

**Laboratory Goals**

- Analyzing, simulating and building a diode based circuit.
- Taking measurements and applying transformations to obtain the diode I-V curve.
- Use the curve tracer to verify the IV curve

**Pre-lab / lab reading**

- Course Textbook
- Oscilloscope User's Guides (Copies of these reference books are available in the lab, or at the website)
- Tektronics 571 Curve Tracer Manual*
- BS170 Transistor Data Sheet
- Read the pre-lab introduction below

**Equipment needed**

- Lab notebook, pencil
- Oscilloscope (Agilent or Tektronics)
- 2 oscilloscope probes (already attached to the oscilloscope)
- BNC/EZ Hook test leads
- Tektronics 571 Curve Tracer
- PB-503 Proto-Board

**Parts needed**

- One Junction diode (e.g IN4003)
- Two Zenor Diode (e.g IN4733A)
- Several Resistors, Capacitors of varying sizes.

**Lab safety concerns**

- Make sure before you apply an input signal to a circuit, all connections are correct, and no shorted wires exist.
- Do not short the function generator signal and ground connections together
- Do not touch the circuit wiring while power is applied to it
- Ensure you connect the correct terminal of the transistor to prevent blowing the transistor

**1. Pre-Lab Introduction**

A bit of diode history:

The diode is one of the oldest and most important electronic devices, although it is not as famous as its cousin, the transistor. It is used in all sorts of electrical and electronic systems, the diode functions as a one-way valve for electric current, it only allows current to flow in one direction. This is useful in converting AC to DC, processing high frequency signals, regulating voltages, and in other applications. There are two basic types of diodes. One is an electron tube similar to the triode and the other type uses semiconductors, like the transistor. Both were invented early in the 20th century.

The first diode was a modified light bulb. Thomas Edison discovered that including an extra electrode in a light bulb and connecting it to the positive side of a battery resulted in a current flowing from the filament through the empty space. Joseph J. Thomson (1856~1940) announced the discovery of the electron in April 1897 and explained the Edison effect where current travels just one way through a vacuum tube. Thompson received a Nobel prize in 1906. Others found another use for this device. In the early 1900s, John Ambrose Fleming used this one-way electrical “valve,” to convert radio waves into a flow of current that could be measured by a galvanometer. The Fleming valve is remembered as the first true electronic device. It came into use for radio transmission and soon became the basis of Lee De Forest’s Audion electron tube, which he invented in 1906.

Also around 1906, American engineer Greenleaf W. Pickard invented a new type of diode. Pickard based his design on the earlier discovery that electricity can flow in only one direction through certain types of mineral crystals, such as silicon. By placing a silicon crystal between a metal base and a carefully placed fine wire, Pickard created a valve that could also be used to detect radio waves. This type of “cat’s whisker” diode (so-named because of the fine wire used in it) became more popular after American H. C. Dunwoody patented a version of it that used a material called carborundum

Today the variety of diodes and their uses have greatly expanded. Electron-tube diodes are rarely used, but silicon diodes are used in many types of equipment to detect high frequency electromagnetic waves, to convert sunlight into electricity, and many other purposes.

## 2. Pre-Lab Calculations

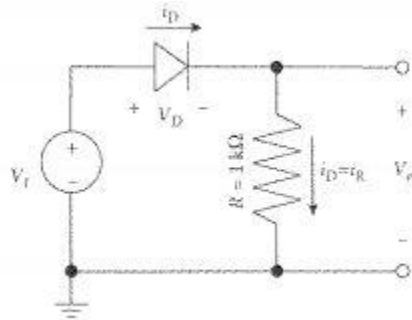


Figure 1: Circuit to characterize junction diode terminal characteristics

## 3. Circuit Construction and Signal Measurement

- Build the circuit shown above in Figure 1 using a diode provided by your teaching assistant and available resistors
- Read the Diode data sheet to identify which pins correspond to the positive and negative terminals.
- Simulate the circuit by varying input voltage from -3 to +3 in increments of 0.1V.
- For various input voltages measure the output voltage using a digital multimeter and current consumption indicated  $I_D$  indicated by the power supply.
- Generate a plot of  $I_D$  vs  $V_{in}$  and  $V_o$  vs  $V_{in}$ .
- In your lab notebook accurately graph the IV curve
- When all measurements are complete, turn the equipment off
- Disconnect the test leads from the circuit

## 4. Curve Tracer

- Use the Tektronics Curve tracer to verify the IV curve produced by the transistor
- The Teaching Assistant will verify the produced curve and sign your lab notebook

**Before leaving the lab, take a few minutes to clean up your workstation, and return all equipment to your cabinet.**

**5. Analysis**

Write a brief summary report for the lab. Be sure to also include the following topics:

1. Draw a Diode diagram and be sure to include the channel, body, gate, drain, source, etc.
2. Identify and explain the operating regions of the IV curve generated for the diode.
3. Compare and contrast the results of the hand computation, physical experiment and curve tracer output graph. Do the values generally agree? Explain possible reasons for any differences in the data.
4. Explain any difficulties you had with these labs. (Please include any suggestions to improve them).