EXPERIMENT 3: ZENER I-V CHARACTERISTICS

AIM: 1) Obtain I-V characteristics of zener diode
2) To study zener diode as voltage regulator

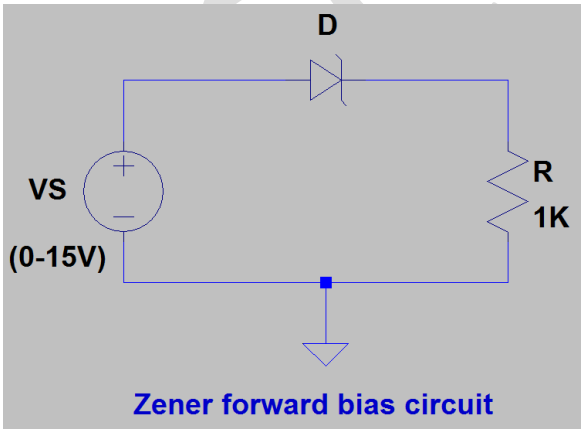
APPARATUS: Zener diode (6.8V, 1W), Bread board, Resistor (1KΩ, 100Ω), Connecting wires, Ammeters (0-10mA), DC power supply (0-30V), 10KΩ pot and multimeter.

THEORY: Zener diode is a P-N junction diode specially designed to operate in the reverse biased mode. It is acting as normal diode while forward biasing. It has a particular voltage known as break down voltage, at which the diode break downs while reverse biased. In the case of normal diodes the diode damages at the break down voltage. But zener diode is specially designed to operate in the reverse breakdown region.

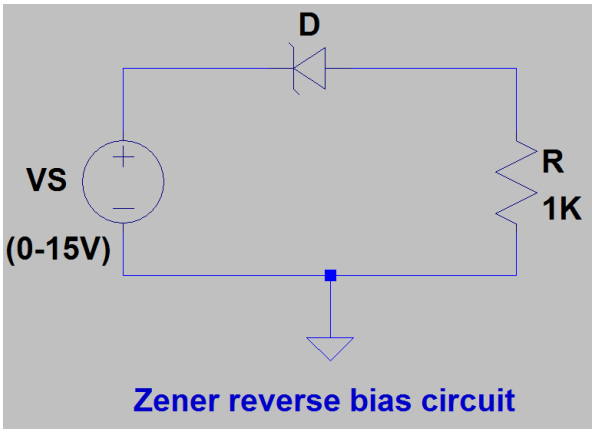
The basic principle of zener diode is the zener breakdown. When a diode is heavily doped, it's depletion region will be narrow. When a high reverse voltage is applied across the junction, there will be very strong electric field at the junction. And the electron hole pair generation takes place. Thus heavy current flows. This is known as zener breakdown.

The breakdown voltage depends upon the amount of doping. For a heavily doped diode depletion layer will be thin and breakdown occurs at low reverse voltage and the breakdown voltage is sharp, whereas a lightly doped diode has a higher breakdown voltage. This explains the zener diode characteristics in the reverse bias region.

So a zener diode, in a forward biased condition acts as a normal diode. In reverse biased mode, after the break down of junction current through diode increases sharply. But the voltage across it remains constant. This principle is used in voltage regulator using zener diodes.



