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Course Title: Basic Electrical Engineering

1. Describe a Zener Cathode regulator

The zener diode is like a general-purpose signal diode. When biased in the forward direction it behaves just like a normal signal diode, but when a reverse voltage is applied to it, the voltage remains constant for a wide range of currents.

There is a limit for the reverse voltage. Reverse voltage can increase until the diode breakdown voltage reaches this point is called Avalanche Breakdown region. At this stage maximum current will flow through the zener diode. This breakdown point is referred to as "Zener voltage".

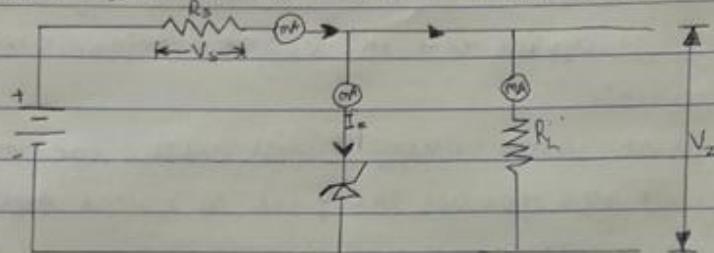
The ability to control itself can be used to great effect to regulate or stabilize a voltage source against supply or load variations. The fact that the voltage across the diode in the breakdown region is almost constant turns out to be an important application of zener diode as a voltage regulator.

Zener as ^{diode} Voltage Regulators

The function of a regulator is to provide a constant output voltage to a load connected in parallel with it in spite of the ripples in the supply voltage or the variation in the load current and the zener diode will continue to regulate the voltage until the diode current falls below the minimum (I_{Zmin}) value in the reverse breakdown region. It permits current to flow in the forward direction as normal, but ~~will not permit~~ ^{will also allow it} to grow in the reverse direction when the voltage is above a certain value - the breakdown voltage known as the zener voltage. The zener diode specially made to have a reverse voltage breakdown at a specific voltage. Its characteristics are otherwise very similar to common diodes. In breakdown the voltage across the zener diode is close to constant over a wide range of currents thus making it useful as a shunt voltage regulator.

The purpose of a voltage regulator is to maintain a constant voltage across a load regardless of variations in the applied input voltage and variations in the load current. A typical zener diode shunt regulator

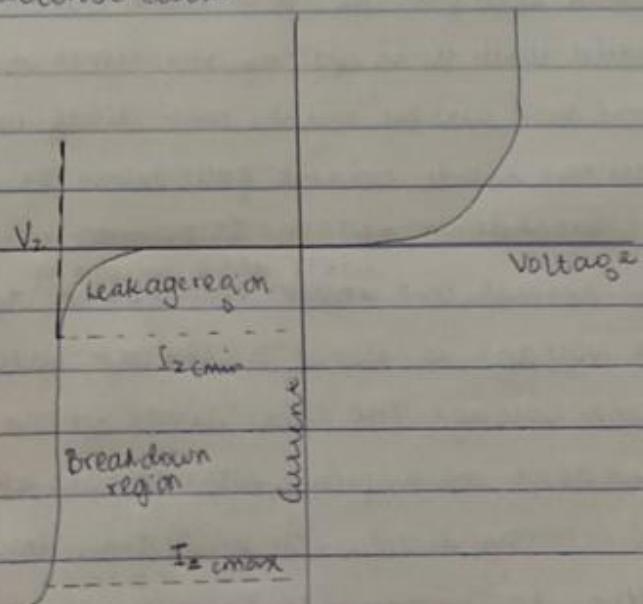
is shown below. The resistor is selected so that when the input voltage is at $V_{in\ min}$ and the load current is at $I_{load\ max}$ that the current through the Zener diode is at least $I_{z\ min}$. Then for all other combinations of input voltage ^{and} load current the Zener diode conducts the excess current thus maintaining a constant voltage across the load. The Zener conducts the least current when the load current is the highest and it conducts the most current when the load current is the lowest.



Zener diode shunt regulator

If there is no load resistance, shunt regulators can be used to dissipate total power through the series resistance and the Zener diode-shunt regulators have an inherent current limiting advantage under fault conditions because the series resistor limits excess current.

1 I-V characteristic curve:



Symbol for Zener diode



2 Maximum Power = 5W

$$I_s = 500 \text{ mA} = 0.5 \text{ A}$$

$$V = 20 \text{ V}$$

$$V_{\text{max}} \text{ to } D.C = \frac{2V_{\text{max}}}{\pi}$$

$$V_s = \frac{2 \times 20}{\pi} = 12.73 \text{ V}$$

$$I_s (\text{Maximum Current}) = \frac{P}{V_s}$$

$$\frac{V_s}{I_s} = \frac{P}{0.5} = 5$$

$$V_s = 10 \text{ V}$$

$$V_R = V_s - V_Z \\ = 12.73 - 10$$

$$\therefore V_R = I R_s$$

$$R_s = \frac{V_R}{I} = \frac{2.73}{0.5}$$

$$R_s = 5.46 \Omega$$

$$I_R = \frac{V_Z}{R_L} = \frac{10}{500}$$

$$I_L = 0.02 \text{ A} = 20 \text{ mA}$$

$$I_Z = I_s - I_L \\ = 500 - 20 \\ = 480 \text{ mA}$$