ELEN 115 Lab 4: Diode Basics
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Thursday, 2:15 Section
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Objective:

For lab 4, students were introduced to the basic mechanics of diodes, LEDs, and diode clamp systems. Students were given a specific diode, 1N4148, on which they ran a number of tests. Tests run include measuring the current of the diode, creating a Piecewise-Linear (PWL) representation of the given diode and comparing its iv curve to that of the original 1N4148 device. Students also worked with LEDs, taking various measurements across the device and creating a power-efficient system with which to power the LED. Finally, students used several diodes to create a diode clamp, which acted as a voltage regulator.

Procedure:

For part 1 of the lab, students were given the 1N4148 diode and tasked with connecting it to a power supply. After doing so, students measured the iv curve of the diode, showing an activation voltage of about 800mV.

For part 2, students created a PWL representation of the previous diode, although an ideal substitute was used instead of the original diode itself. With this model created, students were able to match the iv curve of the PWL device to that of the original diode to some degree, though further adjustments to the device increased the PWL's accuracy significantly.

For part 3, students were given a light-emitting diode (LED) and tasked with powering the device while having a total power consumption of less-than 200mW. Students were eventually able to power the LED with a total power dissipation of ~118mW, or 59% of the given power limit. Students also found the operating point of the diode to be ~23mA, which was quite-close to the calculated value determined before the lab.

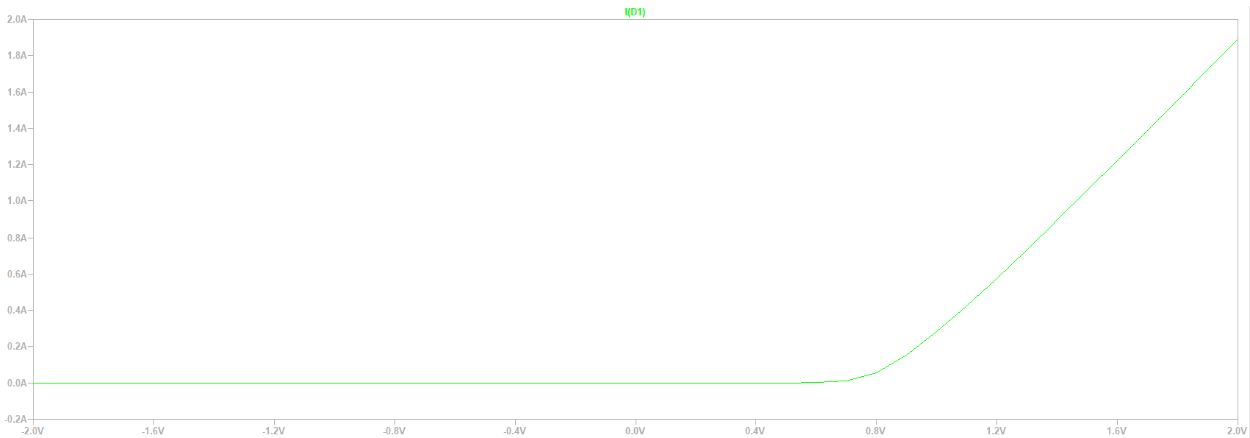
For part 4, students were given a prototype diode clamp circuit and tasked with testing the device under different conditions. Without the clamps in place, students discovered that the output voltage would briefly "spike" significantly above the 3V limit before returning to the expected value. Students then created an ideal diode clamp to regulate the voltage. While an ideal diode isn't particularly realistic, it kept the voltage from going above the clamp-imposed limit, which in this case was 2.5 volts. Finally, students used realistic diodes for clamping and got results in-between the first 2. The diode clamp was able to significantly-reduce the voltage spikes, though it was unable to *completely* eliminate all spikes.

