UNIVERSITY OF DHAKA
ELECTRONIC DEVICE AND CIRCUITS LAB

Exp. 1: STUDY OF DIODE CHARACTERISTICS

OBJECTIVE

To study the current-voltage (I-V) characteristics of silicon p-n junction diodes.

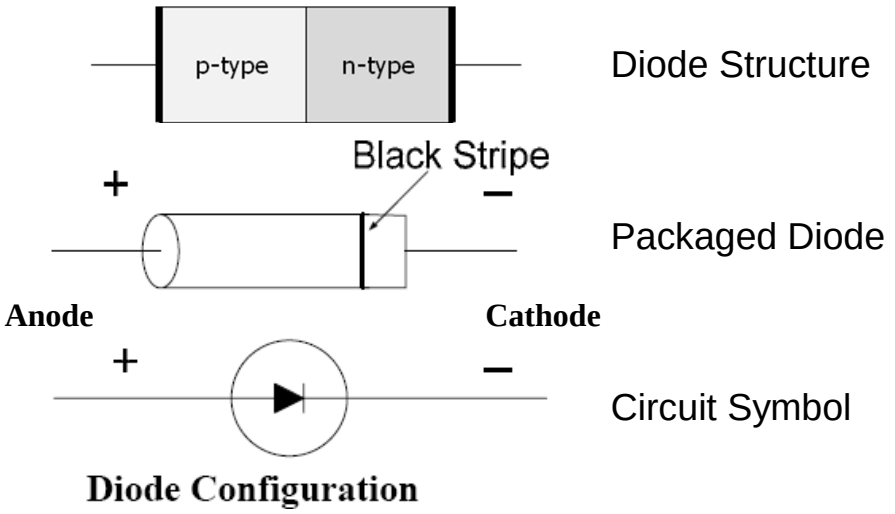
EQUIPMENT

p-n junction diode(1N4003)	two pieces
resistor (1K)	one piece
dc power suply	one piece
oscilloscope	one unit
chords and wire	lot

THEORY

Diode is a semiconductor device that allows current flow only in one direction, from *p* to *n* or anode to cathode. The schematic diagram, diode notation and circuit symbol are shown in Figure 1. Diodes are usually marked with a dot or a bar appearing on the cathode side. This mark helps identify the diode terminals.

