



Adama Science and Technology University
School of Electrical Engineering and Computing
Department of Electrical Power and Control Engineering

Course Name: Electronics Circuit

Course Code: ECEg2101

LAB-NO: 3

Title: Zener diode voltage regulator

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LAB -3 :Zener diode voltage regulator

Objective:

- To study the application of zener diodes as a simple voltage regulator

Materials:-

- DC power supply
- Digital Multimeter(DMM)
- Zener diode(6-10V)
- Resistors: 1k ohm, 3.3k ohm

Theory:

A Zener diode is a **silicon semiconductor device that permits current to flow in either a forward or reverse direction**. The diode consists of a special, heavily doped p-n junction, designed to conduct in the reverse direction when a certain specified voltage is reached.

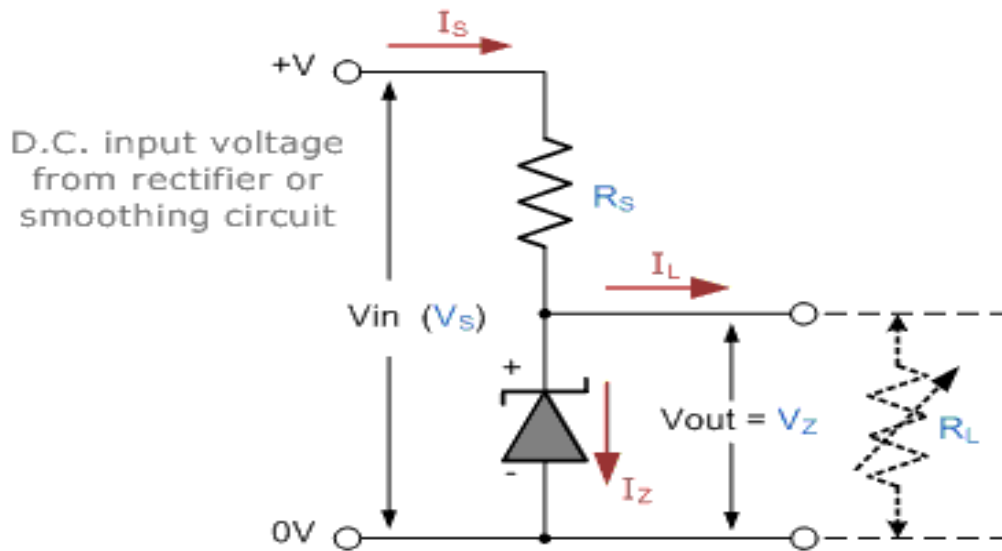
A Zener diode is a type of diode that is designed to operate in the reverse breakdown region. In the reverse breakdown region, the voltage across the diode remains constant regardless of changes in the current passing through it. This voltage is called the Zener voltage, and it is typically in the range of 2 to 200 volts.

A Zener diode can be used as a voltage regulator by connecting it in parallel with the load resistor in a circuit. The Zener diode is reverse biased and is designed to operate in the breakdown region. When the input voltage increases, the Zener diode conducts and maintains a constant voltage across its terminals, which in turn maintains a constant output voltage across the load resistor.

The voltage regulation provided by a Zener diode voltage regulator depends on the current passing through the diode, which is determined by the load current and the current through the series resistor. The series resistor is used to limit the current through the Zener diode and ensure that it operates in the breakdown region. The value of the series resistor can be calculated using Ohm's law, $R = (V_{in} - V_z) / I_z$, where V_{in} is the input voltage, V_z is the Zener voltage, and I_z is the Zener current.

One limitation of using a Zener diode as a voltage regulator is that it can only regulate voltages within a certain range. If the input voltage is too high, the Zener diode will not be able to maintain a constant voltage across its terminals, and the output voltage will be higher

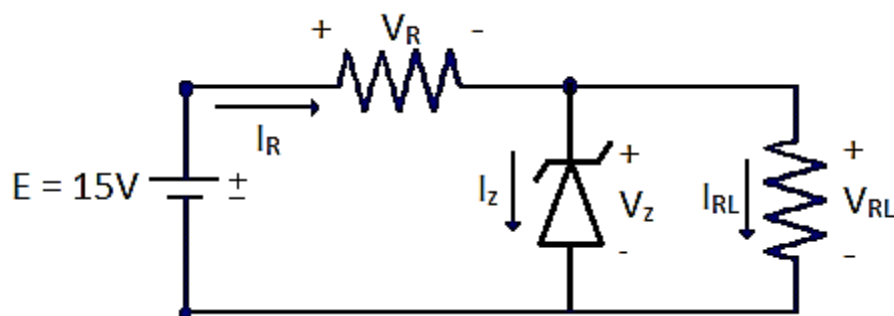
than the desired voltage. Similarly, if the input voltage is too low, the Zener diode will not conduct, and the output voltage will be lower than the desired voltage.



