



The Islamic University of Gaza

Faculty of Engineering

Department of Computer Engineering

Electronics I LAB

[LAB 02]

[DC Characteristics of Diodes]

Student Name

Ahmed Maher Al-Shaikh Khalil

Student ID

120220263

Supervisor

Eng. Nael Dokhan

Objectives:

- To plot V/I characteristics curve of semiconductor diode.
- To study How to check diode using multi-meter.
- To be familiar how can be simulate diode circuit with the LTSpice simulation.

Equipment:

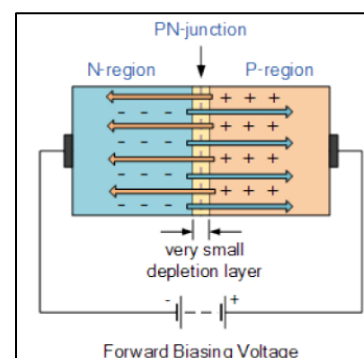
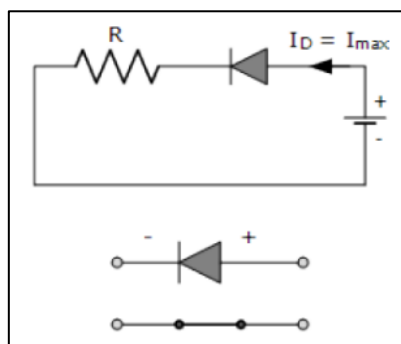
- Diode (1N4007)
- Resistors
- LTSpice

Theory:

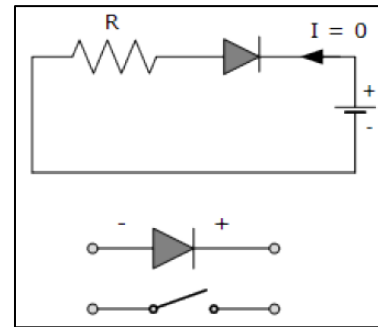
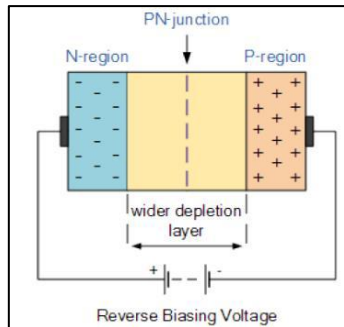
A P-N junction diode is created by introducing donor (pentavalent) impurities on one side of a single crystal of an intrinsic semiconductor and acceptor (trivalent) impurities on the other side. This results in the formation of a depletion region, which is devoid of charge carriers. The boundary between these regions creates a potential barrier, known as the *Cut-in Voltage*, which is the voltage required for the diode to begin conducting. When a sufficient voltage is applied across the diode, it overcomes this barrier and allows current to pass through the junction.

The behavior of the P-N junction is highly dependent on the biasing conditions:

- **Forward Bias:** When the positive terminal of the input supply is connected to the anode (P-side) and the negative terminal is connected to the cathode (N-side), the diode is said to be forward-biased. In this state, the potential barrier at the junction is lowered by an amount equal to the applied forward bias voltage, and current can flow freely across the junction. The diode behaves as a closed switch under these conditions.



- **Reverse Bias:** When the polarity of the input supply is reversed, with the negative terminal connected to the anode and the positive terminal to the cathode, the diode is said to be reverse-biased. In this case, the potential barrier increases, preventing current from flowing across the junction. A very small current, known as the *reverse saturation current*, can still flow due to minority charge carriers. In ideal conditions, the diode behaves as an open circuit in reverse bias.



The current-voltage characteristics of a P-N junction diode are nonlinear, and the relationship can be described by the Shockley diode equation:

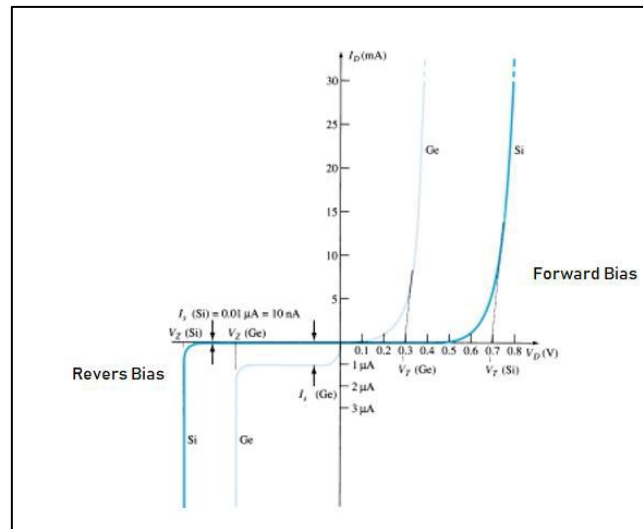
$$I_D = I_S \left(e^{\frac{V_D}{nV_T}} - 1 \right)$$

P-N Junction Biasing

Forward Biasing: In forward bias, the applied voltage decreases the width of the depletion region, allowing current to flow. The holes from the P-side and electrons from the N-side cross the junction, contributing to a forward current. This current is significant enough for the diode to conduct electricity effectively.