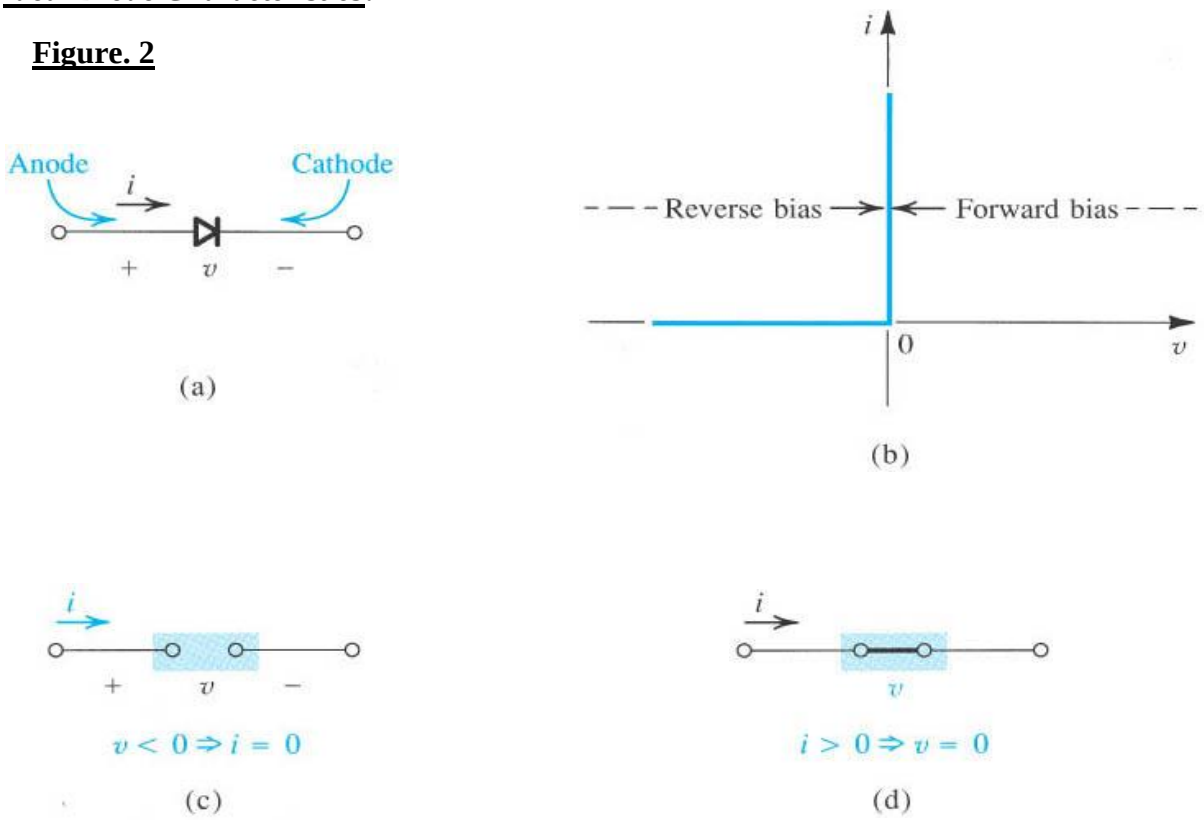
Figure. 1



Diodes have small impedance to current flow in one direction (forward-biased) and large impedance in the reverse-biased mode. When diodes fail they either short-circuit (pass current in both directions – i.e. low resistance in both directions) or open-circuit (do not pass current at all).

***Ideal Diode Characteristics*:**

Figure. 2



***Real Diode Characteristics*:**

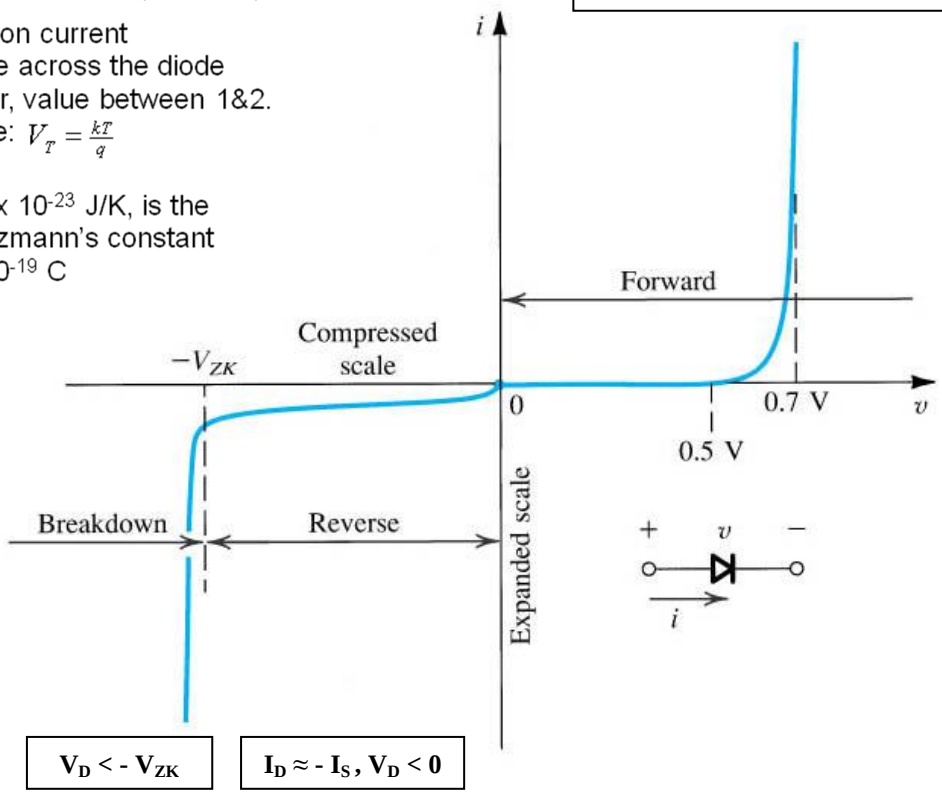
Diode Equation $I_D = I_s\left(e^{V_D/nV_T} - 1\right)$

- I_s reverse saturation current
- V_D applied voltage across the diode
- n an ideality factor, value between 1&2.
- V_T thermal voltage: $V_T = \frac{kT}{q}$

k = 1.38 x 10^{-23} J/K, is the Boltzmann's constant

q= 1.6x10^{-19} C

Figure. 3



Diode Resistance:

As the diode I-V characteristic is not linear, it will have different resistances at different points on the curve. A dynamic or AC resistance for the diode is defined as,

$$r_d = di/dv \approx nV_T/I_D$$

The static or DC resistance at any point is defined as, $R_D = V_D/I_D$.