Results:

Lab 4 checkpoints and questions

Checkpoint 1

Part 1: 1N4148 diode iv curve

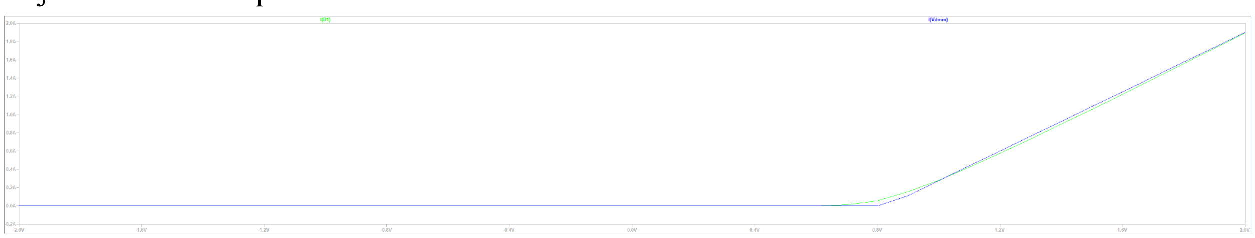


Our diode seems to turn on around 800mV, resulting in a sharp increase in current through the device.

Checkpoint 2

Part 2: diode PWL model iv curve overlayed with 1N4148 diode iv curve

Adjust PWL model parameters to match the two diodes



With the diode of our PWL set to ~.6 ohms and ~.8 volts, we were able to get the above graph.

Questions:

Is the PWL model (0.7V, 5 Ohm) a good representation of the actual 1N4148 diode? Explain your answer.

Adjusted PWL parameters to match 1N4148

The PWL model at .7 volts and 5 Ohms is not a particularly-accurate representation of the 1N4148 diode, as the iv curves of the two devices differ significantly from .8 volts and onwards. When our model is adjusted to .6 ohms and .8 volts, our PWL simulation becomes much more accurate, though small variations beyond 800mV are still present.

Checkpoint 3

LED circuit simulation: LED has enough current to turn on; total power consumption < 200 mW

Questions:

Is the operating point similar to the one you found in prelab? Explain why or why not.

Yes, the operating point was quite-similar to the one found in the prelab, our simulated value of 23.68 mA was less-than 4 mA off our calculated value of 20 mA.

What is the power dissipated in this circuit? Did you meet the specifications?

Our total power dissipation in this circuit was 118.2 mW, which meets the specifications.

What is the power dissipated in the LED? Does it meet the ratings?

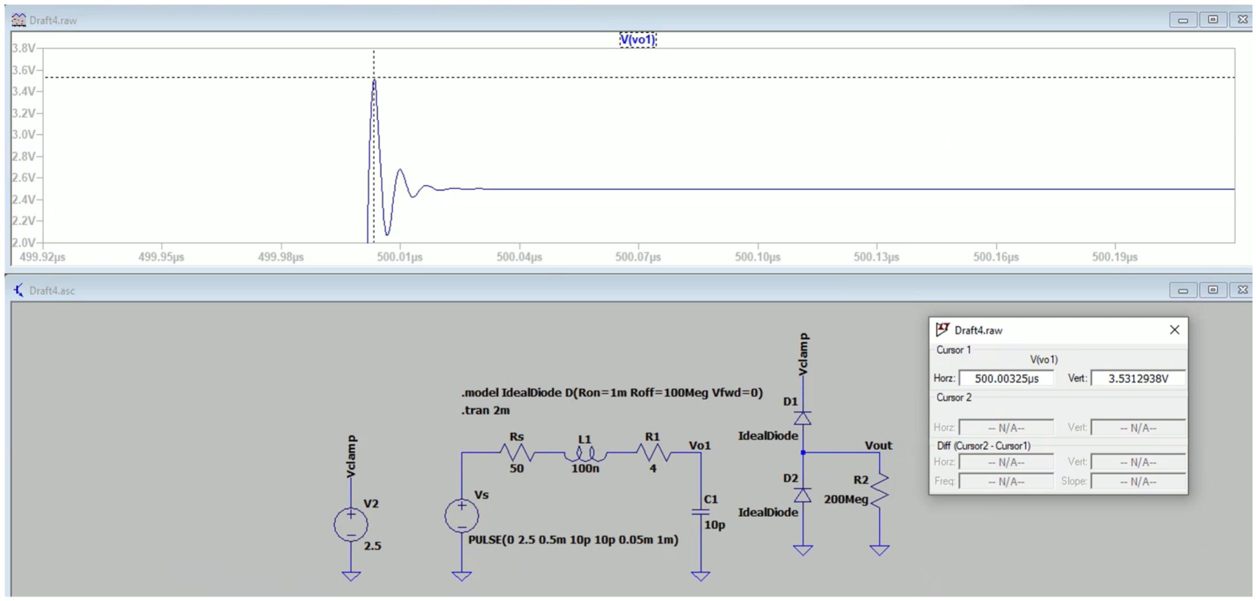
The LED itself dissipated 79.07 mW of power, which meets our rating.

