Experiment No.: 1

1.1 AIM: To study and plot volt-ampere characteristics of P-N junction diode.

1.2 APPARATUS REQUIRED:

Table.1: Apparatus required

S. No.	Equipment Name	Range	Qty
1	Bread Board	----------	1
2	Regulated Power Supply	0-30V DC	1
3	Diodes 1N 4007(Si)	--------	1
4	Resistor	1KΩ, 10KΩ	1
5	Digital Ammeter	0-200μA/20mA	1
6	Digital Voltmeter	0-2V/20V DC	1

1.3 Theory:

Donor impurities (penta-valent) are introduced into one-side and acceptor impurities into the other side of a single crystal of an intrinsic semiconductor to form a p-n diode with a Junction called depletion region (this region is depleted off the charge carriers). This Region gives rise to a potential barrier V□ called ***Cut- in Voltage***. This is the voltage across the diode at which it starts conducting. It can conduct beyond this Potential.

The P-N junction supports uni-directional current flow. If +ve terminal of the input supply is connected to anode (P-side) and –ve terminal of the input supply is connected to cathode (N- side) then diode is said to be forward biased. In this condition the height of the potential barrier at the junction is lowered by an amount equal to given forward biasing voltage. Both the holes from p-side and electrons from n-side cross the junction simultaneously and constitute a forward current (***injected minority current*** – due to holes crossing the junction and entering N-side of the diode, due to electrons crossing the junction and entering P-side of the diode). Assuming current flowing through the diode to be very large, the diode can be

This condition an amount equal to reverse biasing voltage increases the height of the potential barrier at the junction. Both the holes on p-side and electrons on n-side tend to move away from the junction thereby increasing the depleted region. However the process cannot continue indefinitely, thus a small current called ***reverse saturation current*** continues to flow in the diode. This small current is due to thermally generated carriers. Assuming current flowing

through the diode to be negligible, the diode can be approximated as an open circuited switch.

The volt-ampere characteristics of a diode explained by following equation:

$I = I_0 (e^{V/(\eta V_T)} - 1)$ where

I=current flowing in the diode I_0=reverse saturation current

V=voltage applied to the diode

V_T=volt-equivalent of temperature=kT/q=T/11,600=26mV (@ room temp).

η=1 (for Ge) and 2 (for Si)

It is observed that Ge diode has smaller cut-in-voltage when compared to Si diode. The reverse saturation current in Ge diode is larger in magnitude when compared to silicon diode.

1.4 Circuit Diagram:

1.4.1 Forward Bias PN junction:

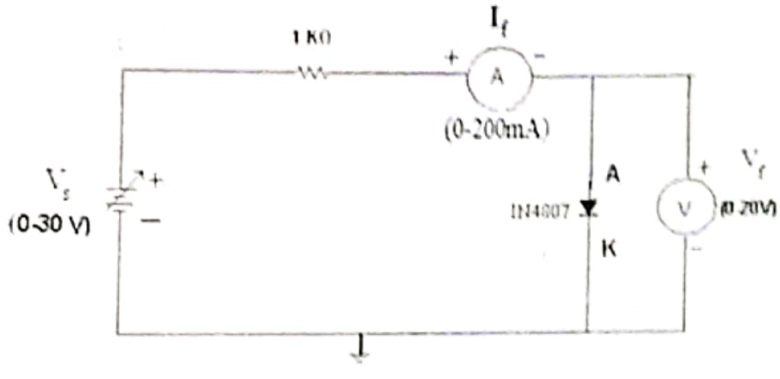


Fig.1 When PN junction is working on forward bias

1.4.2 Reverse Bias of PN Junction

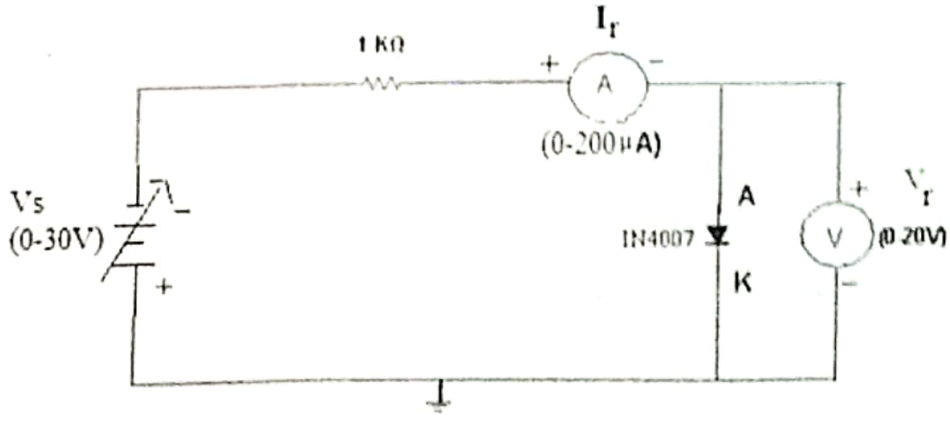


Fig.2 When PN junction is working on reverse bias

1.5 Procedure:

1.5.1Forward Biased Condition:

