LAB SESSION 10

TO STUDY THE CHARACTERISTIC OF ZENER DIODE

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DEPARTMENT OF ELECTRICAL TECHNOLOGY

LAB SESSION 03

TO STUDY THE CHARACTERISTIC OF ZENER DIODE

Objectives

To obtain the voltage-current characteristic curve for a Zener diode

Basic Information

The zener diode is a special type of PN junction, which is designed to operate in the reverse breakdown region. Once the reverse bias potential reaches a specific voltage level, i.e. the Zener breakdown voltage, the ideal zener diode starts behaving as a fixed voltage source with zero internal resistance. All practical diodes have some internal resistance even though, typically, it is limited to 5 to 20 Ω. The internal resistance is the source of variation in zener voltage with current levels flowing through it.

If forward biased, Zener diode behaves like a normal diode. On the other hand, if reverse biased it behaves like a normal diode until the breakdown voltage is reached. At this point, the reverse current rapidly increases, while the voltage across it remains almost constant – unlike the normal diode, which may become permanently damaged if reverse breakdown occurs.

Fig 3.1 shows the symbol and Fig 3.2 shows the IV characteristic of a zener diode. Note that the diode acts as any diode when forward-biased. And it behaves as any other diode when reverse-biased, until the voltage across it reaches the zener voltage (V_Z).

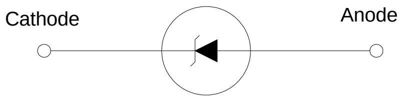

Fig 3.1

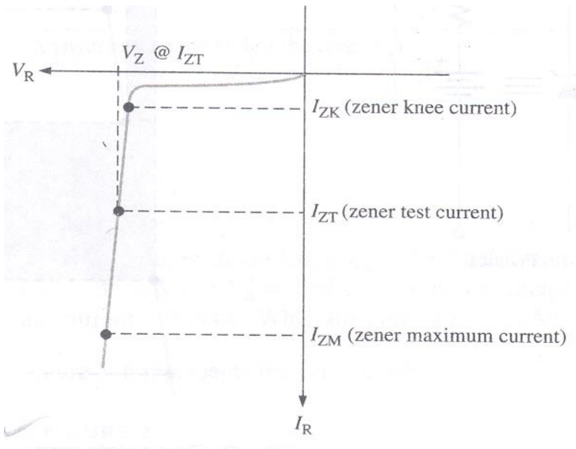

Fig 3.2

Once in the breakdown region, the reverse current flowing through the Zener diode must be kept within the specified limits of the particular diode by using a series resistance, in order to avoid damage to the device. Because the diode is designed to operate as a breakdown device, switching in and out of the zener state is normal.

Zener Specifications

As with all components, manufacturers provide zener diode specifications to guide the user. Typical zener diode specifications are:

Zener Voltage (V_Z)

Reverse biased voltage at which the diode begins to conduct. Zener diodes are available having zener potentials of 1.8V to 200V.

Zener voltage tolerance

Like the tolerance of a resistor, this figure gives the percentage above or below V_Z that is acceptable for the particular diode, for example, 6.3V ±5%.

Maximum Zener Current (IZ, max)

Maximum current allowed to flow while the diode is in its reverse biased conduction (zener mode).

Maximum Power Dissipation (PZ)

Maximum power that can be safely dissipated in the device. This is usually equal to the product of V_Z and $I_{Z,\,max}$. Zener diodes are available with power rating from ¼ W to 50W.

Impedance (ZZ)

Impedance/resistance of the zener diode while conducting in zener mode.

Maximum Operating Temperature

The highest temperature at which the device will operate reliably.

Zener Applications

The largest use of zener diodes is for voltage regulation in power supply applications. Fig 3.3 illustrates a simple zener regulated power supply. The diode will begin to conduct as the zener voltage is reached. At this point the voltage across the zener will remain constant. For the load connected in parallel with zener, the load voltage is equal to the zener voltage, and thus load voltage also remains constant. Because the zener voltage does not change despite changes in the source voltage, the load voltage also does not change and thus is said to be regulated.

