EXPERIMENT N0. 3(ECS51)

ZENER DIODE CHARACTERISTICS & ZENER DIODE VOLTAGE REGULATOR

OBJECTIVES: The aim of this lab experiment is to familiarize you to investigate the reverse Zener diode characteristics and the application of a Zener diode for voltage regulation.

EQUIPMENT and PARTS LIST:

1. Digital Multimeters (DMM). 2. DC power supply. 3. Project Breadboard.
4.Resistors of 220Ω & 1KΩ, 5. Milliammeter..
6. Zener diode. 7. Connection Wires .

PRE-LAB ASSIGNMENTS:

Pre1. Read this lab sheet completely, and do all the problems indicated.

Pre2. Sketch the I-V characteristics curve of a real diode assuming that its threshold (ON) voltage is 0.6V an that reverse breakdown voltage is 50V, like the 1N4001 diode.

Pre3. Sketch the I-V characteristics curve of a real Zener diode assuming that its turn-on voltage is 0.6V and its reverse breakdown voltage (*Vz*) is 5.1V.

Pre4. What is the difference between a Zener diode and a "standard" rectifier diode?

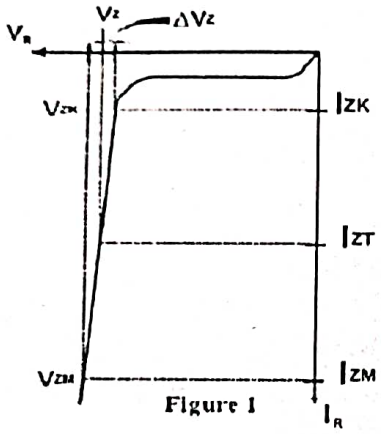


Figure 1

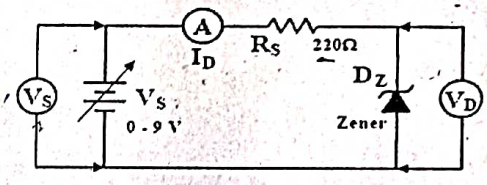


Figure 2. Circuit diagram used to determine reverse Zener diode characteristics.

PROCEDURE: PART-A Zener Diode Characteristics : The Zener diode operates in the reverse breakdown region as shown in Figure 1. The Zener diode has almost a constant voltage across it as long as the Zener diode current is between knee current *IZK* and the maximum current rating *IZM*.

1- Construct the circuit shown in Figure 2. By using **Si Zener** diode.(Make sure the diode is connected with the correct polarity). **2-** Set the correct setting of the DMM & Milliammeter to measure ***VS***, ***VD*** and ***ID***. **3- Ask the Teacher to inspect your circuit. 4-** Set the DC power supply output adjustment potentiometer fully counter clock wise, then switch it ON. (Set ***VS = 0V.)*** **5-** Adjust the voltage source (*VS*) corresponding to Table Use the DMM & milliammeter to measure the remaining values and record it in Table 1. (*Do not exceed the Zener rated current of 20 mA*). **6-** When finished, set the (*VS*) to ***0.0V***. Then switch OFF the DC power supply.

• Plot the reverse diode current *vs.* the reverse diode voltage (*voltage on horizontal axis*). Label each axis with suitable and calibration numbers. • From the curve above determine the Zener breakdown voltage ***VZK***.

• Calculate the Zener diode dynamic resistance ***rZ***, where: $rZ = \Delta VD / \Delta IZ$ (*for* $|VZK| < |VD| < |VZM|$).

Table 1 Zener diode reverse bias characteristics data.