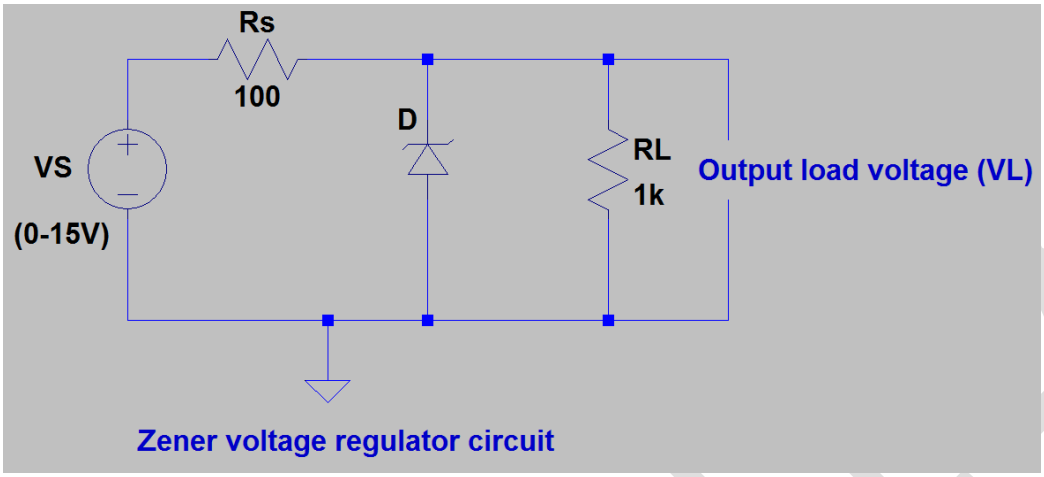
Zener forward bias circuit



Zener reverse bias circuit

VOLTAGE REGULATOR

Voltage regulator is nothing but an electronic circuit which keeps o/p voltage constant irrespective of changes in line voltage & load current.



OPERATION

The figure shows the zener voltage regulator, it consists of a current limiting resistor R_S connected in series with the input voltage V_S and zener diode is connected in parallel with the load R_L in reverse biased condition. The input voltage should be greater than Vz, then only zener diode will work in zener region. The output voltage is always selected with a breakdown voltage Vz of the diode.

If Vs is higher than Vz the current through zener diode increases & $I_L \downarrow$ we will get constant o/p voltage. If I_L changes, then Iz changes in such a way that at the o/p we get constant dc voltage.

OBSERVATION

Forward Biased

Supply Voltage (V)	V_D (V)	V_R (V)	I_D (mA)
0.1			
0.2			
.			
.			
.			
1			
1.5			
2			
2.5			
.			
.			
6			

Reversed Biased

Supply Voltage (V)	V_D (V)	V_R (V)	I_D (mA)
1			
2			
.			
.			
.			
15			

Line Regulation:

Keep $R_L=\infty$

Vin	V_L
10	
11	
12	
13	
14	
15	

Load Regulation:

Keep Vin=10V

R_L	V_L
∞	
1K	
3K	
5k	
7k	
9K	

PROCEDURE:

A) I-V Characteristics of Zener Diode

1) Identify the components required and make the connections on bread board as per circuit diagram.
2) Connect the circuit diagram for diode in forward biasing mode.
3) Switch on the power supply and increase applied voltage gradually.
4) Note down the required readings.
5) Repeat steps 2 to 4 for reverse bias mode.
6) Tabulate the observations and plot the I-V curve for zener diode in forward and reverse bias.
7) From your observations obtain the value of cut-in voltage and breakdown voltage V_Z.

B) Line regulation

1) Identify the components required and make the connections on bread board as per circuit diagram.
2) Keep load resistance fixed value; vary DC input voltage from 5V to 15V and note down the value of output load voltage $V_{L.}$
3) Note down output load voltage with high line voltage V_{HL} and as a load voltage with low line voltage V_{LL}.
4) Plot the graphs for V_S Vs V_L and calculate % line regulation.

C) Load regulation

1) Identify the components required and make the connections on bread board as per circuit diagram.
2) Keep input voltage constant say 10V.
3) Vary R_L in steps of 1KΩ and note down the value of output load voltage $V_{L.}$
4) Note down no load voltage V_{NL} for maximum load resistance and full load voltage V_{FL} for minimum load resistance value.
5) Plot the graphs for R_L Vs V_L & calculate % load regulation.

CALCULATION:

% Line regulation= _____%
% load regulation= _____%

RESULTS:

Cut in voltage = _____
Breakdown voltage = _____
% Line regulation = _____%
% Load regulation = _____%

CONCLUSION:

POST LAB QUESTIONS:

1. Explain how zener works as a voltage regulator with examples w.r.t
   a) Regulation with a varying supply
   b) Regulation with a varying load

2. Define load and line regulation. What should be the ideal values of load and line regulation.

3. Mentions some ratings for the zener diode.