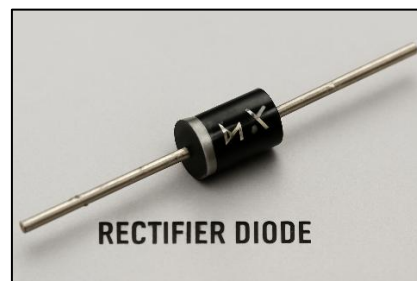
Reverse Biasing: In reverse bias, the applied voltage increases the width of the depletion region, preventing current flow. However, a small reverse saturation current still flows due to the minority carriers. If the reverse bias exceeds a critical value (known as the breakdown voltage), the diode may enter *Zener breakdown*, allowing significant reverse current to flow.

V/I characteristics curve:



Types of Diodes

1. **Rectifier Diode:** A rectifier diode is a type of P-N junction diode primarily used for converting alternating current (AC) to direct current (DC) in power supply applications. The P-side is called the anode, and the N-side is called the cathode. When the diode is forward-biased, current can flow; when reverse-biased, current is blocked.



2. **Light Emitting Diode (LED):** An LED is a specialized P-N junction diode that emits light when forward biased. The electrons from the N-side cross the junction and recombine with holes in the P-side, releasing energy in the form of light. The color of the emitted light depends on the material properties and the energy gap of the semiconductor used.



3. : A Zener diode operates under the principle of Zener breakdown. It allows current to flow in the reverse direction when the applied voltage exceeds the breakdown voltage, making it an ideal component for voltage regulation in power supplies.



Testing Diodes Using a Multimeter

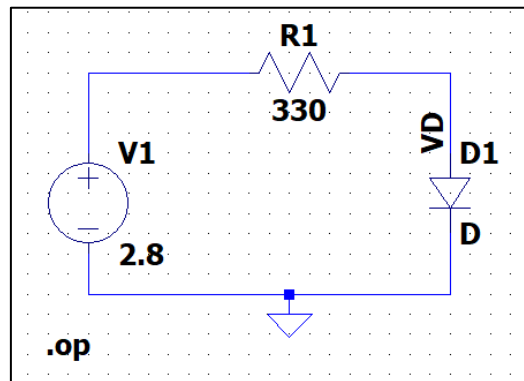
To test a diode, a multimeter can be used in the resistance mode:

1. **Forward Bias Test:** Connect the positive test lead to the anode and the negative test lead to the cathode. A good diode should show a resistance between 250 ohms to 1 M Ω .
2. **Reverse Bias Test:** Connect the positive test lead to the cathode and the negative lead to the anode. A good diode should show *OL* (open loop), indicating no current flows in reverse bias.

If the readings in both directions are the same, the diode is faulty.

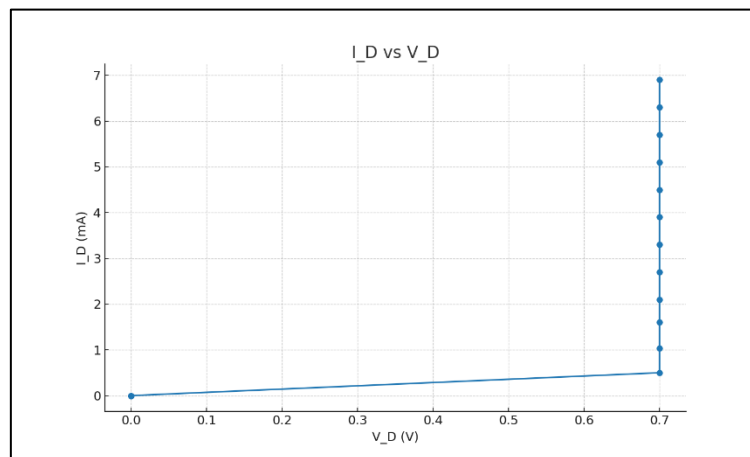
Experiment Procedure:

