UNIVERSITY OF CALIFORNIA, BERKELEY
EE40: Introduction to Microelectronic Circuits

Diodes Background

Overview – The Ideal Diode

An ideal diode allows current to flow in only one direction. Every diode has a characteristic "threshold voltage" – V_T. An ideal diode has an infinite resistance when the voltage across it, V_D, is less than V_T and zero resistance when the V_D is greater than V_T. The threshold voltage concept comes from the fact that a diode is just a *pn* junction; the threshold voltage is defined by the concentration of donors and acceptors in the junction. The I-V graph for an ideal diode should look like:

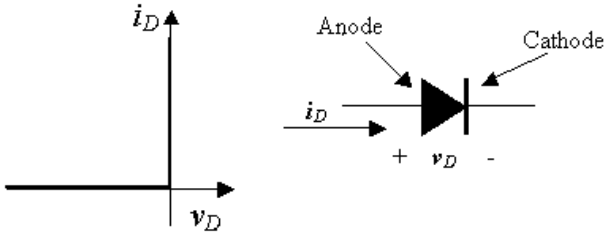

Figure 1 Ideal Diode IV Curve and Schematic

Real diodes do not exhibit this ideal behavior. This lab will explore the actual behavior of diodes.

Diode Logic

Diode logic (DL) is a family of logic circuits that perform logic operations based on the ability of the diode to conduct current in only one direction, under forward bias. Figure 2 contains the schematics for OR and AND gates implemented in DL. V_{CC} is a voltage source that defines the HI logic level, which should be greater than the inherent diode voltage drop. The logic level LO is defined by 0 volts, or "ground". In the OR circuit, the output C is raised HI whenever either A or B are HI. In the AND circuit, output C is LO whenever either A or B are LO.

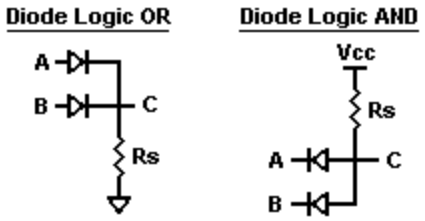

Figure 2 OR, AND gates in Diode Logic

Half-Wave Rectifier

The half-wave rectifier is a circuit that allows only part of a sinusoidal input signal to pass. The circuit is simply the combination of a single diode in series with a resistor, where the resistor is acting as a load (see figure 3).

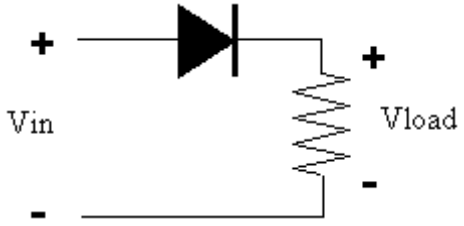

Figure 3 Half-Wave Rectifier Schematic

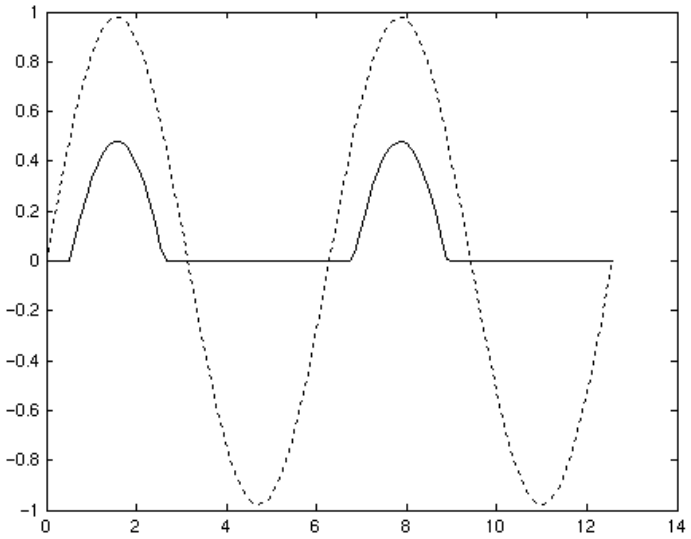

Figure 4 Half-Wave Rectifier, Voltage vs Time

When the input voltage is less than the threshold voltage, the output voltage is 0. This is because when input voltage is less than the threshold voltage (and thus the voltage across the diode is less than the threshold voltage), zero current flows through the diode. By KCL, no current flows through the load resistor resulting in no voltage drop via ohm's law.

If, on the other hand, the input voltage greater than the threshold voltage, essentially any current can pass through the diode (real diodes only approximate this vertical line). The voltage drop across the diode will just be its threshold voltage and the current through it will be defined by the load.

Name:_____
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Date:_____

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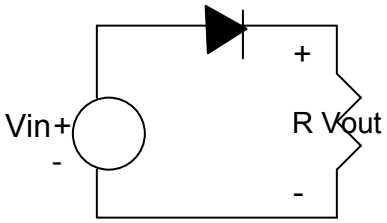
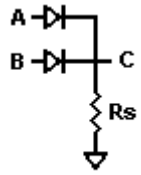
Diodes Prelab

1. Suppose V_{in} is a sine wave that has amplitude voltage V_a, frequency f, and offset = 0V. Suppose the threshold voltage of the diode is V_T = 500mV. Describe and draw what you will see at the output. Make sure to include the amplitude, frequency, and offset in terms of the input and V_T.

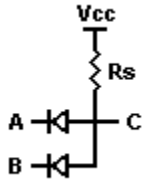


2. Explain where the threshold voltage of a diode comes from and how you will measure the threshold voltage of a diode using the half-wave rectifier circuit.

3. Provide the truth table (include output voltage) and identify the logic function of the following circuits. A, B are the inputs and C is the output. Assume large signal diode model.



Logic X



Logic Y

4. Load Line: The I-V characteristics of a diode are plotted on the graph. Find the circuit current I' and diode voltage V' using the load line method.