EXPERIMENT 1: DIODE I-V CHARACTERISTICS

AIM: To plot forward and reverse I-V characteristics of given PN junction diode.

APPARATUS: D.C. Supply (0 - 15 V), current limiting resistor 1KΩ, Diodes (IN4148-Si and OA95-Ge), Digital Multimeter, milli ammeter (0-10mA), micro ammeter (0 -100 μA)

THEORY:

Semiconductors, like Silicon or Germanium, are elements having resistivity that in intermediate between a conductor and an insulator. They inherently have four electrons in the valence band which helps them to form covalent bonds with four neighbouring silicon atoms. Hence, at absolute zero, the material behaves like an insulator. At room temperature, few of these electrons absorb enough energy to break away from the nucleus and serve as conduction electrons. The conduction properties can also be easily changed by changing the doping (adding different elements to) the semiconductor. Addition of a pentavalent impurity such as Phosphorus, N – type dopant, gives an additional electron after the four silicon bonds are satisfied. Similarly, a trivalent impurity such as Boron, P-type dopant, creates an absence of electron, a hole . The entire semiconductor material is a single crystal, with one region dopes to be P-type, with excess holes, and the adjacent region to be N- type, with excess electrons. This creates a metallurgical junction between the p and n regions. The contact to the p region is called the anode and that of the n region is called cathode.

Equilibrium P – N junction:

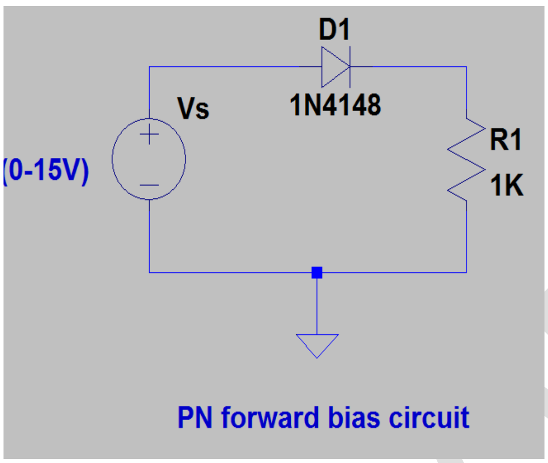
A large density gradient in both hole and electron concentrations occur at this junction. Initially, then, there is a diffusion of holes from the p region to the n region and diffusion of electrons from n region to the p region. The flow of holes from p region uncovers negatively charged acceptor ions, and the flow of electrons uncovers positively charged donor ions. This action creates a charge separation which sets up an electric field oriented in the direction from the positive to the negative charge. This sets up an electric field in such a direction as to oppose the movement of electrons and holes eventually. The region surrounding the junction which contains immobile charges is called the "space charge" or "depletion" region. The electric field creates a potential difference across the region, which is called the built-in potential barrier. This is about 0.7 V for a Si diode at room temperature.

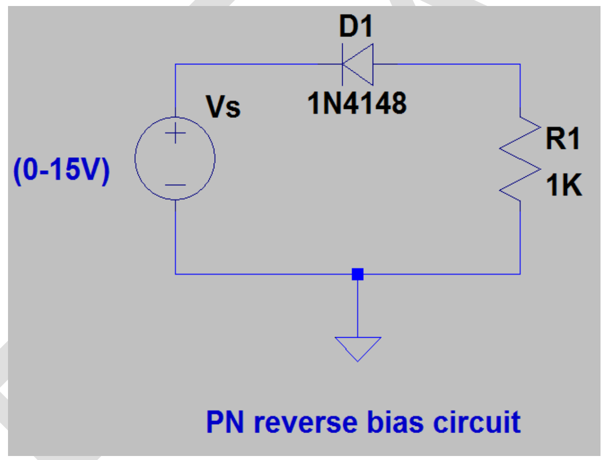
Forward Biased P-N junction:

Application of a positive voltage to the p region and negative voltage to the n region creates an additional electric field in the space charge region. But this time the field opposes the space – charge E-field. This disturbs the balance between diffusion and E-field force. Hence majority carriers from the p region diffuse over to the n side and electrons from n side move over to the p side of the junction. This process continues as long as the voltage is applied. Thus, in the forward bias mode, the diode carries a large current.

Reverse Biased P-N junction:
A voltage source with its positive terminal connected to the n region and negative terminal connected to the p region reverse biases the P-N junction. This increased electric filed holds back the holes in the p region and electrons in the n region and hence, there is no current flow. The electric field and the width of the space-charge region increases. There is also a decrease in junction capacitance associated due to increase in the width. Thus, the reverse bias region is characterized by negligible current (due to minority carriers) even on the application of a very high voltage across the terminals, the limit being decided by reverse breakdown voltage of the diode.

CIRCUIT DIAGRAM:





PROCEDURE:
Part A
1) Connect the diode IN4148 in the forward bias mode.
2) Connect a current limiting resistor in series with the diode.
3) Slowly increase the voltage applied, and measure the current (I) through the diode and the voltage across the diode (V_D). Take more than 10 readings.
4) Use the forward bias data for IN4148 and plot an V_D v/s I_D graph. From this graph, calculate the forward resistance by calculation the slope of the curve in the ON region (where there is sufficiently large change in current w.r.t voltage). Is measured slope is m, then

Forward resistance:

$$r_{ON} = \frac{dV_D}{dI_D} \triangleq \frac{1}{m}$$

Part B
Repeat steps 1 to 4 of part A for OA95 Ge diode

OBSERVATIONS:

Forward Biased

Sr. No.	Supply Voltage (V)	V_D(V)	V_R(V)	I_D (mA)
	0.1			
	0.2			
	.			
	.			
	.			
	1			
	1.5			
	2			
	2.5			
	.			
	.			
	.			
	.			
	.			
	5			

Reversed Biased

Sr. No.	Supply Voltage (V)	V_D(V)	V_R(V)	I_D (mA)
	0			
	1			
	2			
	.			
	.			
	.			
	.			
	.			
	.			
	15			

CALCULATIONS:

Calculate dynamic resistance and cut-in voltage from graph for the given diode.

RESULTS:

a) Forward Bias of PN Junction Diode:

The Cut in Voltage or Knee Voltage of 1N4148 is ______________Volts.
The Dynamic Forward resistance of 1N4148 is ___________________ .
The Static Forward resistance of 1N4148 is ___________________ .

The Cut in Voltage or Knee Voltage of OA95 is ______________Volts.
The Dynamic Forward resistance of OA95 is ___________________ .
The Static Forward resistance of OA95 is ___________________ .

b) Reverse Bias of PN Junction Diode:

The Dynamic Reverse resistance of OA95 is ___________________ .
The Static Reverse resistance of OA95 is ___________________ .

CONCLUSION:

POST LAB QUESTIONS :

1. Differentiate between Ge and Si diodes ?
2. What is diode current equation ?
3. What is cut-in or knee voltage ? What are its values for Si and Ge diodes ?
4. Mentions some specifications for the diode ?