Winter Semester (2018-2019) / 3rd Grade

Experiment No: 8

Zener Diode

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Objective

1- Study of I-V characteristics of zener diode.
2- Using a zener diode as voltage regulator.

Components

Name	Specifications
Zener Diode 1N4735A/ FZ 5.1 Or IZ 6.2	Vz = 5.1 V
Resistors	0.5, 1, 5 and 10 kΩ

Equipment

Name	Specifications
Bread board / Circuit Panel	
AC Power Supply	0-30 V
Digital Ammeter	200 mA
Digital Voltmeter	30 V
Connecting Wires	

Theory

The zener diode is fabricated with a heavily doped Silicon diode. It conducts excellently in reverse biased condition. This diode operates at a precise value of voltage called break down voltage. When a Zener diode is forward biased, it behaves like an ordinary P-N junction diode. But when it is revers biased, it can undergo avalanche break down or zener break down.

Avalanche Break down

When p-region and n-region of a diode are lightly doped, depletion region at the junction will broaden. If a very large electric field applied to the junction, the kinetic energy of the charge carriers increases which collides with the adjacent atoms producing charge carriers by breaking the bonds. This process results in large current causing avalanche breakdown.

Zener Diode Break down

When p-region and n-region of a diode are heavily doped, depletion region at the junction will reduce. This setup a very strong electric field at a small voltage producing large number of charge carriers by breaking the covalent bonds. The sudden increase in charge carriers causes Zener break down.

Zener Diode as Voltage Regulator

The voltage regulator consisting of zener diode is shown in Fig. 1. The current flowing through the zener diode increases to the maximum circuit value (I) determined by

$$I = (V_{in} - V_Z) / R_{IN}$$

where I is the sum of the zener current I_Z and the load current I_L. The voltage across the zener diode becomes stable and is called the "zener voltage", (Vz), which is for example, 5.1V or 6.2V. This zener breakdown voltage on the I-V curve is almost a vertical straight line. However, when the input voltage increases, the current I_Z increases causing a decrease in the output voltage.

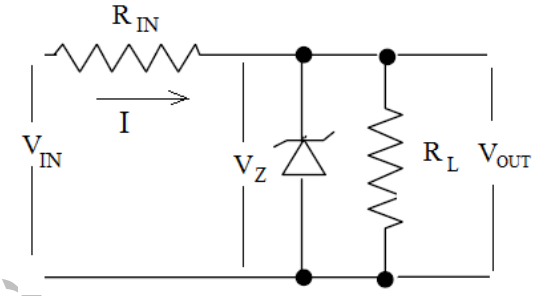

Fig. 1. Electronic circuit of Zener-diode voltage regulator.

Procedure

A: Forward I-V characteristics of zener diode

1- Connect the circuit diagram shown in Fig. 2.

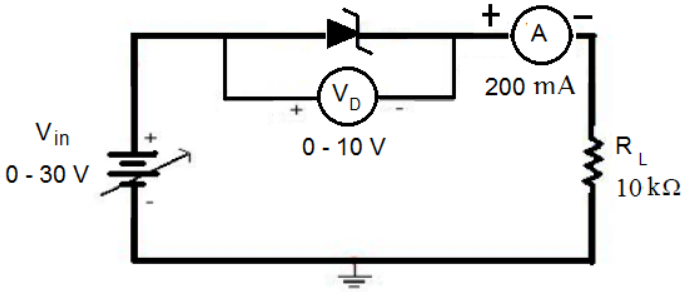

Fig. 2. Electronic circuit of forward-biased Zener diode.

2- Increase Vin from 0 to 2 V by steps of 0.1 V, and record the current I_F.

B: Reverse I-V characteristics of zener diode

1- Connect the circuit diagram shown in Fig. 3.

