

CALCULATIONS FROM THE GRAPH

Static forward Resistance $R_{dc} = V_f / I_f\ \Omega$

Dynamic Forward Resistance $r_{ac} = \Delta V_f / \Delta I_f\ \Omega$

Static Reverse Resistance $R_{dc} = V_r / I_r\ \Omega$

Dynamic Reverse Resistance $r_{ac} = \Delta V_r / \Delta I_r\ \Omega$

For Load regulation,% Voltage Regulation = $\frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$ %

RESULT

The characteristics and Voltage Regulation of Zener diode are studied.

a) Forward Bias Zener Diode:

1. The Knee voltage or Cut-in Voltage (V_y) is _____ Volts.
2. The Dynamic Forward resistance is _____ Ω.
3. The Static Forward resistance is _____ Ω.

b) Reverse Bias of Zener Diode:

1. Zener Breakdown Voltage (V_Z) is _____ Volts.
2. The Dynamic Reverse resistance is _____ Ω.
3. The Static Reverse resistance is _____ Ω.

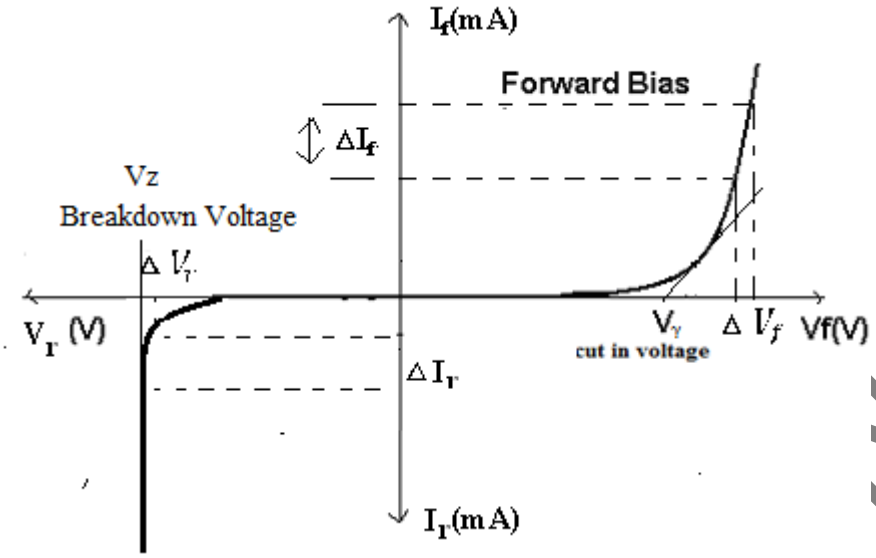


Fig.1 V- I Characteristics of Zener Diode under Forward & Reverse Bias Conditions

DISCUSSION

Students are able to

1. Analyse the forward and reverse bias characteristics of Zener diode.
2. Calculate static and dynamic resistance in both forward and reverse bias condition.

PRECAUTIONS

1. While doing the experiment do not exceed the readings of the diode. This may lead to damaging 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.