EE 2274
DIODE OR GATE & CLIPPING CIRCUIT

The Diode is an active component that when a Voltage above 0.5 to 0.7 volts across the diode it will conduct current. The diode will act as low resistance when it is forward biased. When the voltage applied is reversed the diode will have a high impedance and block the flow of current.

Prelab: To be completed before class.
Part I: Wired **Diode OR Gate LTspice use 1N4002**

1. Design a diode OR gate, Figure 1 in which the maximum current thru R1 I_{R1} = 9mA assume Vin = 5Vdc. Design the R1 resistor with a single diode on such that the current thru the diode is 9ma assume the forward diode voltage drop V_D = 0.6 Vdc. Show all work including the **LTspice schematic and plots.**
   a. Use two 1N4002 diodes.
      Remember to place on the schematic (.LIB 1N4002.sub) for LTspice.
   b. Verify your design using LTspice Vin A = 5Vdc and Vin B = 0vdc, use a diode 1N4002 and the closes standard resistor value for R1. Include LTspice schematic.
   c. Plot the voltage transfer function (DC Sweep) by varying the input voltage on Pin A while holding the voltage at Pin B to 0V .
   d. Assume the Vin A sweeps from 0V to 5V. Turn in the plot of current thru R1.
   e. Verify that the maximum current thru diode is within specification from LTspice.

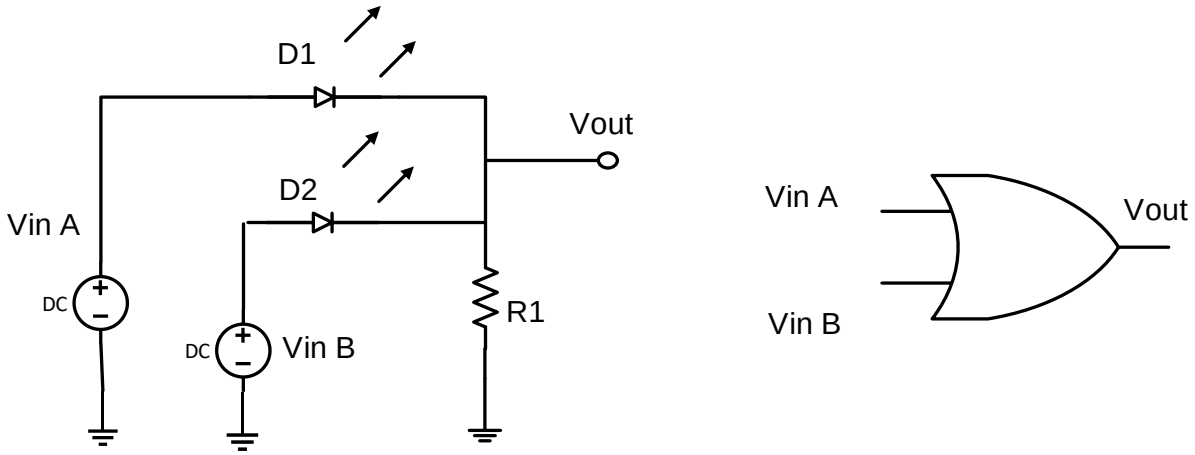


FIGURE 1

2. Simulate the circuit again after substituting D1N914 diodes for the 1N4002 diodes.
   LTspice schematic and plots
   a. Plot the voltage transfer function by sweeping the input voltage from 0v to 5v on Pin A while holding the voltage at Pin B to 0V.
   b. Determine the maximum diode current from a plot of current thru R1.

Part II: Prelab Clipping Circuit (use 1N4002 diodes)

Given the circuit in Figure 2, **sketch by hand** (do not use LTspice) the input v_{in} and output v_{out} signals expected. Assume diode forward voltage drop is 0.6V.

1. v_{in} = 8 V_{pp}, 5 kHz sine + 2 V DC offset.

2. v_{in} = 8 V_{pp}, 5 kHz sine – 2 V DC offset.

