West Virginia University LCSEE

EE 355L

Spring 2023

Section: 001

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Lab 2: LTSpice and Intro to Amplifier

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Objective

The objective of this lab is to get familiar with ideal operational amplifiers. An ideal operational amplifier is such that it has an infinite gain, infinite input impedance and no output impedance. Generally amplifiers are used to amplify a signal by a gain factor.

Procedure

Part 1: A simple ideal op amp is simulated using the e component in LTSpice. The open loop gain value is set to 100. The inverting input is grounded and the non inverting input is connected to a voltage source with a sine wave with peak voltage of 10mV with frequency 1000 Hz. The output voltage is taken with respect to ground.

Part 2: An ideal op amp is simulated again, but in this circuit negative feedback is added. The circuit is set up similarly for the non-inverting input but the inverting input is connected to the feedback network which is connected to the output. The feedback network contains Rf= 5k ohms and Ri=25.13 ohms which is then grounded. This circuit is also called a non inverting amplifier.

Calculation

Part 1: No calculations for this part.

Part 2: Using the open loop gain value, and the formula for non inverting amplifier, values of Rf and Ri are chosen such that the overall gain is a factor of 200. The formula (A=1+(Rf/Ri)) is used. Here the open loop gain value is 10,000.

Circuit Diagram(s)

