DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY
COURSE NO. : EEE 264
EXPT. NO.-01

NAME OF THE EXPERIMENT: STUDY OF DIODE CHARACTERISTICS

OBJECTIVE

To study the **I-V** characteristics of silicon p-n junction diodes.

MATERIALS REQUIRED

p-n junction diode(1N4003)	one piece
5V Zener diode	one piece
resistor (1K)	one piece
dc power suply	one piece
signal generator	one piece
oscilloscope	one unit
chords and wire	lot

THEORY

A p-n junction diode is a two-terminal device that acts as an one-way conductor. When a diode is forward biased as shown in Fig. 1(a), current I_D flows through the diode and current is given by

$$I_D = I_S\left[e^{\frac{V_a}{nV_T}} - 1\right] \qquad (1)$$

where, n is the ideality factor and $1 \geq n \geq 2$. I_S is the reverse-saturation current and $V_T = kT/q$ is the thermal voltage. V_T is about 0.026V at room temperature.

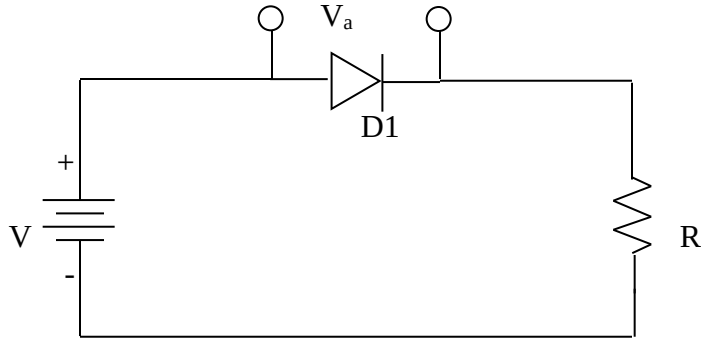

Fig.1(a)

When it is reverse biased as shown in Fig. 1(b), $I_D = -I_S$ (for see eqn. (2)). As it is generally in pA (pico-amp) range, in many applications this current is neglected and diode is considered open.

$$I_D = I_S\left[e^{-V_R/V_T} - 1\right] = -I_S \quad \text{for } |V| >> V_T \qquad (2)$$

The material for p-n junction diode is silicon semiconductor. Semiconductors are a group of materials having electrical conductivity intermediate between metals and insulators.
Metals: Al (aluminum), Cu(copper),Au(gold).
Insulators: Ceramic, Wood , rubber.
Semiconductor: Si (silicon), Ge (germanium), GaAs (gallium-arsenide).

P-type Silicon:

When an intrinsic silicon semiconductor is doped with Al impurities, it becomes p-type. At thermal equilibrium,

$$p_o = N_A \text{ and } n_o = n_i^2/N_A$$

where, p_o is the hole concentration , n_o is the electron concentration , N_A is the doping density of impurities(acceptor atoms), n_i is the intrinsic concentration. $n_i = 1.5 \times 10^{10} cm^{-3}$ for Si at room temperature .

N-type silicon:

When an intrinsic silicon semiconductor is doped with P(phosphorous) impurities it becomes n-type . At thermal equilibrium, $n_o = N_D$ and $P_o = n_i^2/N_D$. Here, N_D is the doping density of impurities (donor atoms).

In semiconductor both holes and electrons contribute to current .