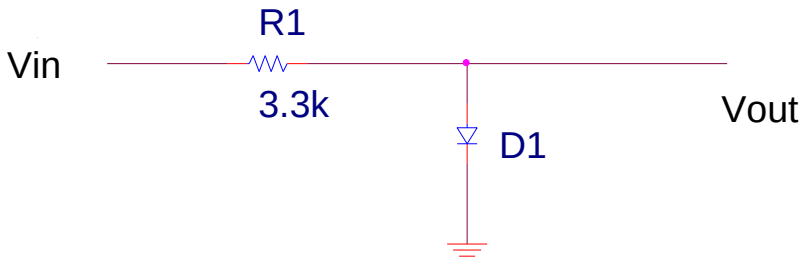


FIGURE 2

Given the circuit in Figure 3, **sketch by hand** (do not use LTspice) the input v_i and output v_o signals expected. Assume diode forward voltage drop is 0.6V.

3 v_{in} = 8 V_{pp}, 5 kHz sine + 2 V DC offset.

4. v_{in} = 8 V_{pp}, 5 kHz sine – 2 V DC offset.

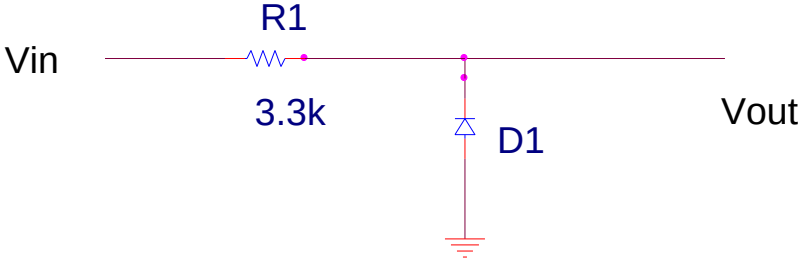


FIGURE 3

5. Design a clipping circuit as shown below, Figure 4, so that the waveform will be clipped at +2V and –3V. Use R1 = 3.3kΩ, C1 = 0.1uF, 1N4002 diodes for D1, and D2. Show all work. Verify your design using **LTspice include schematic** and plot of Vin and Vout. Vin = $6V_{peak}$, 5kHz sinewave for plot 2 to 5 cycles. Assume diode forward voltage drop is 0.6V.

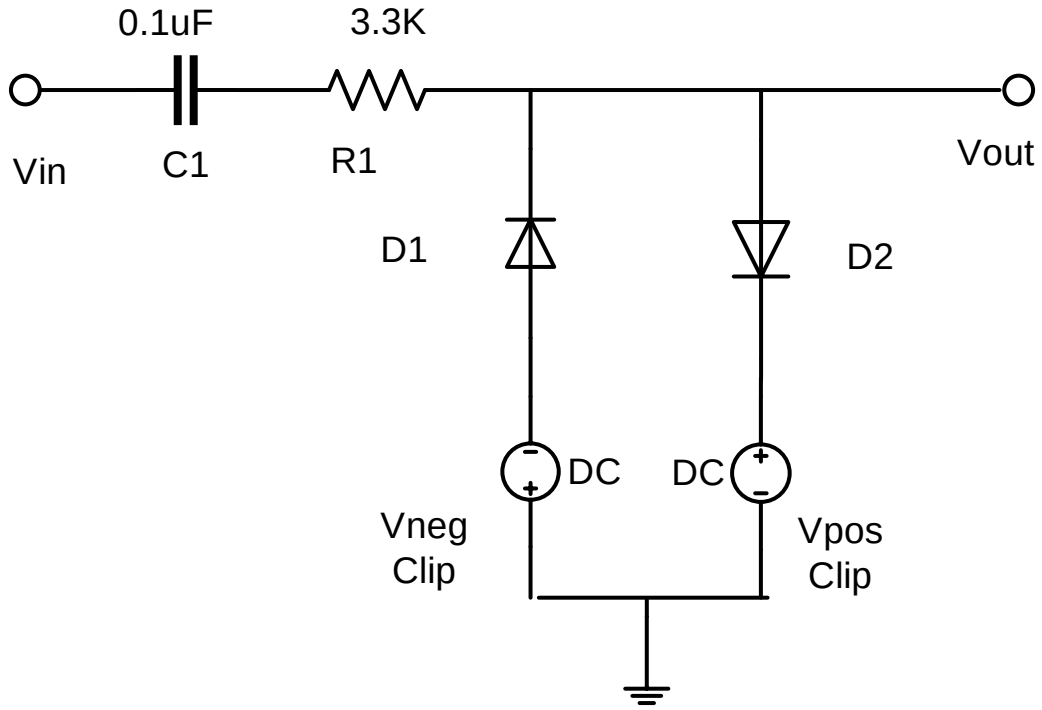


FIGURE 4

R = 3.3k, D1,D2 = 1N4002
Your design:
Vneg = _____
Vpos = _____

Why might the circuit not clip at exactly -3V and +2V?