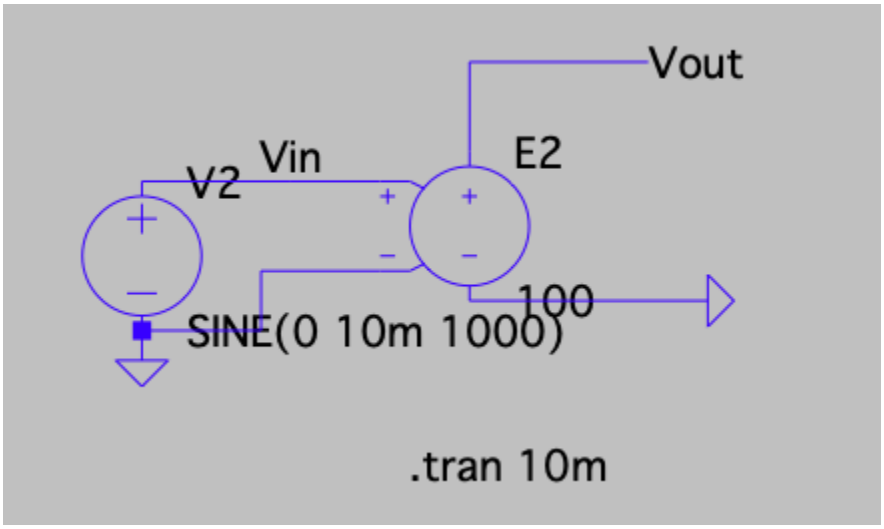

Figure 1: Part 1 Circuit

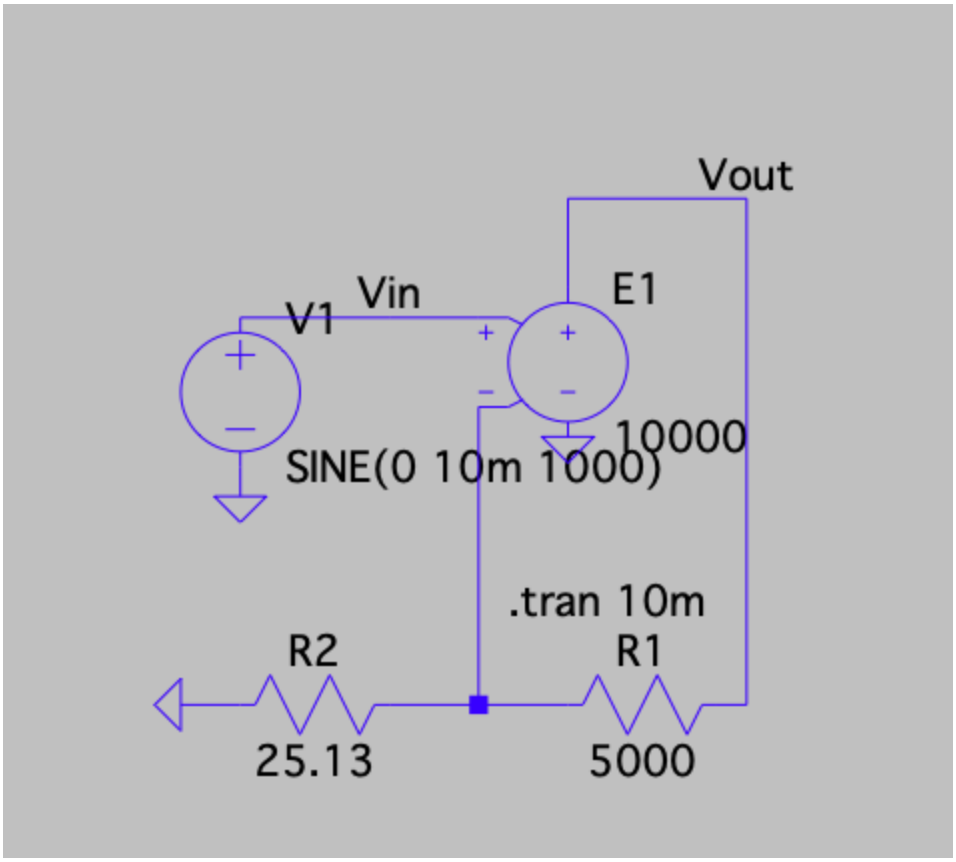

Figure 2: Part 2 Circuit

Results & Discussion (Values, Graph & Wave forms)

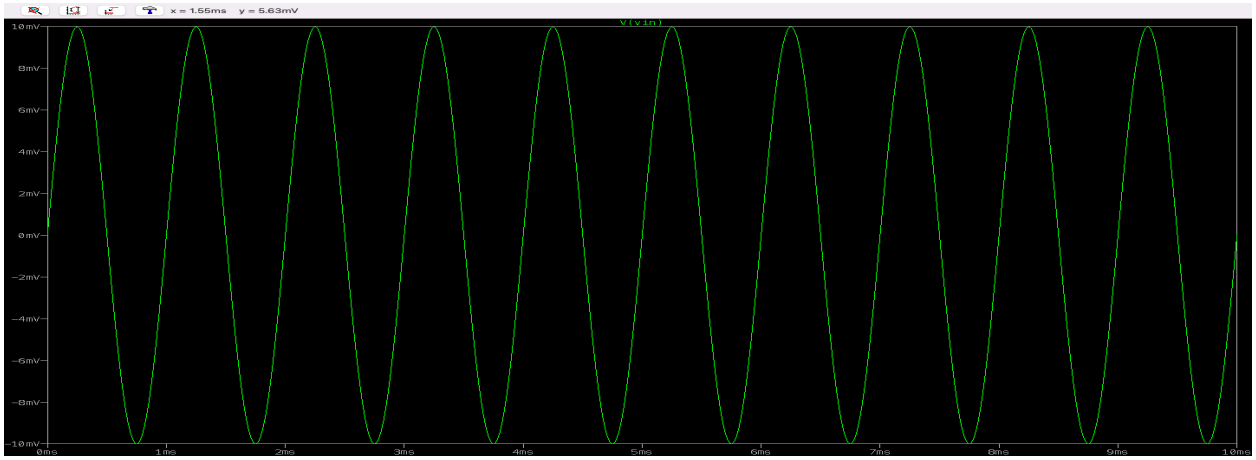

Figure 3: Part 1 Input vs Time (peak amplitude is 1mV)

