Aim ↬ To find the VI characteristics of the P-N Junction Diode and to find the cut-in voltage.

Equipment Required ↬

Si diode, Resistance, Power supply, Ammeter, Voltmeter, Breadboard and connecting wires.

Theory ↬

A P-N junction diode is a semiconductor device formed by joining a P-type material, which has an abundance of holes, with an N-type material, which has an abundance of electrons. At the interface of these two materials, electrons from the N-type region diffuse into the P-type region and recombine with holes, creating a region around the junction that is devoid of free charge carriers, known as the depletion region. This region establishes an electric field and a built-in potential across the junction, which opposes further diffusion of charge carriers.

When a forward bias voltage is applied to the diode (positive voltage to the P-region and negative to the N-region), the potential barrier of the depletion region is reduced. This reduction in barrier allows majority charge carriers (holes in the P-region and electrons in the N-region) to cross the junction more easily, resulting in a significant increase in current flow through the diode. Conversely, when a reverse bias voltage is applied (negative voltage to the P-region and positive to the N-region), the potential barrier is increased, which widens the depletion region and prevents the flow of majority charge carriers. This results in only a minimal current flow, known as reverse leakage current, until the reverse breakdown voltage is reached.

The VI (Voltage-Current) characteristics of a P-N junction diode illustrate its behaviour under varying applied voltages. Under forward bias conditions, the diode current increases exponentially with increasing voltage, following the diode equation. In reverse bias conditions, the current remains extremely small until the breakdown voltage is approached, where it then increases sharply due to breakdown mechanisms such as avalanche or Zener breakdown, depending on the diode type.

The cut-in voltage, also referred to as the threshold or forward voltage drop, is a critical parameter for diodes. It is the minimum forward bias voltage at which the diode starts to conduct significantly. For silicon diodes, this cut-in voltage is typically around 0.6 to 0.7 volts, whereas for germanium diodes, it is approximately 0.2 to 0.3 volts. This voltage must be exceeded to overcome the built-in potential of the depletion region and allow for substantial current flow through the diode.