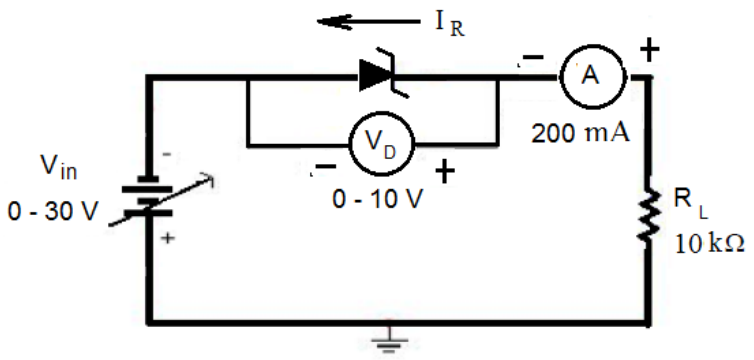

Fig. 3. Electronic circuit of reversed-biased Zener diode.

2- Increase Vin from 0 to 10 V by steps of 0.2 V and record the current.

C: Zener diode as a voltage regulator

1- Connect the circuit diagram shown in Fig. 4.

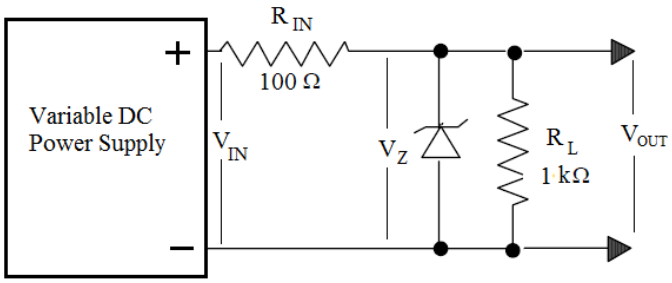

Fig. 4. Zener diode as voltage regulator.

2- Calculate the current passes through the input resistance

3- Increase Vin from 0 to 10 V by steps of 1 V and record Vout.

4- Change the load resistor and fill in the below table.

V_{in} (volts)	Vout (volts)		
	R = 100Ω	R = 1kΩ	R = 10kΩ
0.0			
0.5			
1.0			
1.5			
2.0			
2.5			
10			

Calculations

1- Plot I-V characteristics of zener diode, which should be like Fig. 5.

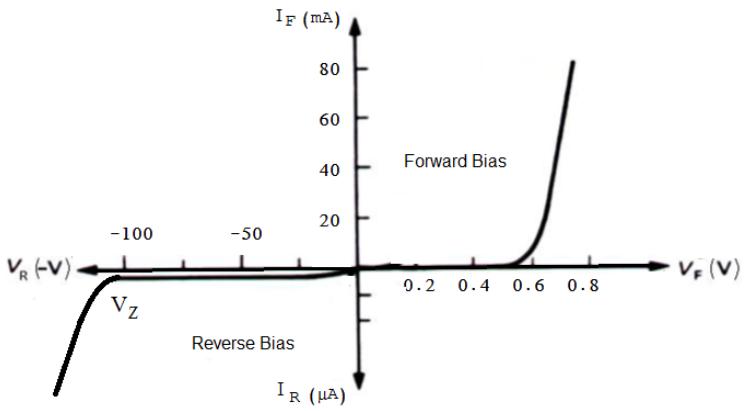

Fig. 5. V-I Characteristics of zener diode

2- Plot the relationship between Vin and Vout of the regulator for every load resistance, as shown in Fig. 6.

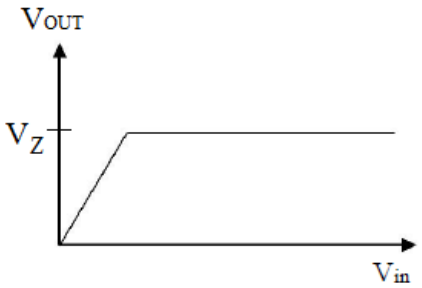

Fig. 6. The relationship between Vin and Vout of zener diode at a certain load.

Discussion

1- What is the difference between p-n Junction diode and zener diode?

2- What is break down voltage?

3- Discuss your results stating the error sources.