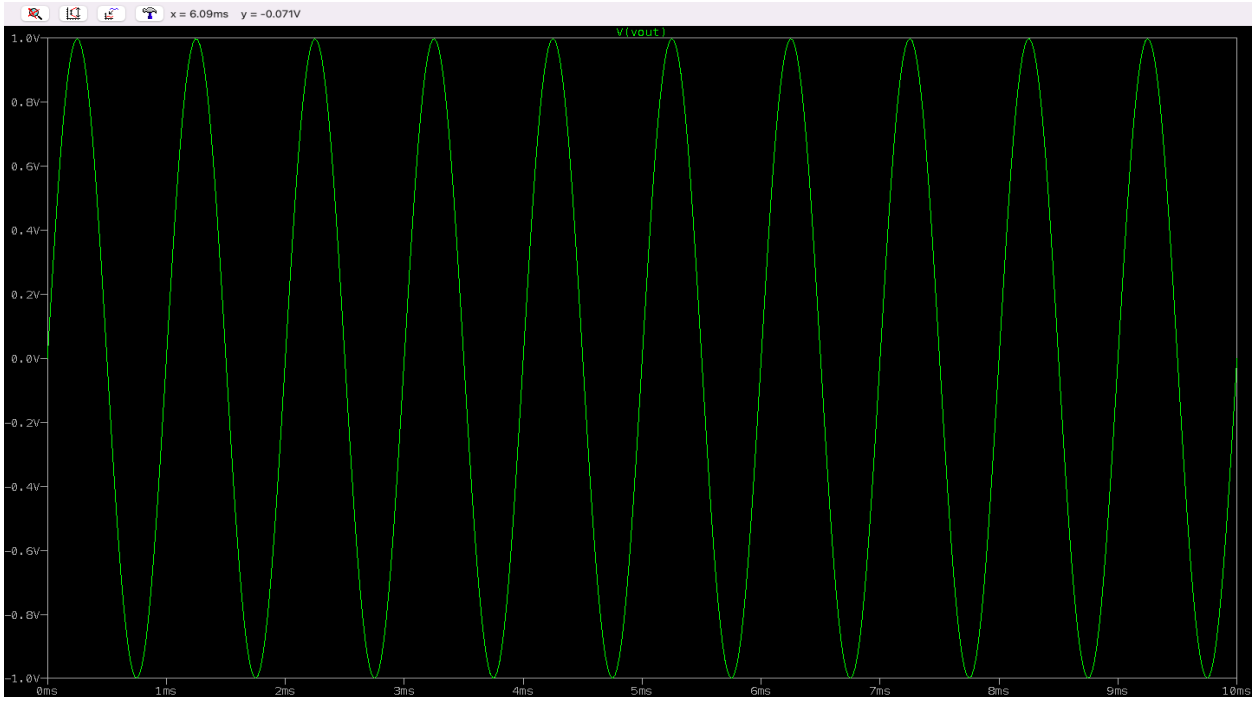

Figure 4: Part 1 Output vs Time (peak amplitude is 1v)

