Experiment #6- Part#1

Zener Diode Application

Object

The purposes of this experiment are to demonstrate Zener diode as a simple voltage regulator.

Required Parts and Equipment's

1. Variable DC Power Supply.
2. Digital Multimeters.
3. Zener Diode, ZPD (3.6V, 0.5W).
4. Carbon Resistors 330Ω (2W), 1kΩ (2W).
5. Variable Box Resistor
6. Leads and Wires.

Theory

A Zener diode operating in breakdown acts as a voltage regulator because it maintains a nearly constant voltage across its terminals over a specified range of reverse current values.

The minimum value of reverse current required to maintain the Zener diode in breakdown for voltage regulation is known as the knee current I_{ZK} as illustrated in Fig.1. When the reverse current is reduced below I_{ZK}, the voltage decreases drastically and regulation is lost.

On the other hand, the maximum current that the diode can withstand is abbreviated as I_{ZM}, and is defined as the Zener current above which the diode may be damaged due to excessive power dissipation. This current can be determined from:

$$I_{ZM} = \frac{P_{ZM}}{V_Z}$$

Where PZM represents the maximum DC power dissipation of the zener diode, which is usually specified in the datasheet.

So, the practical operating range of the zener diode current should be maintained between I_{ZK} and I_{ZM} for proper voltage regulation.

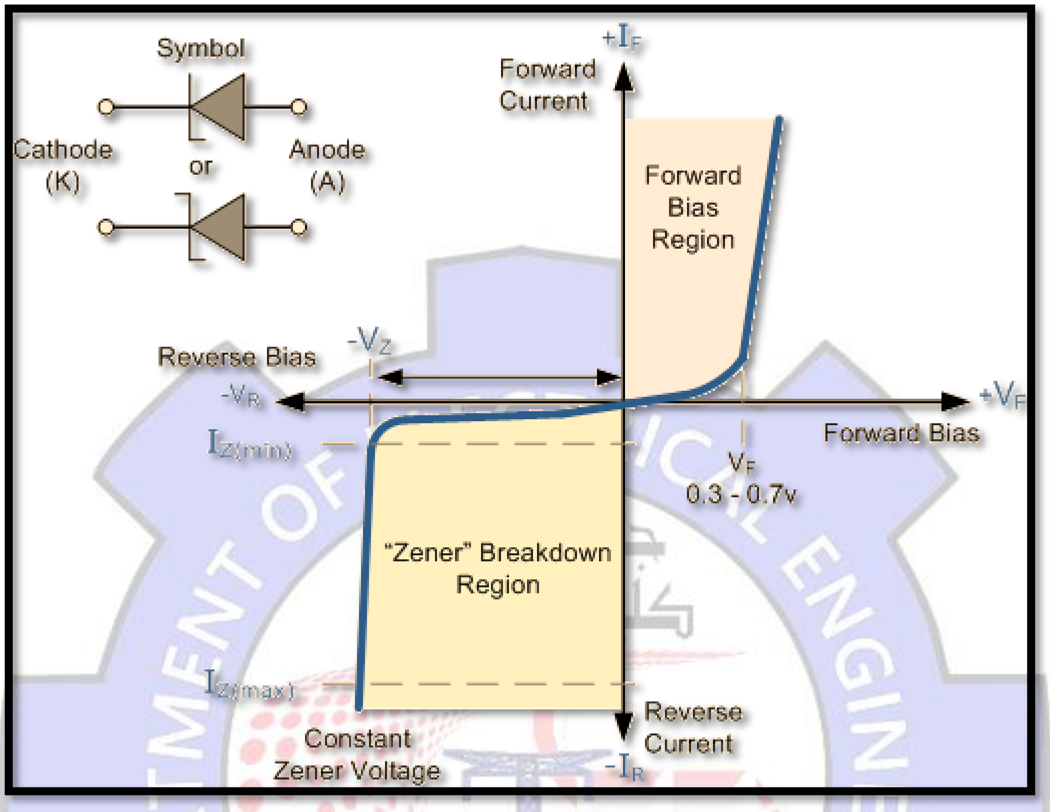

Figure 1: Zener Diode Symbol and IV Characteristic

Fig.2 shows the ideal and practical models of the zener diode in the reverse breakdown region.