0.0027

V_S (V)	0.0	2.0	4.0	5.0	5.2	5.5	6.0	6.5	7.0	8.0	9.0
I_Z (mA)	0	0	0	0.002		0.0038	0.0058	0.008	0.0105	0.0144	0.019
V_D (V)	0	2	4	4.62	4.62	4.62	4.62	4.62	4.62	4.62	4.62

-II Zener Diode Voltage Regulator

ne ion of a voltage regulator is to provide a constant low ripple output voltage under varying load current conditions. ve high quality voltage regulators are available in integrated circuits, at times it may be sufficient and convenient to er diode as voltage regulator in simple power supplies and as voltage references in more complex power supplies re pplications. Since the Zener diode will conduct in the reverse direction for any output voltage *Vo* greater than *Vz*, er exceed *Vz* at normal conditions. As the load current *IL* changes, the Zener diode will conduct sufficient current ta a voltage drop of (*VS* – *Vo*) across the series dropping resistor, *Rs*. The selected Zener diode must have a reverse ow voltage equal to the desired output voltage *Vo* and be capable of dissipating the power that results when *RL* is rg The difference between *VS* and *Vo* should be selected as small as possible but must be large enough to prevent the p across *Rs* from exceeding (*VS* – *Vo*), when *IL* is maximum. It is clear that a smaller value for *Rs* means a ue for (*VS* – *Vo*); however, a smaller value for *Rs* will result in a greater diode current when *RL* is large and this se the power dissipation requirement of the diode. Since the load is in parallel with the Zener diode, the voltage *RL* is always the same as across Zener diode and is *VZ* = constant Zener voltage. The supply voltage *VS* must be th *VZ*. Zener diode **MUST be operated under load**. If not, the Zener is still delivering power (more than usual) y rn.

PROCEDURE

st ct the circuit shown in Figure 3. By using ***Si Zener*** diode. (*Make sure the diode is connected with correct polarity).*

th correct setting of the DMMs to measure *Vs*, *Vo* and *Is*.

th **Teacher to inspect your circuit.**

th DC power supply output adjustment potentiometer fully counter clock wise,

s witch it ON. (Set *Vs = 0V.)*

as he voltage source (*Vs*) corresponding to Table 2. Use the DMM to measure the load voltage *Is* nd record it in Table-2. Then Calculate *IL*, *Iz* and *Pz*

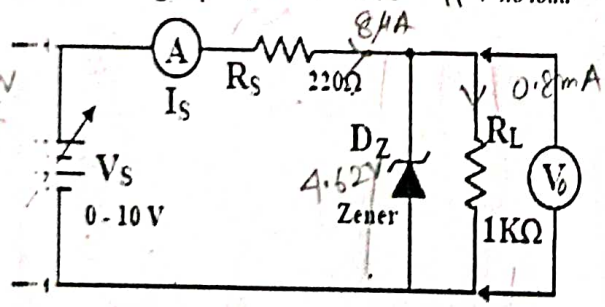
re *IL = Vo / RL*, *Iz = Is – IL and Pz = Iz x Vz*.

en finished, set the (*Vs*) to *0.0V*.

ti what happens to *Vo* and why.

ala the percentage voltage regulation (V.R %) of your circuit, and record it in Table 2.

h following equation: $V.R\ \% = ((V_{no\ load} - V_{full\ load}) / V_{full\ load}) \times 100\%$



Zener diode voltage regulator with variable power supply.

Zener diode voltage regulator with variable power supply data.

Vs (V)	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Vo (V)	0.824	1.667	2.58	3.28	4.62	4.62	4.62	4.62	4.62	4.62
Is (mA)	08	1.7	2.0	3.3	484	6.6	10	14.5	19.9	23.1
IL (mA)	0824	0	0	0	4.62	4.62	4.62	4.62	4.62	4.62
Iz (mA)	0	0	0	0	0.002	1.58	5.88	9.88	14.33	18.56
Pz (W)	0	0	0	0	0.009					
VR (V)	21.36	19.97	18.58	21.9	0	0	0	0	0	0

1. What is the difference between p-n Junction diode and zener diode? 2. What is break down voltage? 3. What are the applications of Zener diode? 4. What is cut-in-voltage ? 5. What is voltage regulator?

q = V/R ✓