Diode Specifications:

There are many specifications for each type of diode, the most important two are: (1) PIV (*Peak inverse Voltage*) maximum voltages the diode can tolerate in reverse direction. (2) I_F, *Maximum Forward Current* the diode can conduct in forward biased condition without exceeding the safe limit. Take a look at the data sheet of a diode provided at the last page to get familiar with some of the diode specifications.

Diodes are widely used in applications such as mixers, detectors, protection circuits. In this experiment you will investigate application of diodes as a switch in a logic gates (AND gate), and study its I-V characteristics.

EXPERIMENTAL

***Circuit Diagrams*:**

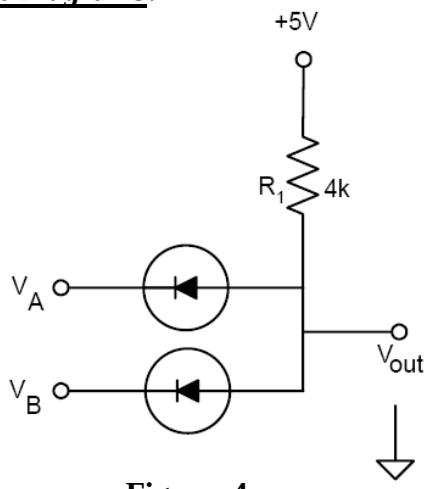


Figure. 4

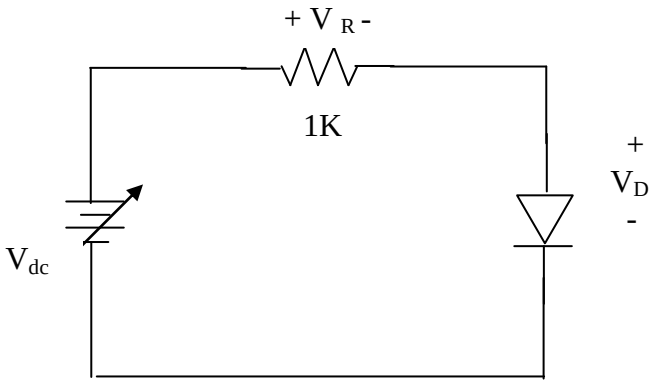


Figure. 5 Circuit diagram for diode characteristics

***Procedure*:**

1. Connect the circuit of Figure 4 (See Diode Configuration); Measure the output voltage using a voltmeter for all possible input combinations (0 or 5V).
2. Measure resistance accurately using multimeter. Construct the circuit as shown in Fig. 5. Vary input voltage (V_{dc}) from 0 to 15 V and measure V_R and V_D. Increase V_{dc} in steps of 0.1 V for 0-1 V and in steps of 1 V for 1-15 V. (Note that $I_D=V_R/R$).
3. Reverse the polarity of supply voltage in Fig. 5 and repeat step 2.
4. Plot I_D vs V_D and calculate the static and dynamic resistances for I_D = 4, 8 and 12 mA.

REPORT

1. Generate the truth table by computing the output for all possible input combinations. What logic function does the circuit perform?
2. Plot diode I-V characteristics of the diode for different readings obtained in steps 2 and 3.
3. Calculate the diode ideality factor, n, and the reverse saturation current, I_S, using the diode equation assuming $V_D >> V_T$.
4. Calculate static and dynamic resistances for I_D = 4, 8 and 12 mA. Tabulate and comment on the results.
5. Perform PSpice simulation of the circuits in Figs. 1 and 2 and repeat steps 1 to 4. Compare the PSpice results with those obtained experimentally. Use the diode model D1N4002 for PSpice simulation.

Typical data sheet of a diode:

DATA SHEET

Small Signal Diode

Absolute Maximum Ratings* T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{RRM}	Maximum Repetitive Reverse Voltage	100	V
$I_{F(AV)}$	Average Rectified Forward Current	200	mA
I_{FSM}	Non-repetitive Peak Forward Surge Current Pulse Width = 1.0 second Pulse Width = 1.0 microsecond	 1.0 4.0	 A A
T_{stg}	Storage Temperature Range	-65 to +200	°C
T_J	Operating Junction Temperature	175	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 200 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.