Course Name:	**EEEE**	**Semester:**	**I/II**
Date of Performance:	**2/12/21**	**Batch No:**	**G3**
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Faculty Sign & Date:		**Grade/Marks:**	

Experiment No: 6
Title: Zener diode voltage regulator

Aim and Objective of the Experiment:

- To understand the working of Zener diode as voltage regulator
- To calculate line and load regulation of Zener diode based shunt regulator

Requirements:

Zener diode, resistor, potentiometer, voltmeter, ammeter, DC source and bread board.

Theory:

A zener diode functions as an ordinary diode when it is forward biased. It is a specially designed device to operate in the reverse bias. When it is in the reverse breakdown region, the voltage (V_z) across Zener diode remains almost constant irrespective of the current (I_z) flowing through it. A series resistor A series resistor *Rs* is used to limit the zener current below its maximum current rating. The current through *Rs* is given by the expression is $I_S=I_Z+I_L$, where I_L is the current through the load resistor . The value of *Rs* must be properly selected to ensure breakdown of the Zener diode and also to keep *Iz* in limited in specified current limit.

$$Rs_{min}= (V_{in}-V_z)/Iz_{max} \quad (1)$$

$$Rs_{max}= (V_{in}-V_z)/(Iz_{min} + I_L) \quad (2)$$

Design steps:

1. If for regulator

Desired output parameters Vo=5.6 V, I_{Lmax}= 5mA

Input voltage in the range V_{IN} = 8 V- 14 V

2. Choose Zener diode (5.6 V, 45 mA)
3. Choose a potentiometer of value 4.7 kΩ so that I_L can be varied from 5.6/4.7 kΩ ≈ 1.2 mA.
4. I_{Zmax} = 45 mA so I_{Zmin} = 10% of I_{Zmax} = 4.5 mA
5. $R_{Smax} = (V_{INmin} - V_Z) / (I_{Zmin} + I_{Lmax}) = (8-5.6)\ V/(4.5+ 5.0)\ mA \approx 253\ \Omega$

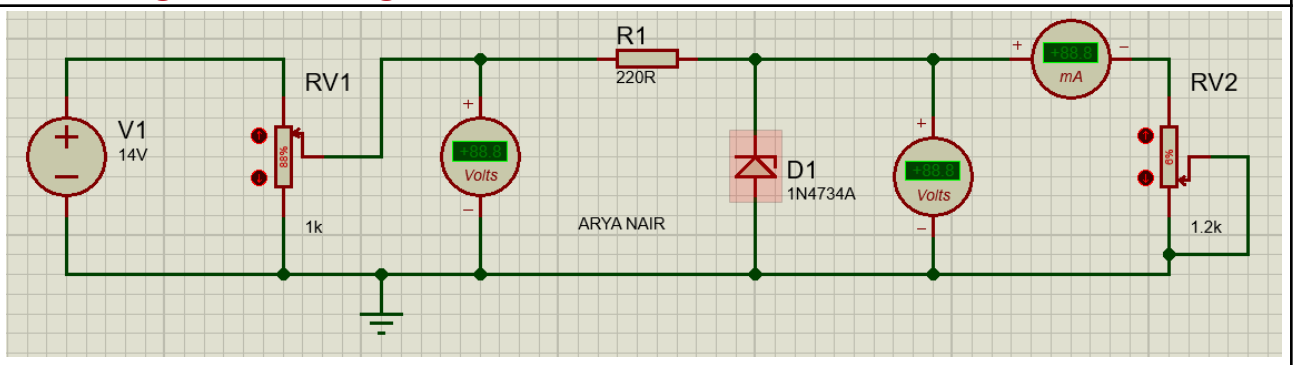
   $R_{Smin} = (V_{INmax} - V_Z) / I_{Zmax} = (14-5.6)V/(45\ mA) \approx 186\ \Omega$

   Choose $R_{Smin} < Rs < R_{Smax}$ so Rs = 220 Ω and Power rating $(I_{max})^2 \times R_S$

   $I_{max} = (V_{IN} - V_Z)/ Rs = (14-5.6) / 220 = 38$ mA

   Power rating = $(38\ mA)^2$ x220 = 0.32 watt ≈ 0.5 watts.

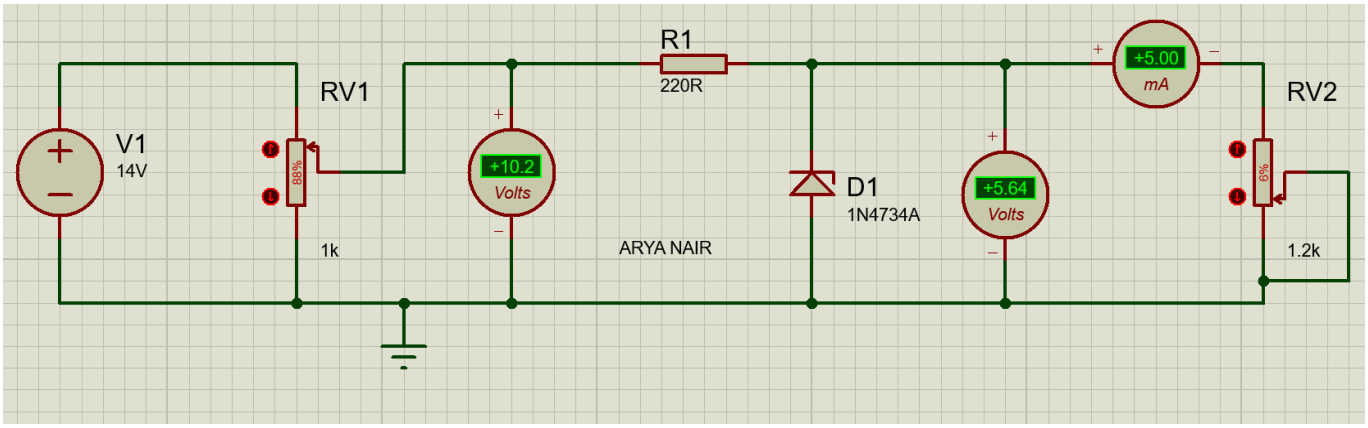
Circuit Diagram/ Block Diagram:



