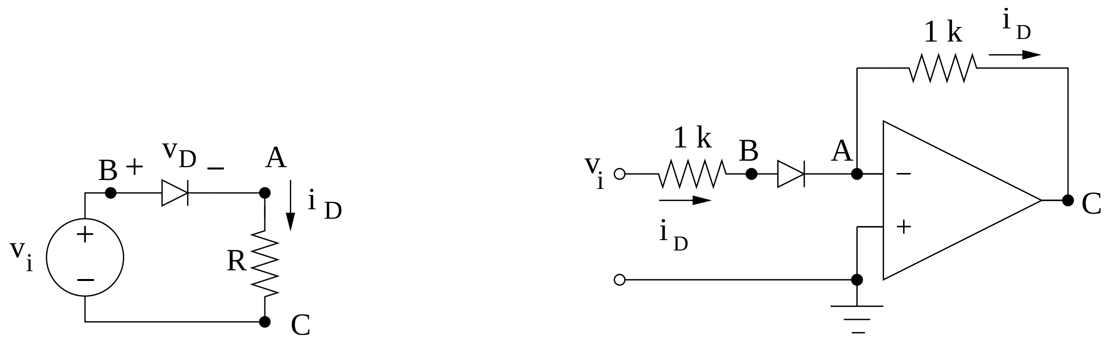
University of California, San Diego
Department of Electrical and Computer Engineering

ECE65, Fall 2010

Lab 2: Diode iv Characteristics, Zener Diode

Experiment 1: General Purpose diode iv Characteristics

This simulation shows how to measure iv characteristics of a diode. The circuit is made of an 1N4148 diode and $R = 1$ kΩ.



(a) (b)

Pspice Simulation: Simulate circuit (a) above with v_i being a 1-kHz triangular wave with a peak to peak value of 15 V and a DC offset of −5 V (*i.e.,* input signal ranges from −10 to +5 V. Runs the simulation for a few periods.

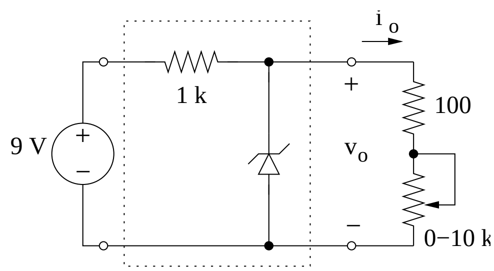
Plot i_D vs v_D. On your plot, identify forward-bias and reverse-bias regions.

Lab Exercise: It turns out that we cannot use the simple circuit above to measure the iv characteristics of the diode in the lab and we need a more complicated circuit: Build the circuit (b) above with a 741 OpAmp chip. The chip should be powered with ±15 V supplies. Set the function generator to produce a triangular wave with a frequency of 1 kHz and DC off set of zero. Set the amplitude to be zero. Attach the function generator to the circuit (v_i). Attach the scope ground to the non-inverting terminal of the OpAmp which is grounded (because of the "virtual short" principle of OpAmps, inverting and non-inverting terminals have the same voltage and, thus, point A is effectivelt grounded). Attach Channel 1 probe to point B (so Channel 1 reads v_D) and channel 2 probe to point C (which will read $10^3 i_D$). Set the scope of show (x vs y). Set both channels to 1 V/division. Scope should show one point. Move the point such that it is at the lowest, right-most voltage division marks on the scope. Slowly increase the amplitude of the input. The scope shows the $i - v$ characteristics of the diode. Increase the amplitude of input wave until the the diode iv curves "fills" the scope display. Print out the scope output and mark and label the axis.

Explain why we could not use circuit (a) to the show the iv characteristics of the diode on the scope (corresponding points A,B, and C are shown).

Experiment 2: Zener Diode Power Supply

Set up the circuit below with a 1N5232B Zener diode ($V_Z = 5.6$ V). In this circuit, the 9-V supply represents the "unregulated voltage." The elements in the box (1 kΩ resistor and the Zener diode) form the regulator circuit. The combination of the variable resistor (potentiometer) and 100 Ω resistor, represents the "load" in this circuit (call their combination R_L). With varying the resistance of the potentiometer, we can draw different amount of current from the regulator circuit. What is the purpose of the 100 Ω resistor?



Circuit Analysis: Using a "Constant voltage" model for the Zener region, calculate the output voltage of the regulator (v_o) as a function of its output current (i_o). Estimate the maximum load current for the circuit to act as a voltage regulator.

PSpice Simulation: Simulate the circuit with PSpice with R_L (combination of the potentiometer and 100 Ω resistor) as a parameter with a range of 100 Ω to 10 kΩ (do NOT include the 100 Ω resistor in your simulation!). Plot v_o versus i_o and compare with your analytical results.

Lab Exercise: Assemble the circuit. Start with the potentiometer set at maximum resistance (*i.e.,* about 10 kΩ). Measure the load current and the load voltage. Then, vary the potentiometer resistance and measure the load voltage for a range of load currents. Plot v_o, versus i_o. Compare with your circuit analysis and PSpice simulation and explain the results (specially the observed slight drop in v_o when i_o is increased).