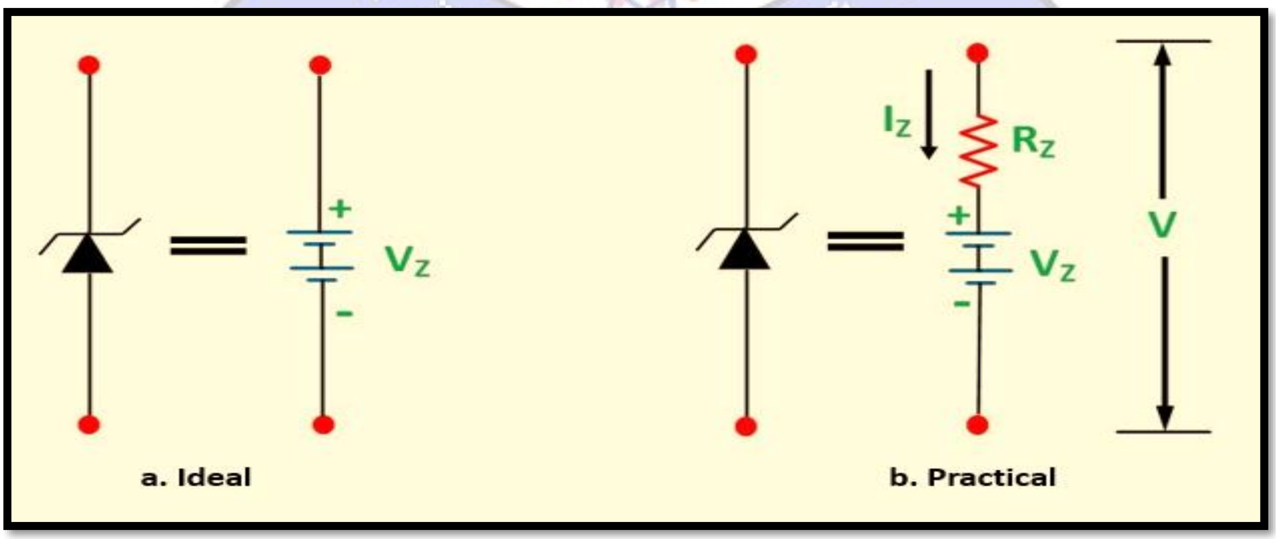

Figure 2: Zener Diode Equivalent Circuit Models

The ideal model of the zener diode shown in Fig.2a has a constant voltage drop equal to the nominal zener voltage. This constant voltage drop is represented by a DC voltage source which indicates that the effect of reverse breakdown is simply a constant voltage across the zener terminals.

Fig.2b represents the practical model of the zener diode, in which the internal zener resistance R_Z is included. Since the actual voltage curve is not ideally vertical, a change in zener current ΔI_Z produces a small change in zener voltage ΔV_Z as illustrated in Fig.3. By Ohm's law, the ratio of ΔV_Z to ΔI_Z is the zener diode internal resistance as expressed in the following equation:

$$R_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

In most cases, we can assume that R_Z is constant over the full linear range of the zener diode current values.

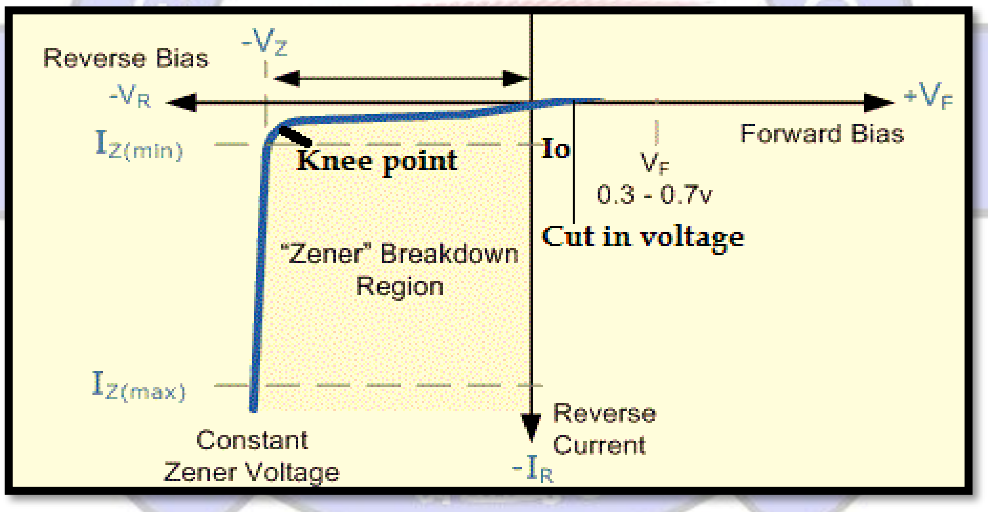

Figure 3: Reverse Characteristic of a Zener Diode Showing the Determination of the Internal Resistance R_Z