From Fig 2.3, one can see that the current flowing through the series resistance *R* is equal to the sum of current flowing through the zener and the load current, i.e. $I_T = I_Z + I_L$. Thus the voltage drop across the series resistor *R* is

$$V_R = (I_Z + I_L)R$$

Now, if the load voltage across R_L is to be kept constant despite the variations in the source voltage, then the voltage drop across the series resistor V_R should absorb those source voltage changes – which require that the current (I_Z) through the Zener diode should get automatically adjusted in such a way that all the source voltage, over and above the desired load voltage V_{out} is dropped across the series resistor *R*. For example, if for some reason, the load voltage V_{out} tries to increase, the voltage across Zener also tries to increase. However, a slight increase in Zener voltage causes a large increase in the Zener current, which in turn increases the drop in the series resistor and thus offsetting the initial rise in the load voltage. Likewise, if V_{out} decreases, I_Z decreases causing V_R to decrease thus leaving more voltage for V_{out}.

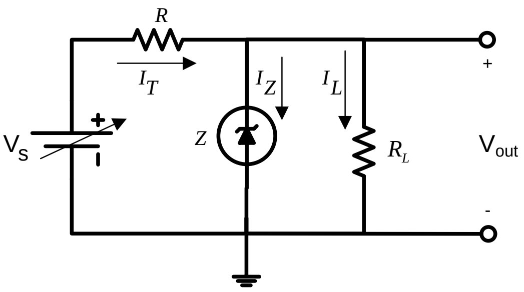

Fig 3.3

Material Required

a) DC Power Supply	1
b) Breadboard	1
c) Zener Diode:	1
d) Resistor: 560Ω (1W)	1
e) Connecting wires, etc.	

Procedure

1. Connect the circuit as shown in Fig 3.4. Initially set the DC supply to 0V.
2. Set the DC supply (E) to the values appearing in Table 3.1 and measure both V_Z and V_R. You may have to use the milli-volt range of your DMM/scope for low values of V_Z and V_R.
3. Calculate the zener current (I_Z) in mA at each setting of E using Ohm's law as indicated in Table 3.1 and note the result. (Remember to place minus sign in front of each value of I_Z and V_Z because these represent current and voltage values in the reverse region).
4. Keeping in mind that the reverse region is in the third quadrant of a complete diode characteristic curve, plot the data of Table 3.1 on a graph paper and attach it as Fig 3.5.

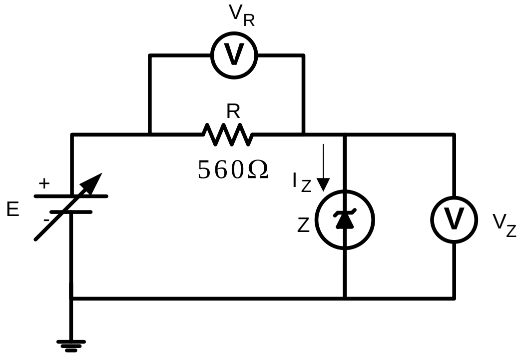

Fig 3.4

Attach your graph Here

Fig 3.5

Experimental Results

Calculation for Forward biased

E (V)	V_Z (V)	V_R (V)	$I_Z = \frac{V_R}{R}$ (mA)

0.1			
0.3			
0.5			
0.7			
0.8			
0.9			
1.0			

Calculation for Reverse biased

E (V)	V_Z (V)	V_R (V)	$I_Z = \frac{V_R}{R}$ (mA)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Calculation for load Resistance

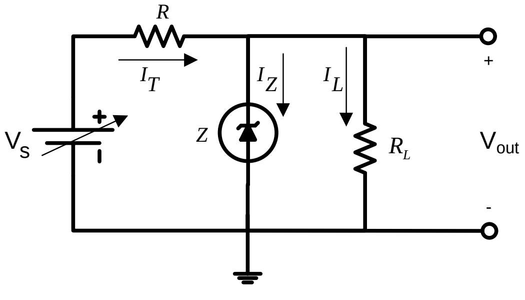

Fig 3.6

For 2.2 KΩ Resistance

$E_{(V)}$	$V_{(R)}$	$V_{(Z)}$	$V_{(RL)}$
10			
12			
14			

For 3.3 KΩ Resistance

$E_{(V)}$	$V_{(R)}$	$V_{(Z)}$	$V_{(RL)}$
10			
12			
14			

For 4.7 KΩ Resistance

$E_{(V)}$	$V_{(R)}$	$V_{(Z)}$	$V_{(RL)}$
10			
12			
14			