Part01: Forward Bias



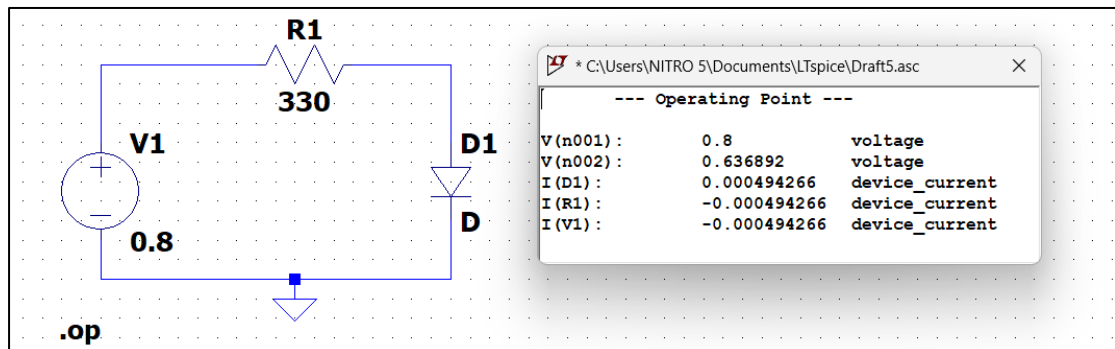
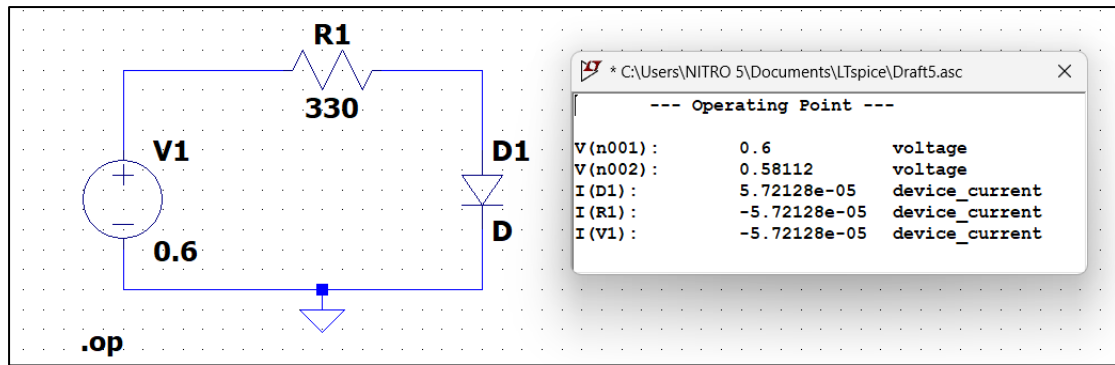
Simulation Forward Biased Diode

$V_s(\text{V})$	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3
$V_D(\text{V})$	0	0	0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
I_D (mA)	0	0	0	0.5	1.04	1.6	2.1	2.7	3.3	3.9	4.5	5.1	5.7	6.3	6.9

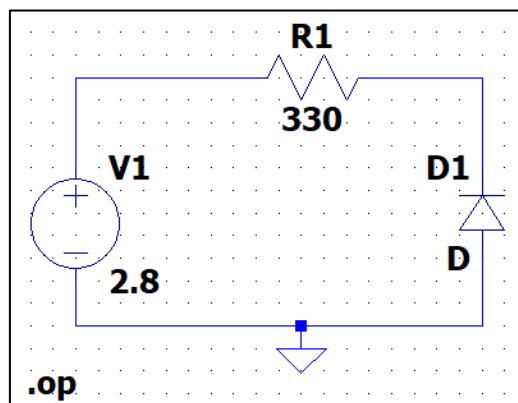


Theoretical Forward Biased Diode to Calculate V_R

$V_s(\text{V})$	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3
$V_D(\text{V})$	0	0	0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
I_D (mA)	0	0	0	0.5	1.04	1.6	2.1	2.7	3.3	3.9	4.5	5.1	5.7	6.3	6.9
$V_R(\text{V})$	0.2	0.4	0.6	0.8	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3



Part02: Reverse Bias



Simulation Reverse Biased Diode

V_s (V)	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4
V_D (V)	-0.2	-0.4	-0.6	-0.8	-1	-1.2	-1.4	-1.6	-1.8	-2	-2.2	-2.4
I_D (mA)	0	0	0	0	0	0	0	0	0	0	0	0

Continue:-

2.6	2.8	3
-2.6	-2.8	-3
0	0	0

