

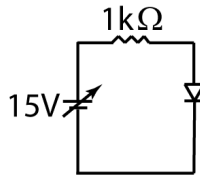
## Experiment 7 – Diodes: i-v Characteristic and Diode Clipping Circuit

### Physics 242 – Electronics

#### Introduction

A diode is composed of a p-n junction, a boundary between n-doped semiconductor (electron donating) and p-doped semiconductor (hole donating). The diode's nonlinear current-voltage characteristic makes it useful in many applications as a rectifier and voltage limiter.

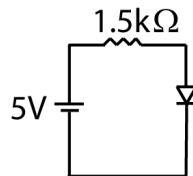
#### Procedure and Questions



1. Measure the resistance of a 1 k $\Omega$  resistor and then connect it in the circuit shown above. The adjustable 15 V source is the positive adjustable source on your breadboard. The white ring on your diode corresponds to the tip of the arrow of the diode circuit symbol (i.e. it marks the n-doped part of the diode).

Starting at zero, increase the voltage in small increments. Use your voltmeter to measure the voltage drop across the 1 k $\Omega$  resistor and across the diode (two separate measurements). Choose a series of voltages, with the voltage across the diode ranging from zero to around 0.7 V, and the current through the diode ranging from 0 to about 14 mA. You will not measure the current directly; rather, the current can be found by dividing the voltage across the 1 k $\Omega$  resistor by its resistance. Try to use small enough changes in the applied voltage that you measure approximately one data point for each milliamp increase in the current.

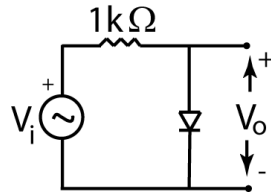
Record your data in a table.



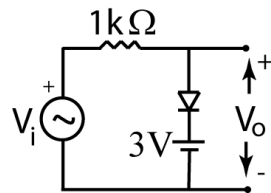
2. Measure the resistance of a 1.5 k $\Omega$  resistor, and then construct the circuit shown above. Use the 5 V fixed voltage source on your breadboard. Measure the voltage of the voltage source, the voltage drop across the 1.5 k $\Omega$  resistor, and the voltage drop across the diode.

Plot  $i$  vs.  $v$  (diode current vs. diode voltage) using your data from Procedure 1. Then plot a load line on the same plot, using the data from Procedure 2. Determine the voltage of the intersection point of your load line and the diode i-v curve. Compare with your measured value of the diode voltage in Procedure 2, and calculate the percent difference between the measured diode voltage

and the diode voltage determined from the load-line plot. The load line can be conveniently plotted using Mathematica—see the sample code included at the end of these instructions.



3. Build the diode clipper circuit shown above. You do not have to measure the  $1\text{ k}\Omega$  resistor. Use your function generator to provide a  $1\text{ kHz}$  sine wave with an amplitude of  $2\text{ V}$  as the input. Measure the output voltage  $V_o$  as shown in the figure, using the 'scope. Sketch the input waveform and the output waveform  $V_o$  (show the voltage scale on your sketch, indicating the maximum positive and negative signal voltages).



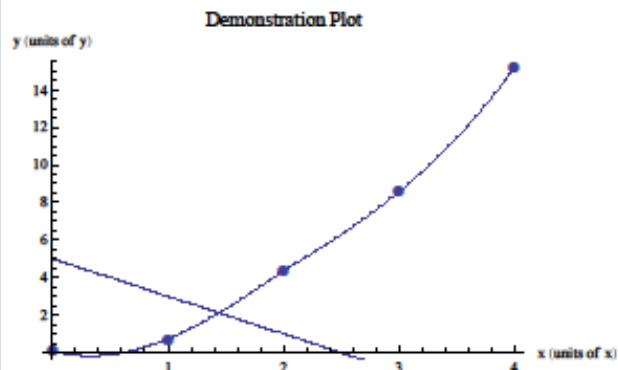
4. This part is theoretical—you do not need to build the circuit. Suppose the circuit shown above was assembled with  $V_i = 5 \sin \omega t$ . Predict the output waveform and sketch your prediction, indicating the maximum positive and negative signal voltages.

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(* Sample code to fit an Interpolating Function to data, and then
plot and find the intersection of the Interpolating Function with a given line. *)

dataset = {
  {0, .1},
  {1, .75},
  {2, 4.4},
  {3, 8.6},
  {4, 15.2}
};

plot1 = ListPlot[dataset, PlotMarkers -> {Automatic, 10}];
ifun = Interpolation[dataset];
plot2 = Plot[ifun[x], {x, 0, 4}];
givenline[x_] = 5 - 2 x;
plot3 = Plot[givenline[x], {x, 0, 4}];
Show[plot1, plot2, plot3,
  AxesLabel -> {"x (units of x)", "y (units of y)"}, PlotLabel -> "Demonstration Plot"]

(* From the plot, we see the the intersection is near x=1.5,
so use that value at the initial guess for the FindRoot function. *)
FindRoot[givenline[x] == ifun[x], {x, 1.5}]
```



$(x \rightarrow 1.438)$