Checkpoint 4

Show the clamping function functioning correctly. Three scenarios: no clamping, ideal diode clamping, real diode clamping.

Questions:

No clamping: plot the input and output on one plot and explain the output signal you observe.

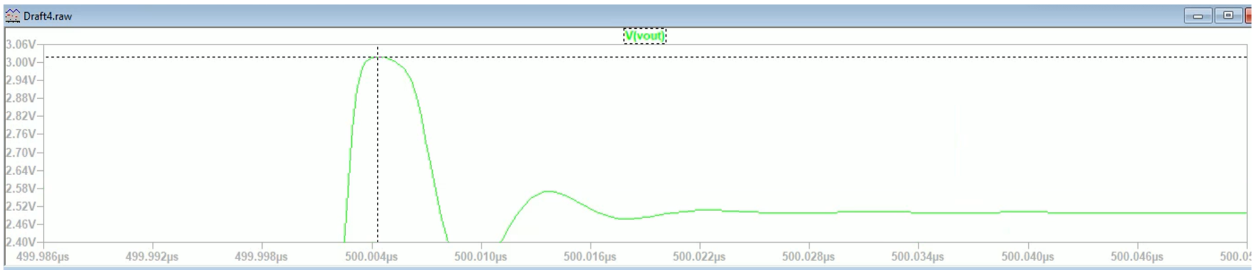


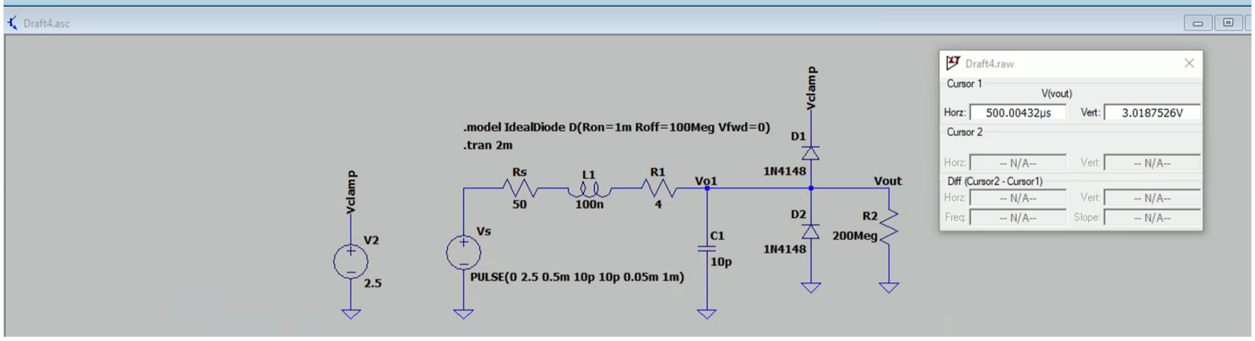
Without the clamps, our Vout goes (for a short amount of time) significantly above 3V, while our input alternates continuously.

Place the ideal diodes you have made as clamps as is in Figure 2(b) and plot the result on the same plot. Explain the result of this clamping action.

With our clamps in place, our Vout does not go above 2.5 volts, since our clamp is set for a maximum of 2.5 volts. Thus, our input and output voltages are equal.

Replace the ideal diodes by the real diodes (1N4148) and plot the result on the same plot. Explain the result of this clamping action. Is the voltage range that the clamp function appropriate?





Since these diodes are not ideal, they seem to cause both the input and output voltages to spike above 2.5 volts, though are able to keep such voltages at a significantly-lower value than having no clamp at all.

If a diode is chosen with a forward drop of 0.2V will that improve the clamp performance?

In real life there is no such thing as an ideal diode. A diode with a forward drop of 0.2V is known as a schottky diode which will give us the best possible output, since there is no ideal diode.

Conclusion:

Not only did this lab familiarize students with the mechanics and applications of diodes in electric circuits, it also gave students experience in practical circuit design, namely with designing an efficient way of powering an LED. Students were also familiarized with diode clamping and voltage regulation, a crucial tool of circuit design.