Current-Voltage Characteristics

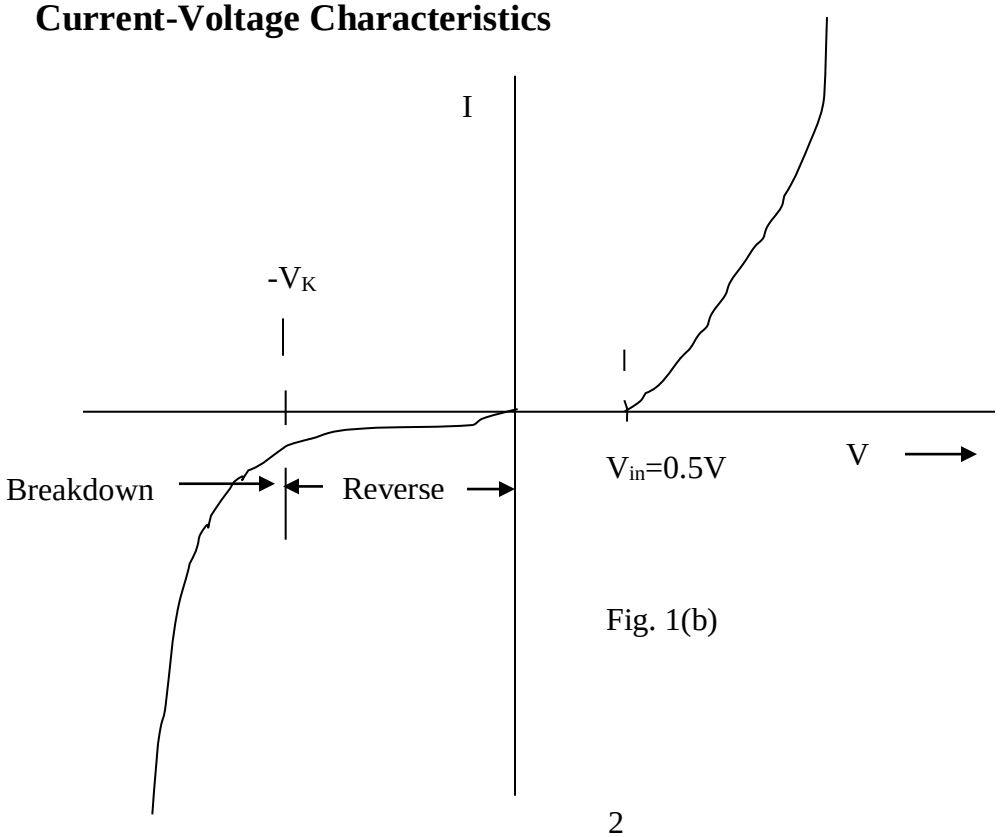

Fig. 1(b)

V_{in} is the cut-in voltage. Its value is usually 0.5V. At this voltage, diode is forward biased but even then I is very small and it is usually neglected. When diode is reverse biased and $V < V_K$, diode drives into breakdown and a large current will flow. The current can be limited by using resistor in diode circuit. If the slope (dI/dV) is very steep, the breakdown mechanism is called Zener breakdown. Zener diode can be used in regulator circuit.

Small Signal

Consider the circuit shown in Fig. 1(c). For ac voltage $V_d < 10$ mV, we can write

$$i_d = [I_D/nV_T] * v_d = v_d/r_d$$

where, $r_d = nV_T/I_D$ is the diode small-signal (dynamic) resistance and I_D is the dc current. Dc resistance is given by $r_D = V_D/I_D$ where V_D is the dc voltage across the diode .

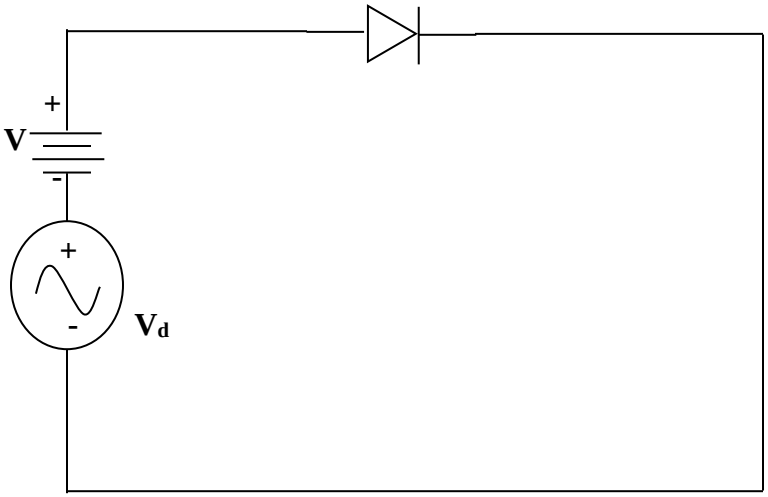

Fig. 1 (c)

CIRCUIT DIAGRAMS FOR EXPERIMENTS

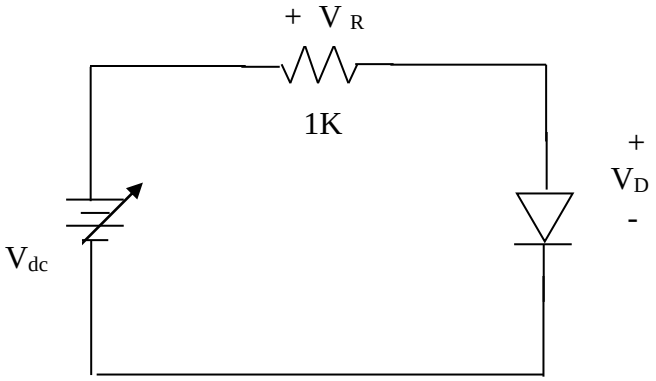

Fig. 2

(Circuit diagram for diode characteristics.)