Circuit Diagram ↬

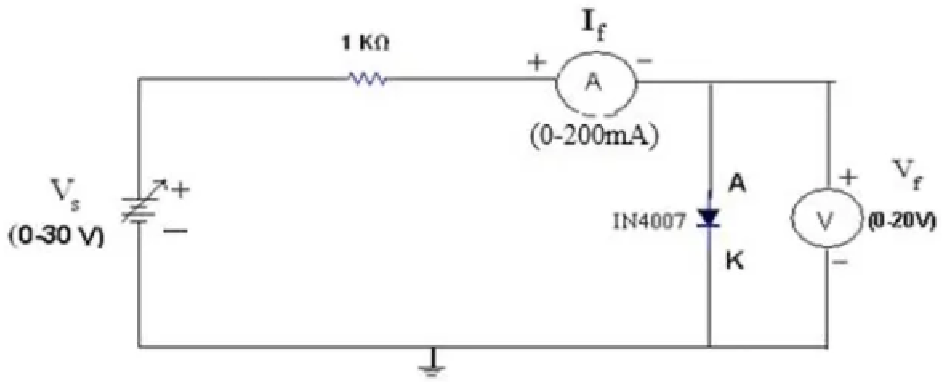

Fig 1. Forward Bias

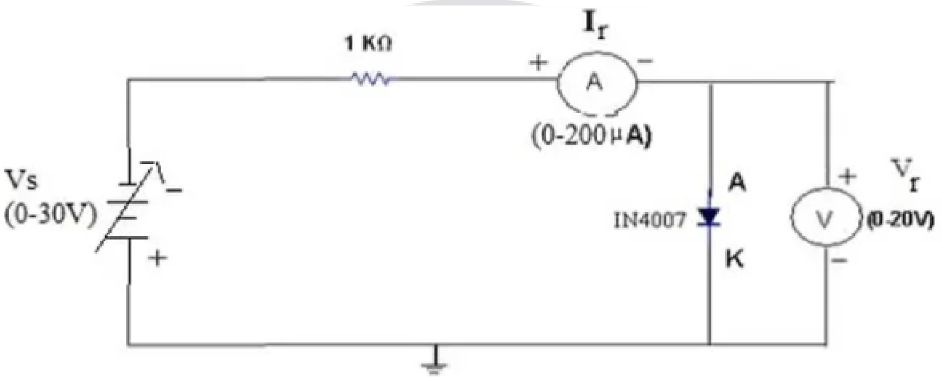

Fig 2. Reverse Bias

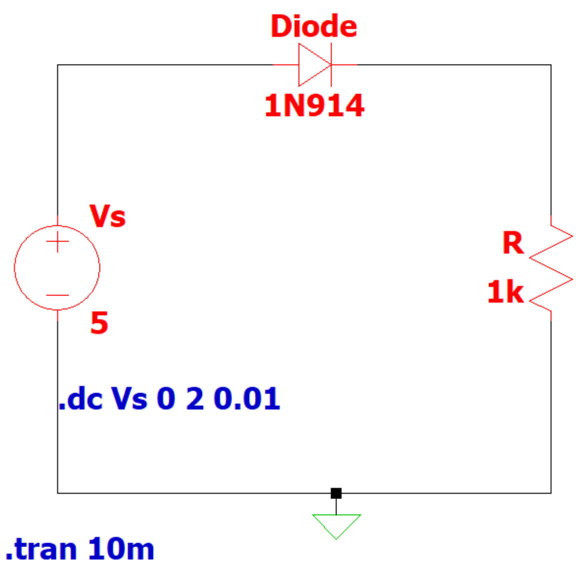

Fig 3. Circuit in LTSpice

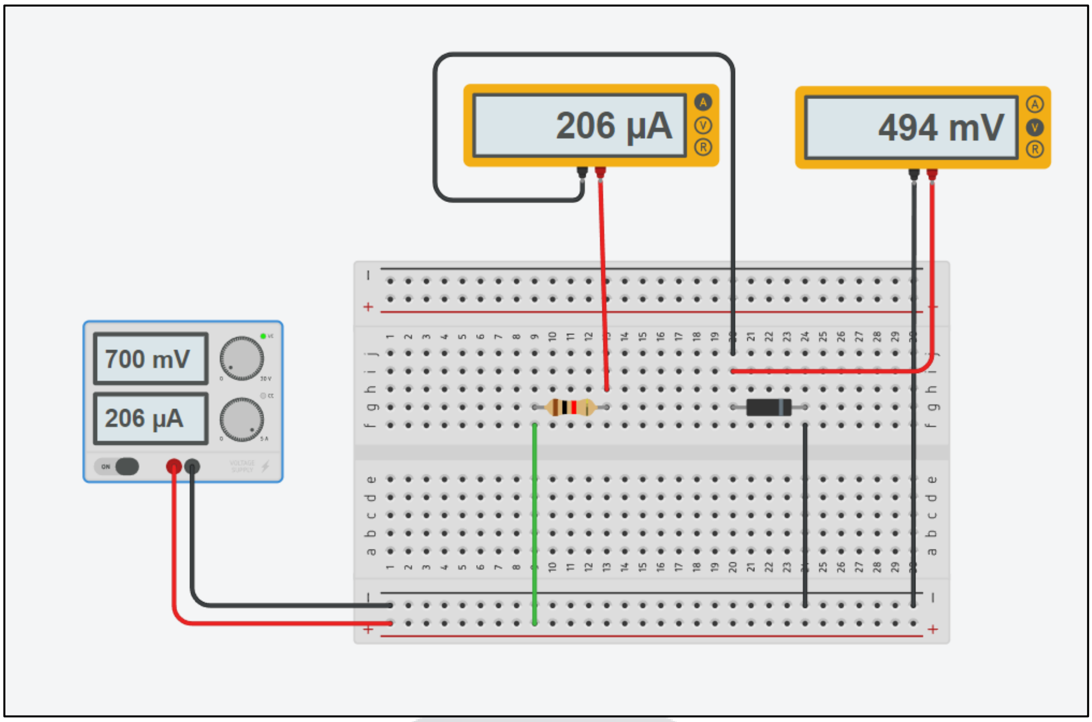

Fig 4. Circuit in TinkerCad

Observation Table ↬

- **Forward Bias ↪**

S.No.	Supply Voltage Vs(V)	Output Voltage Vo(V)	Output Current Io(μA)
1	0	0	0
2	0.2	0.2	0
3	0.4	0.395	0
4	0.5	0.455	45.2
5	0.6	0.480	120
6	0.7	0.494	206
7	0.8	0.503	0.297
8	0.9	0.510	390
9	1.0	0.516	484
10	1.1	0.521	579
11	1.2	0.525	675
12	1.3	0.528	772
13	1.4	0.531	869
14	1.5	0.534	966
15	1.6	0.536	1060