Resistor, R_S is connected in series with the zener diode to limit the current flow through the diode with the voltage source, V_S being connected across the combination. The stabilised output voltage V_{out} is taken from across the zener diode.

Procedure:

1) The circuit was constructed. .



2) The value of V_L and V_R was obtained by using digital multimeter which were V_R meas=9.08V, V_L meas=5.95V and $I_R = V_R/R = 9.08\text{ma}$.

3) Then the value of I_R , I_{RL} , and I_Z were calculated. $I_L = V_L/R_L = 5.95\text{ma}$, $I_Z = I_R - I_{RL} = (9.08 - 5.95)\text{ma} = 3.13\text{ma}$.

4) Value of input voltage was varied from 0 up to 15V and in each step the measured value of V_Z , V_R , I_R , I_Z and I_{RL} were obtained.

5) We drawn the curve of v_z versus i_z in reverse biased mode and zener resistance was determined R_Z .

- 6) What was the value of regulated voltage.
- 7) We kept the value of E at 12V constant and the load resistance was varied from 400 to $1.2K\Omega$ and the corresponding values of V_Z, V_R, I_R, I_Z and I_{RL} were measured.
- 8) The curve of V_Z versus I_Z has drawn in reverse biased mode and determined the value at which the zener diode held the output voltage V_{RL} constant.
- 9) The minimum value of R_L was determined that can be used for successful regulation.

Result and discussion

In this experiment we analysed how Zener diode regulate the output voltage. The **Zener Diode** is used in its “reverse bias” or reverse breakdown mode, i.e. The diodes anode connects to the negative supply.

The results show that the Zener diode voltage regulator circuit was able to maintain a constant output voltage of 5.94 V across the load resistor for voltage ranging from 0 to 15V.

This is because the Zener diode operated in the breakdown region and maintained a constant voltage across its terminals, which in turn maintained a constant output voltage across the load resistor. The results are shown below in Table and in graph form:

Table 1

$E[V]$	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
$V_Z[V]$	0	0.5	1.01	1.48	2.05	2.53	3.02	3.52	4.04	4.53	5.04	5.51	5.91	5.93	5.94	5.95
$V_R[V]$	0	0.51	1.01	1.49	2.08	2.51	3.03	3.53	4.05	4.54	5.05	5.52	6.07	7.09	8.12	9.03
$I_Z[ma]$	0	0	0	0	0	0	0.01	0.01	0.01	0.01	0.01	0.01	0.16	1.16	2.18	3.13
$I_{RL}[ma]$	0	0.5	1.01	1.48	2.05	2.53	3	3.52	4.04	4.53	5.04	5.51	5.91	5.93	5.94	5.95
$I_R[ma]$	0	0.51	1.01	1.49	2.08	2.51	3.03	3.53	4.05	4.54	5.05	5.52	6.07	7.09	8.12	9.03

Tabe2

$R_L[\Omega]$	400	480	560	720	800	880	960	1040	1120	1200
$V_Z[V]$	3.49	3.91	4.39	5.1	5.38	5.6	5.92	5.92	5.92	5.93
$V_R[V]$	8.72	8.26	7.87	7.15	6.81	6.47	6.15	6.14	6.14	6.14
$I_Z[mA]$	0	0.02	0.04	0.07	0.09	0.11	0.01	0.45	0.86	1.2
$I_{RL}[mA]$	8.72	8.14	7.83	7.08	6.72	6.36	6.16	5.69	5.28	4.94
$I_R[mA]$	8.72	8.26	7.87	7.15	6.81	6.47	6.15	6.14	6.14	6.14

Conclusions

In conclusion, the Zener diode voltage regulator is a simple and effective circuit that can regulate voltage in a wide range of applications. Through our lab experiment, we were able to verify the theoretical operation of the Zener diode and its ability to maintain a constant voltage across a load. By varying the input voltage and the load resistance, we observed the Zener diode's response and the effect on the output voltage. The results obtained during the experiment were consistent with the expected values, demonstrating the reliability and accuracy of the Zener diode voltage regulator circuit. Overall, this lab experiment provided us with a practical understanding of the Zener diode voltage regulator, which is an essential component in many electronic devices and circuits.