Zener Diode as a Voltage Regulator

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2

Zener Diode as a Voltage Regulator: When the Zener diode is in reverse biased mode or reverses break down region then we can operate the Zener diode as a voltage regulator.

Contents

V-I Characteristics of Zener Diode

The V-I characteristic curve of the Zener diode is shown below.

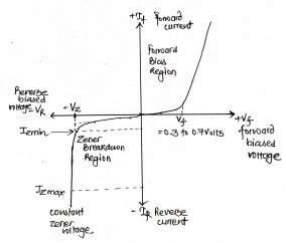


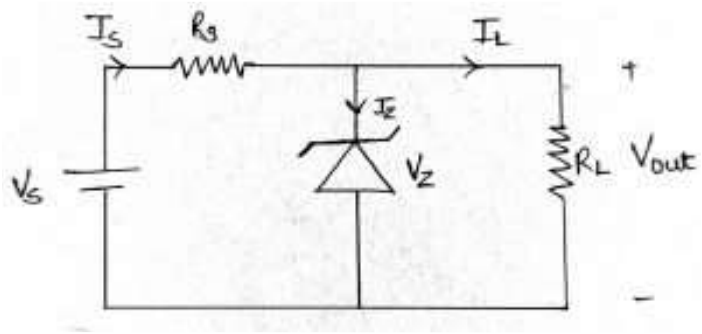
Figure: V-I Characteristics of Zener Diode

From V-I characteristic curve we can observe that the Zener diode has a region in its reverse bias characteristic where a constant negative voltage appears regardless of the value of the current flowing through the diode.

The voltage remains constant even with a large change in current. This ability of a Zener diode to control itself can be used to regulate or stabilize the voltage source against supply or load variation. Due to this property Zener diode being operated in the breakdown region can be used as a voltage regulator.

Illustration of Zener Diode as a Voltage Regulator

Consider a given circuit,



Here, V_s=Source voltage

R_s= Resistor to limit the reverse current through Zener

diode

R_L=load resistance

V_z= Zener voltage and zener current

I_Z= Zener current

When the voltage across the load R_L is less than the breakdown voltage V_z then the Zener diode does not conduct any current.

Here, voltage V_s and resistor R_s are selected in such a way that the Zener diode operates in the breakdown region.

For load voltage (V_{out}) greater than Zener voltage V_z the Zener diode will operate in the breakdown region.

Now, the supply current I_s is divided into I_z and I_L.

$$I_S = I_Z + I_L \ldots (i)$$

For a Zener diode operating in a breakdown region voltage, V_z remains almost constant even though the current I_z may change significantly.

With the increase in V_s, Is increases. Since R_L is constant and V_{out} being equal to V_z, I_L is also constant.

So, from equation (i) we can observe that increase in I_s will be compensated by an increase in I_z.

Now the Zener voltage becomes,

$$V_Z = V_S - I_S R_S \ldots (ii)$$

When V_s increases I_sR_s also increases this makes Zener voltage V_z almost constant. As the voltage across RL is equal to V_z. So, V_{out} also remains constant. Hence, Zener diode operating in the breakdown region acts as a voltage regulator.