Stepwise-Procedure:

1. Design circuit and connect it as shown in the circuit diagram using Proteus simulator.
2. Keep V_{IN} more than 8V and adjust Potentiometer R_L such that I_L= 5 mA. Vary V_{IN} and Note V_O for finding line regulation.
3. Keep V_{IN} = 10 V and vary Potentiometer R_L such that I_L changed from 0 to 5 mA and not V_O for finding load regulation.
4. Plot the graph V_o Vs V_{IN} for line regulation and V_o Vs I_L for load regulation.

Proteus Screenshots



Observation Table:

Line Regulation: Set I_L= 5 mA **Load Regulations: Set V_{IN}= 10.1 V**

V_{IN} (V)	Vo (V)		I_L (mA)	Vo (V)	RL
3.97	3.32		0	5.65	Infinity
4.98	4.16		2	5.65	2825
6.02	5.03		4	5.65	1412.5
6.5	5.43		5.02	5.64	1123.505976
7	5.58		5.96	5.64	946.3087248
8.04	5.62		8	5.63	703.75
8.99	5.63		9.99	5.63	563.5635636
10.2	5.64		12	5.63	469.1666667
11.1	5.65		14	5.62	401.4285714
11.9	5.66		16	5.61	350.625
13.1	5.66		18	5.59	310.5555556
14	5.67		19.9	5.56	279.3969849

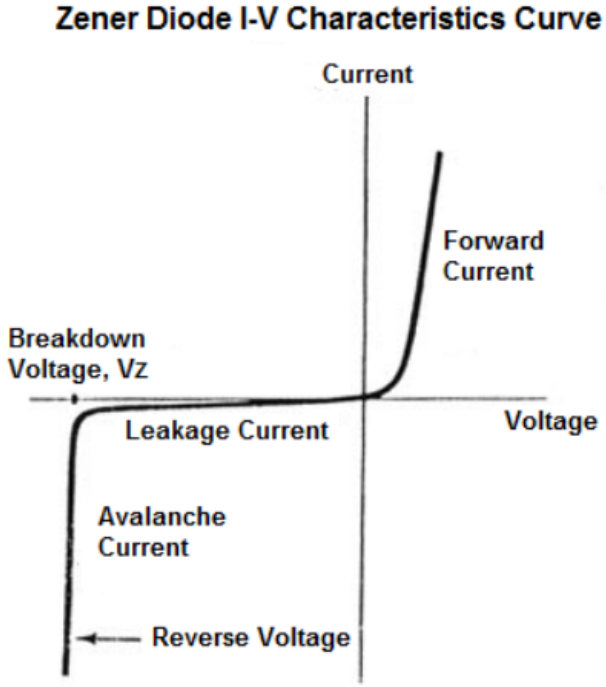
Line Regulation- 23.429%

Load Regulation- 0.4522%

Post Lab Subjective/Objective type Questions:

1. Draw and explain I-V characteristics of Zener diode.

ANS:



The VI characteristics of a zener diode is shown in the below figure. When forward biased voltage is applied to the zener diode, it works like a normal diode. However, when reverse biased voltage is applied to the zener diode, it works in a different manner.

When reverse biased voltage is applied to a zener diode, it allows only a small amount of leakage current until the voltage is less than zener voltage. When reverse biased voltage applied to the zener diode reaches zener voltage, it starts allowing a large amount of electric current. At this point, a small increase in reverse voltage will rapidly increase the electric current. Because of this sudden rise in electric current, breakdown occurs called zener breakdown. However, zener diodes exhibit a controlled breakdown that does damage the device.

The zener breakdown voltage of the zener diode depends on the amount of doping applied. If the diode is heavily doped, zener breakdown occurs at low reverse voltages. On the other hand, if the diode is lightly doped, the zener breakdown occurs at high reverse voltages.

2. What is the difference between PN junction diode and Zener diode?
ANS:The major difference between PN junction and the Zener diode is that the PN junction diode allows current to pass only in the forward direction, whereas the Zener diode allows the current to flow both in the forward and the reversed direction. The other differences between the PN-junction and Zener diode are shown in the comparison chart.

The PN junction diode is used for rectification purposes because it allows the current to flow only in one direction. It is a type of switch which only allows the forward current to pass through it. On the other hand, the Zener diode allows both the forward and reverse current to pass through it. The Zener diode is used as a voltage regulator in the electronic circuit because it provides the constant voltage from the supply to the load whose voltage varies over sufficient range.

Conclusion:

- In this experiment we learned to use Zener diode as a voltage regulator in a circuit
- In doing so we also learned

Signature of faculty in-charge with Date: