Lab 10: Diodes and Transistors using LTSspice

Getting started with LTspice

Hello again!! I hope you are healthy and safe! :) If you have already installed LTspice and learned how to work with it, ignore this section and move on to the next.

LTspice is a very cool and simple software to use for simulating circuits. Please download the software from:
https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html?gclid=EAIaIQobChMIsqGC6r-h4AIVSbjACh0y5QOmEAAYASAAEgLz4_D_BwE
LTspice could be slightly different for Mac and Windows users. Therefore, we provide two video links, the first one for Mac users and the second one for Windows users. They are very similar though.
1. https://www.youtube.com/watch?v=6AA4YBtqhwE (Mac users)
2. https://www.youtube.com/watch?v=JRcyHuyb1V0&t=19s (Windows users)
And a small written tutorial could be found here:
https://eecs.oregonstate.edu/education/docs/tutorials/LTSpiceIntro.pdf

Please create a report and include all the steps explained in each experiment.
Note: the values used in the experiments below, might be different from what have been used in lab11 handout in the website.

Lab 10: Diodes and Transistors

Voltage follower: (5pts)

Please read lab 11 handout.
1. Run the Lab11_Voltage_Follower.asc in LTspice, which mimics the voltage follower circuit in Fig. 1. You need to have both LM324.ti.lib and Lab11_Voltage_Follower.asc in the same directory to be able to see the results.
2. Make a plot of Va (the signal from the function generator) and V_b (the at the negative gate). Attach the plots to your report. (4pts)
3. Are Va and V_b similar or different? (1pts)

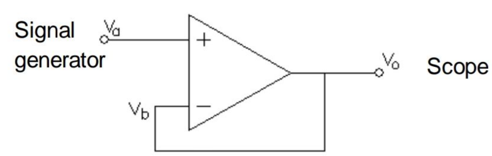

Fig. 1. Voltage follower schematic.

Noninverting amplifier: (10pts)

Please read lab 11 handout for this part.
1. Draw a noninverting amplifier based on Fig. 2 in LTspice. You may use the Lab11_Voltage_Follower.asc and add resistors to it to create a noninverting amp. Attach the picture of your LTspice circuit to your report. (5pts)
2. What is the amplitude of Va and Vb? Are they the same or different? (3pts)
3. What is the gain (Vo /Vin)? (2pts)

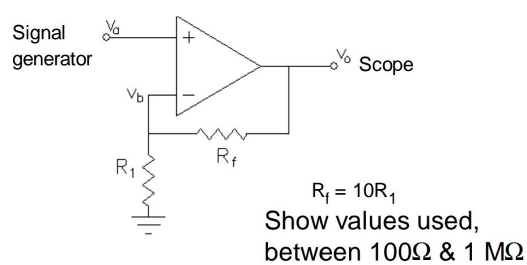

Fig. 2. Noninverting amplifier schematic.

Clipping (10pts)

Please read lab 11 handout for this part.

1. Turn up the amplitude of the signal generator until the output is clipped.
2. Attach the plot of the clipped waveform to your report. (5pts)
3. Measure the maximum positive and maximum negative voltages available from the op-amp (the clipping levels, also called the "rail" voltages). Check the two op-amp inputs. Notice that the two inputs are not the same anymore and that whenever they are noticeably different, the output is at either its positive or negative limit. Attach the plot of these two waveforms (the two op-amp inputs inputs) to your report. (5pts)

Slewing (5pts)

Please read lab 11 handout for this part.

1. Turn up the input frequency of the signal generator until the output is slewed.
2. Attach the plot of the slewed waveform to your report. (4pts)
3. What happens if you turn down the amplitude? (1pts)

Inverting amplifier: (10pts)

Please read lab 11 handout for this part.

1. Draw an inverting amplifier based on Fig. 3 in LTspice. Attach the picture of your LTspice circuit to your report. (5pts)

2. What is the relationship between the input and output? (2pts)

3. Record Vin, Vout, and the gain relationship with the ratio of the chosen resistors. (3pts)

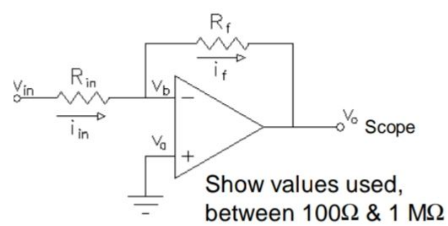

Fig. 3. Inverting amplifier schematic.

One More Op-amp Circuit(10pts)

Draw another one of the circuits discussed in the Operational Amplifiers handout (any one you want). If you make the summer, make it with just two inputs and either use the "+5V" output of the DC supply as your second input or check-out a second signal generator. If you make the differentiator, I suggest C = 0.22 μF (224) capacitor R_{in} = 10 k. If you make the integrator, I suggest C = 0.22 μF (224) capacitor R_{in} = 1 k and R_f = 100 k.

1. Attach the picture of your circuit to your reports, which also includes the part values. (5pts)
2. Devise tests which will measure the important properties of your circuits. (Does the circuit do what it should do and is the output the right amplitude for the given input?) Compare your measurements to calculated expectations. (5pts)

Conclusion (5pts)

Write a normal conclusion in your notebook. Comment on how some of these circuits might be used. You may not be able to see how they could *all* be used, but I expect you to be able to describe uses for at least a couple of them.

Total score: 55 points