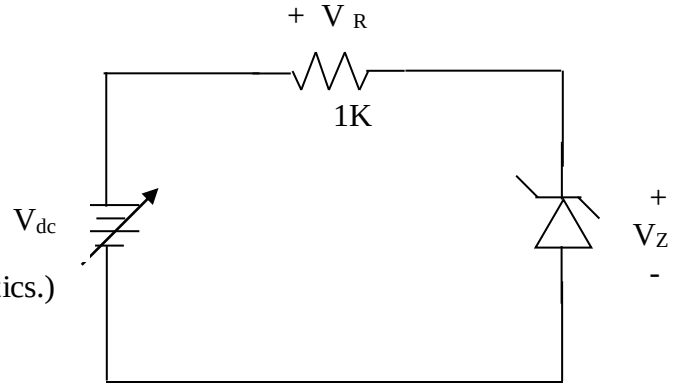

Fig. 3

(Circuit diagram for zenner diode characteristics.)

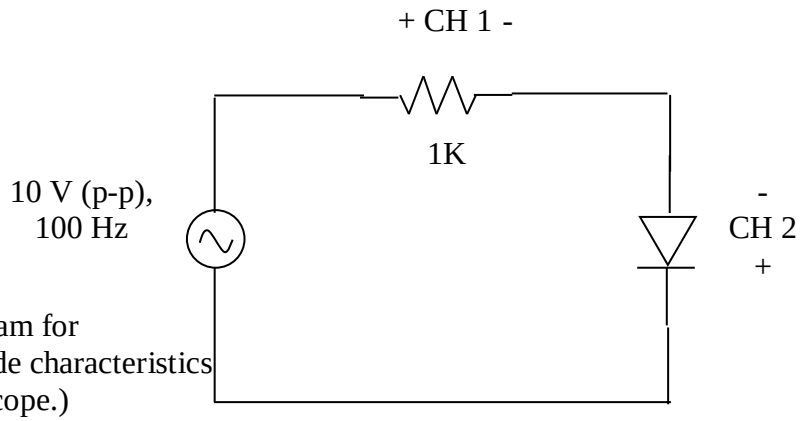

Fig. 4

(Circuit diagram for obtaining diode characteristics from oscilloscope.)

PROCEDURE

1. Measure resistance accurately using multimeter. Construct the circuit as shown in Fig. 2.Vary input voltage (V_{dc}) and measure V_D, V_R for values of V_D=0.1V, 0.2V, 0.3V, 0.4V, 0.5V, 0.6V, 0.7V and so on. Obtain maximum value of V_D without increasing V_{dc} beyond 25 V (Note that $I_D=V_R/ R$).

2. Repeat step1 for the values at V_z =0.5V, 1.0V, 1.5V, 2.0V, 2.5V, 3V and so on up to the maximum value obtainable without increasing V_{dc} beyond 25V. Apply circuit in Fig. 3 for this step.

3. Construct the circuit as shown in the Fig. 4. Set the oscilloscope in X-Y mode and locate the zero point on oscilloscope display. Make proper connection (according to Fig. 4) and observe the output.

4. Repeat step3 by increasing supply frequency to 5 kHz.

REPORT

1. Plot diode I-V characteristics for different readings obtained in this experiment.

2. Calculate static and dynamic resistance for I_D=5 mA, 10 mA and also for V_D=0.6 V, 0.72 V for circuit in Fig. 2.

3. Determine the Q-point for the circuit in Fig. 2 when V_{dc}=15 V.

4. Explain the result obtained in step 4.

5. What is the Zener voltage of the diode of Fig. 3?

6. What is the dynamic resistance of the Zener diode at Zener voltage?