➤ **Reverse Bias ↪**

S.No.	Supply Voltage Vs(V)	Output Voltage Vo(V)	Output Current Io(A)
1	0	0	0
2	0.2	0.2	0
3	0.5	0.5	0
4	0.7	0.7	0
5	1	1	0
6	1.5	1.5	0
7	2	2	0
8	3	3	0
9	4	4	0
10	5	5	0

Graphs ↬

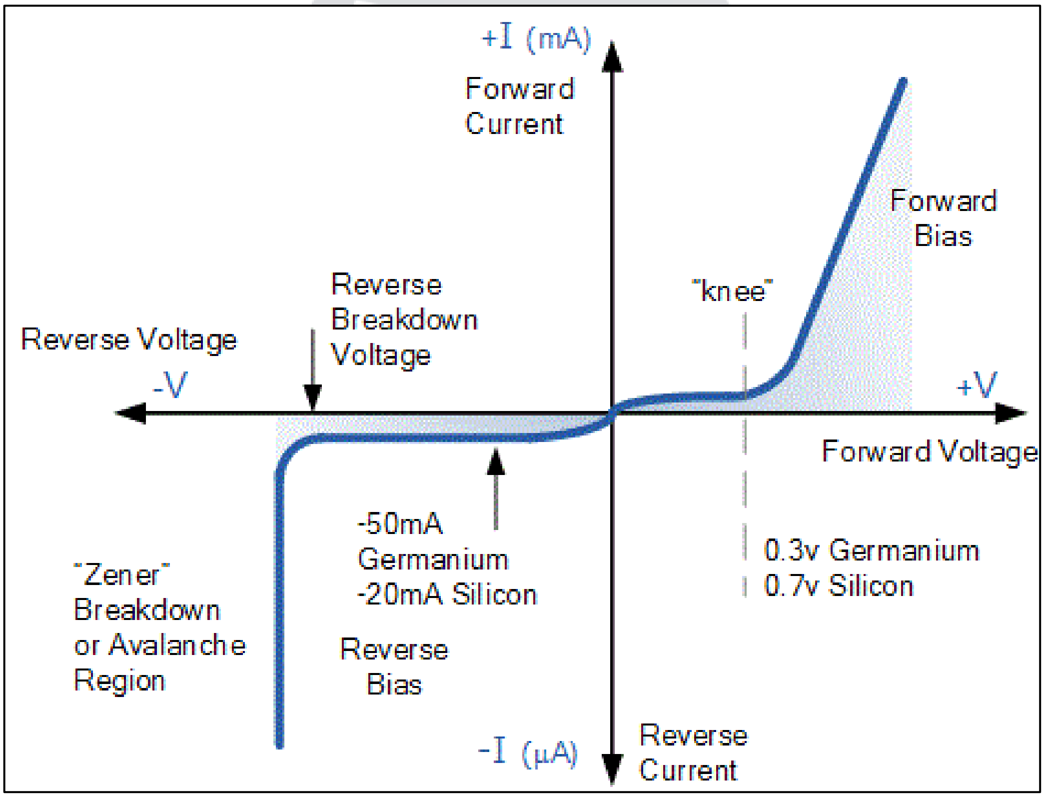

Fig 5. Ideal Characteristic Curve

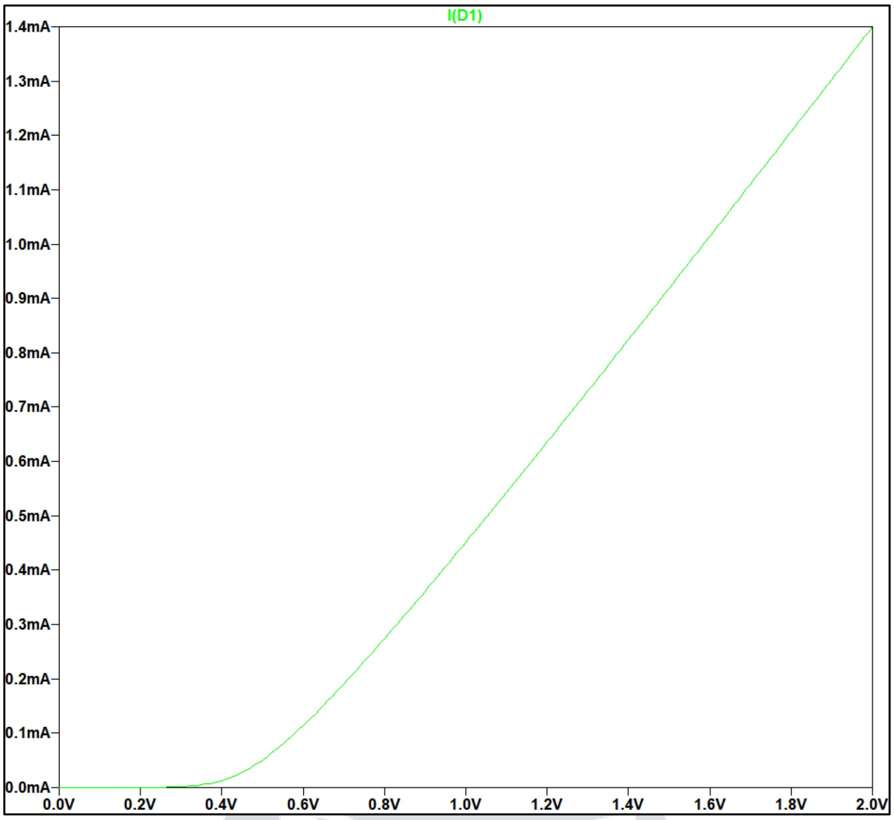

Fig 6. Forward Bias

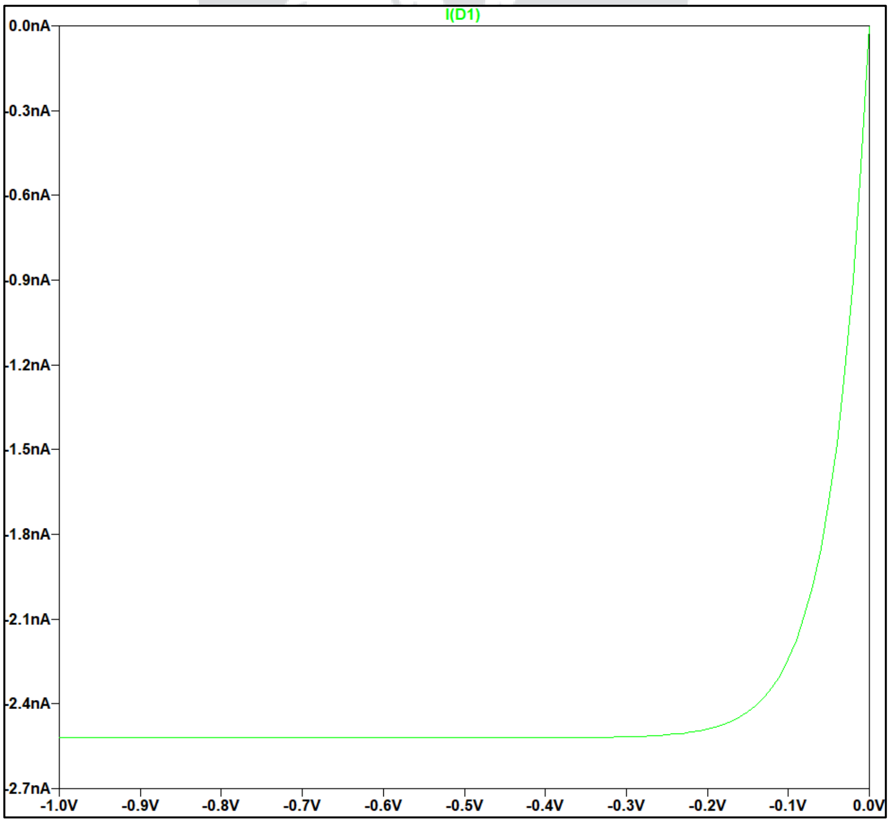

Fig 7. Reverse Bias

Result ↬

The experiment showed that the silicon diode began to conduct significantly at a forward voltage of around 0.7V, with current increasing exponentially beyond this point. In reverse bias, the diode exhibited minimal leakage current, effectively blocking current flow.

Conclusion ↬

Successfully performed the experiment and matched the result with the simulation result.

Precautions ↬

- While doing the experiment, do not exceed the ratings of the diode. This may lead to damage to the diode.
- Connect the voltmeter and Ammeter in the correct polarities as shown in the circuit diagram.
- Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.