1. Connect the circuit as shown in figure (1) using silicon PN Junction diode.
2. Vary V_f gradually in steps of 0.1 volts up to 5volts and note down the correspondingreadings of I_f.
3. Step Size is not fixed because of non linear curve and vary the X-axis variable (i.e. if output variation is more, decrease input step size and vice versa).
4. Tabulate different forward currents obtained for different forward voltages.

1.5.2 Reverse biased condition:

1. Connect the circuit as shown in figure (2) using silicon PN Junction diode.
2. Vary V_r gradually in steps of 0.5 volts up to 8 volts and note down the correspondingreadings of I_r.
3. Tabulate different reverse currents obtained for different reverse voltages. ($I_r = V_R$ /R, where V_R is the Voltage across 10KΩ Resistor).

1.6 Observations

1.6.1 Diode in forward biased conditions:

Sl. No	RPS Voltage	Forward Voltage across the diode V_f (volts)	Forward current through the diode I_f (mA)

1.6.2 Diode in reverse biased conditions:

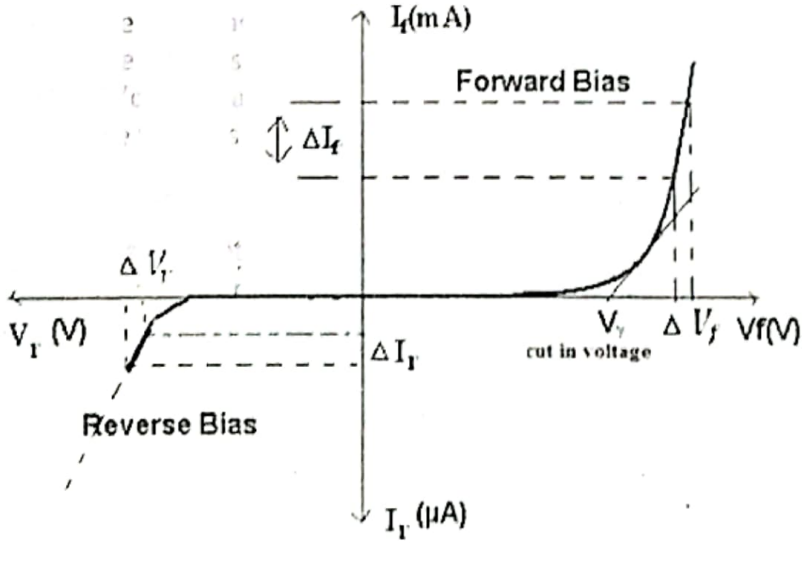
Sl. No	RPS Voltage	Reverse Voltage across the diode V_r (volts)	Reverse current through the diode I_r (μA)

1.7 Graph (Instructions):

1. Take a graph sheet and divide it into 4 equal parts. Mark origin at the center of thegraph sheet.
2. Now mark + ve x-axis as V_f
   - Ve x-axis as V_r
   + Ve y-axis as I_f
   - ve y-axis as I_r.

3. Mark the readings tabulated for Si forward biased condition in first Quadrant and Sireverse biased condition in third Quadrant.

1.8 Calculations from Graph:



1.9 Calculations from Graph:

Cutin Voltage = V_γ

Static forward Resistance $R_{dc} = V_f/I_f\ \Omega$

Dynamic Forward Resistance $r_{ac} = \Delta V_f/\Delta I_f \Omega$

Static Reverse Resistance $R_{dc} = V_r/I_r\ \Omega$

Dynamic Reverse Resistance $r_{ac} = \Delta V_r/\Delta I_r \Omega$

1.10 Precautions:

1. While doing the experiment do not exceed the ratings of the diode. This may lead todamage the diode.
2. Connect voltmeter and Ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch **ON** the power supply unless you have checked the circuit connectionsas per the circuit diagram.

1.11 Result:

1. Cut in voltage = ... V
2. Static forward resistance = ... Ω
3. Dynamic forward resistance = ...Ω

VIVA-VOCE Questions

1. How depletion region is formed in the PN junction?
2. What are trivalent and pentavalent impurities?
3. What is cut-in or knee voltage? Specify its value in case of Ge or Si?
4. What is maximum forward current and maximum reverse voltage? What is itrequired?
5. What is leakage current?
6. How does PN-junction diode acts as a switch?
7. What is the effect of temperature in the diode reverse characteristics?
8. What is break down voltage?
9. What is incremental resistance of a diode?
10. What is diode equation?