Prelab work sheet

CRN# _____ Date:_____ Bench: _____

Name: _____ Instructor: _____

Part I: Diode OR Gate(use 1N4002 diodes)

1. Assume a voltage drop of 0.6V across the diode and Vin = 5Vdc. Maximum current allowed through resistor is about 9 mA. Solve for value of R1.

R1=_____ For 1N4002 I_{max} from LTspice =_____

2. For 1N914 I_{max} from LTspice =_____

Part II : Clipping Circuit (use 1N4002 diodes)

Given the circuit in Figure 2 , **sketch by hand** (do not use LTspice) the input v_{in} and output v_{out} signals expected if

1. v_{in} = 8 V_{pp}, 5 kHz sine + 2 V DC offset.
   v_{out} = _____ when $v_i \geq 0.7V$
   v_{out} = _____ when $-0.7V < v_i < 0.7V$
   v_{out} = _____ when $v_i \leq -0.7V$

2. Repeat part 1 with v_{in} = 8 V_{pp}, 5 kHz sine – 2 V DC offset.
   v_{out} = _____ when $v_i \geq 0.7V$
   v_{out} = _____ when -0.7V <vi < 0.7V
   v_{out} = _____ when $v_i \leq -0.7V$

Given the circuit in Figure 3, **sketch by hand** (do not use LTspice) the input v_i and output v_o signals expected if

3. v_{in} = 8 V_{pp}, 5 kHz sine + 2 V DC offset

v_{out} = _____ when $v_i \geq 0.7V$

v_{out} = _____ when $-0.7V < v_i < 0.7V$

v_{out} = _____ when $v_i \leq -0.7V$

4. Repeat part 3 with v_i = 8 V_{pp}, 5 kHz sine – 2 V DC offset.

v_{out} = _____ when $v_i \geq 0.7V$

v_{out} = _____ when $-0.7V < v_i < 0.7V$

v_{out} = _____ when $v_i \leq -0.7V$

5. Verify figure 4 results with LTspice. Turn in with Pre-Lab
R1 = 3.3k, C1 = 0.1uF, D1,D2 = 1N4002
Your design:

Vneg = _____

Vpos = _____

Why might the circuit not clip at exactly -3V and +2V?

Required Graphs
1. Part I 1.b LTspice schematic
2. LTspice DC sweep of diode 'or' circuit with 1N4002. LTspice schematic
3. LTspice DC sweep of diode 'or' circuit with 1N914. LTspice schematic
4. Sketch of Part II.1
5. Sketch of Part II.2
6. Sketch of Part II.3
7. Sketch of Part II.4
8. Part II.5 LTspice Transient of -3V and 2V clipping circuit figure 4. LTspice schematic

LAB EXERCISE
DIODE GATE AND CLIPPING CIRCUIT

Part I. Diode OR GATE:

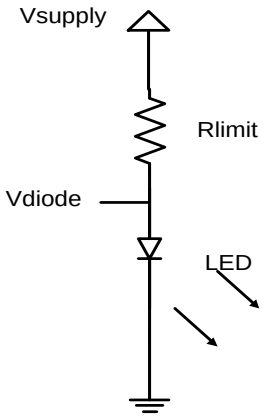
1a. Build an OR gate (Figure 1) using 1N4001 diodes on LTspice.
Fill in the function table in the lab datasheet.

