Experiment No: 05

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 5.1.

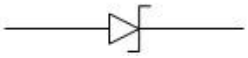


Figure 5.1 : Symbol of Zener Diode.

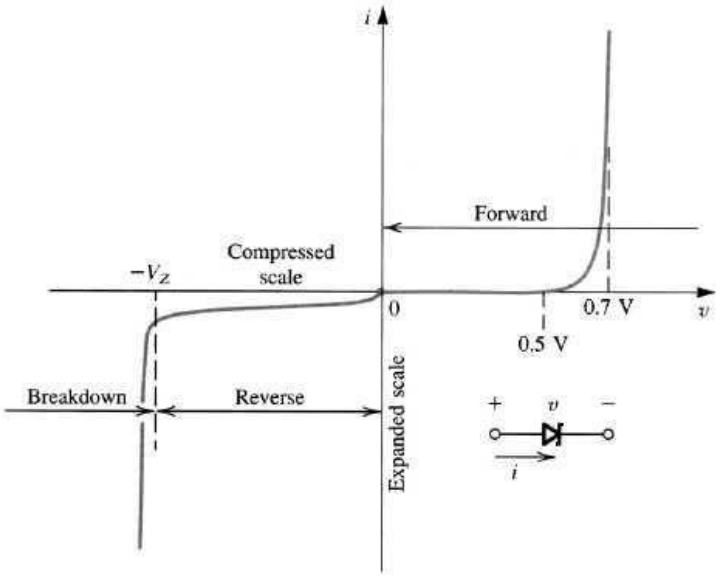


Figure 5.2 : I - V Characteristics of Zener Diode.

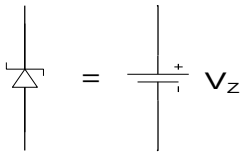
The Zener diode may have a breakdown voltage from about 2 to 200 volts. These diodes can operate in any of three regions – forward, leakage and breakdown. Figure 4.2 shows the I-V characteristics curve of Zener diode.

- 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.

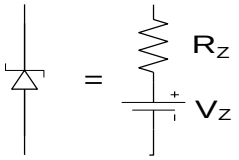
- In the breakdown it has a sharp knee, followed by an almost vertical increase in current without changing the voltage.
- The voltage is almost constant, approximately equal to V_z over most of the breakdown region.

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.



Load Regulation: Load regulation is the change in output voltage due the change per mA load current.

$$\text{Load Regulation} = \Delta Vo/\Delta I$$

Line Regulation: Line regulation is the change in output voltage due the change per volt input voltage.

$$\text{Line Regulation} = \Delta Vo/\Delta Vs$$

Equipments and Components:

Serial no.	Component Details	Specification	Quantity
1.	Zener diode	5 volts	1 piece
2.	Resistor	220Ω, 470Ω, 1KΩ	1 piece each
3.	POT	10KΩ	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:

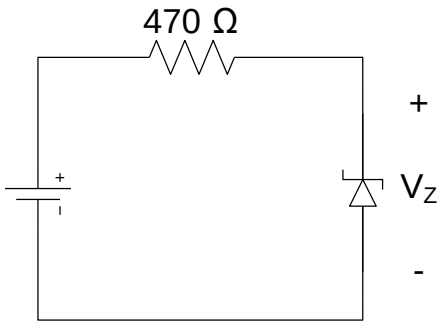


Figure 5.3 : Experimental Circuit 1.

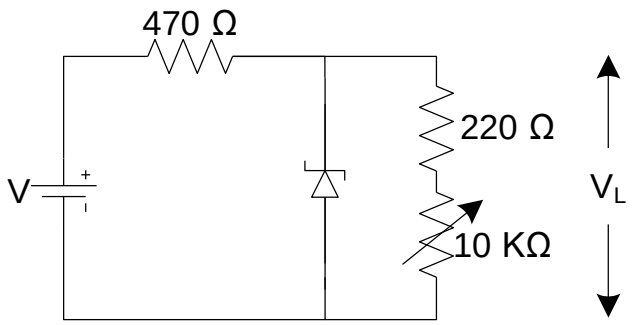


Figure 5.4 : Experimental Circuit 2.

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 5.1 : Data for I - V characteristics.

V (volts)	V_R (volts)	V_z (volts)	$I_z = V_R / R$ (mA)
0			
1			
4			
5			
6			
6.5			
7			
7.5			
8			
8.5			
9			
9.5			
10			
11			
12			
14			

Table 5.2 : Data for regulation due to load variation.

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

Table 5.3 : 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.
4. Add the PSPICE simulation waveforms of all the experimental circuits.