Laboratory Goals

- Analyzing, simulating and building several rectifier circuits.
- In this lab, you will build rectifier circuit and capture input and output waveforms

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
- BNC/EZ Hook test leads
- Elvis Board.

Parts needed

- One Junction diodes (eg. In 4003)
- For Half-rectifier, R = 1K
- For Peak detector I: R= 1K, C=47 μF. For Peak detector II: R = 10K, C=47 μF

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

The circuits are plotted below. For figure 1(a) and 1(b), plot the waves you calculated.

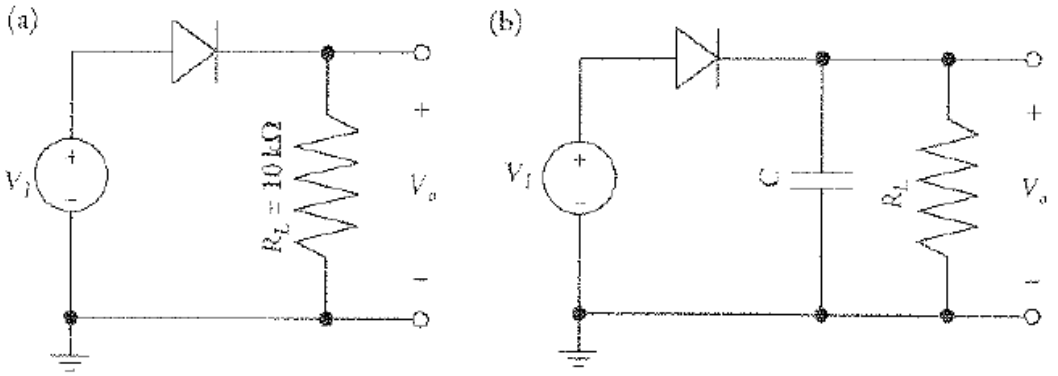

Figure 1: (a) Half-wave rectifier **(b) Peak rectifier/detector**

3. Circuit Construction and Simulation

- Build the circuit shown above in Figure 1 using a diode provided by your teaching assistant and capacitors and resistors.
- For Half-wave rectifier, consider figure 1(a), simulate the circuit using a 10-$V_{pk\text{-}pk}$ 1-kHz sinusoid generated by function generator, and a 1N4003 diode. Provide plot of V_I and V_o versus time.
- Consider the peak rectifier shown in Figure 1(b). Simulate the circuit using a 10-$V_{pk\text{-}pk}$ 1-kHz input sinusoid for two following sets of parameters. For both simulations, provide a plot of V_I and V_o versus time, and report the peak voltage (V_p) and the ripple voltage (V_r)
  - Peak detector I: Use R= 1K, C=47 μF, 1N4003 diode
  - Peak detector II: Use R = 10K, C=47 μF, 1N4003 diode
- For each circuit, assemble the circuit, apply the required waveform using a function generator, and capture the input and output voltage waveforms on an oscilloscope; for the peak rectifier, record the values of peak voltage (V_p) and the ripple voltage (V_r). Use the DMM meter measure the resistors.

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

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:

Using your measured resistor values, resimulate your circuits. How do the updated results compare with your simulations, and experiments? Explain any discrepancies.
What conclusions do you draw from the two different peak rectifiers?

Explain any difficulties you had with these labs. (Please include any suggestions to improve them).