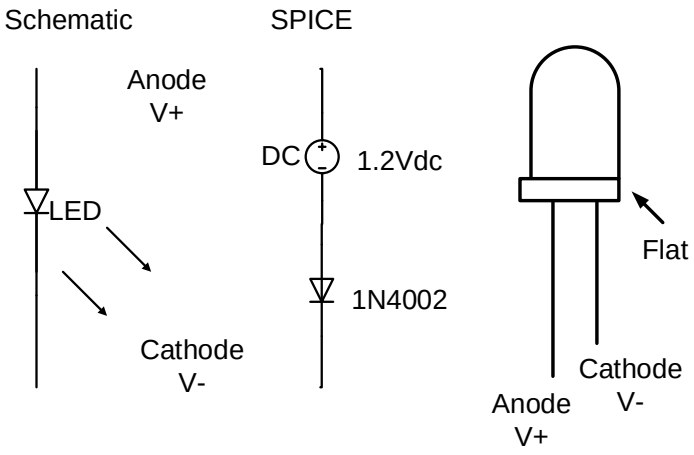
1b. Run the DC Sweep and determine the maximum output voltage Vout.

Red LED

2a. Build the circuit below on LTspice. Right click on the diode and choose "Pick new diode." You can change the diode model to LED (you can pick the LED from Fairchild, QTLP690C). Run a DC Sweep for the voltage source from 0 to 5V. Use a 270 Ohm resistor for Rlimit and plot the current through the LED and voltage across the resistor Rlimit on the same plot.

At what Vdiode (voltage across the diode) does the Red LED begin to conduct? What is the Vdiode if the current in the circuit is 9mA? Measure V_{diode} when the supply is the V_{supply} = 5Vdc.





2b. Now change the Rlimit to 0.5 Ohms and plot the current through the LED to get the IV characteristic curve. Right click on the y axis of your plot and on the vertical axis

window change the maximum to 10mA and ticks to 1mA. Determine V_{diode} at the maximum current of your design from the graph. Include your plot with the report. Compare with your results of your DC sweep plot.

Part II. Clipping Circuits: **(use 1N4001 diodes)**

1. Build the clipping circuit Figure 2 of the pre-lab on LTspice with an 1kHz $8V_{PP}$ sinewave input with an offset of 2V. Plot the input and output voltage waveforms.

2. Change the offset of the Vin to -2v and plot the Vin and Vout waveforms.

3. Change the direction of the diode Figure 3 change the offset to 2V and plot the input output waveforms.

4. Change the offset to -2V and repeat.

5. Now that you know the voltage drop across the diodes that you are using in prelab, design your circuit (Figure 4 from prelab) so that the source is a 5kHz 12Vpp square wave that after clipping is approximately a 0 to 4V square wave. Build your circuit on LTspice and plot the input and output waveforms. Include the LTspice plots and schematics in the report.

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DATA SHEET CRN# _____ Date:_____
Name: _____

DIODE GATE & CLIPPING CIRCUIT

PART I. (use 1N4001)
Diode Gate figure 1
1a. Fill in the function table.

Vb	Va	Vout
0Vdc	0Vdc	
0Vdc	5Vdc	
5Vdc	0Vdc	
5Vdc	5Vdc	

1b. Maximum output voltage Vout from DC Sweep in LTspice _____.

Red LED
2a. DC sweep of Red LED and resistor (Rlimit = 270Ω).
At what Vdiode does the LED begin to conduct? _____
What is the Vdiode if the current is 9mA from plot? _____
Vdiode = Vsupply - VRlimt

2b. From the IV characteristic plot determine the V_{diode} when the current is 9mA.

V_{diode} = _____

Any difference from the results from DC Sweep? Why?

PART II. Clipping Circuits (use 1N4001 diodes)

1-4. Compare the differences in circuit behavior between having a forward and reverse-biased diode, include input (Vin) plot 2 to 5 cycles and output (Vout) plot to turn in with lab.

5. Turn in waveform.

Vpos = _____.
Vneg = _____.

a. Does the circuit clip at exactly 0V and +4V? _____

Why would there be differences between the LTspice simulation results and the real-life results?

b. turn in waveform plot 2 to 5 cycles.

Required Graphs and schematics from LTspice

1. LTspice schematic of LED circuit
2. DC Sweep plot of LED circuit
3. LTspice schematic of LED IV characteristic
4. IV characteristic plot of LED circuit
5. 4 plots showing the Input and output waveforms from LTspice for the diode clipping schematics
6. LTspice schematic of designed circuit with 0V and 4V clipping
7. Input and output waveform showing 0V and 4V clipping