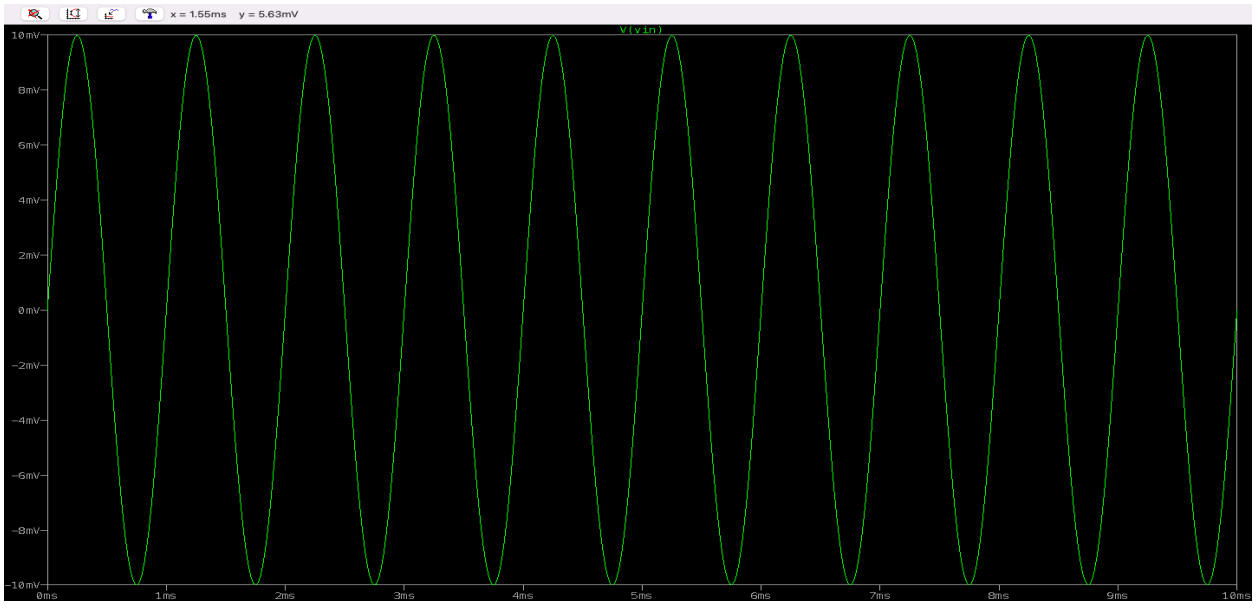

Figure 5 : Part 2 Input vs Time (peak amplitude is 10mV)

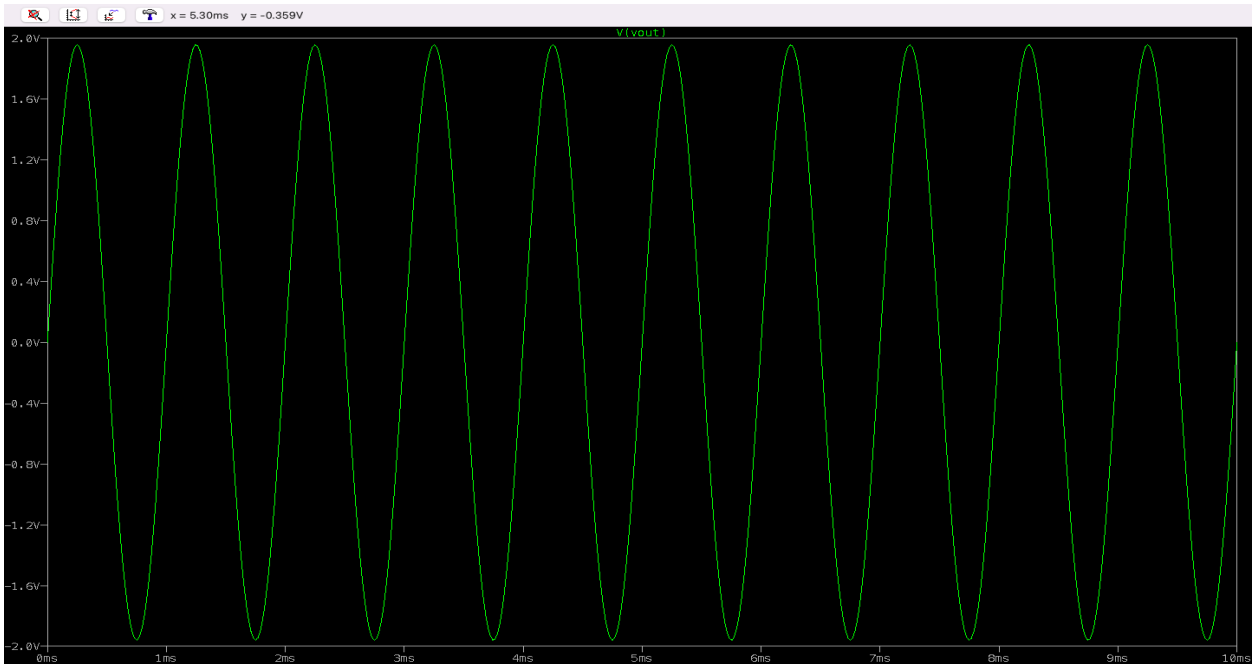

Figure 6 : Part 2 Output vs Time (peak amplitude is 2V)

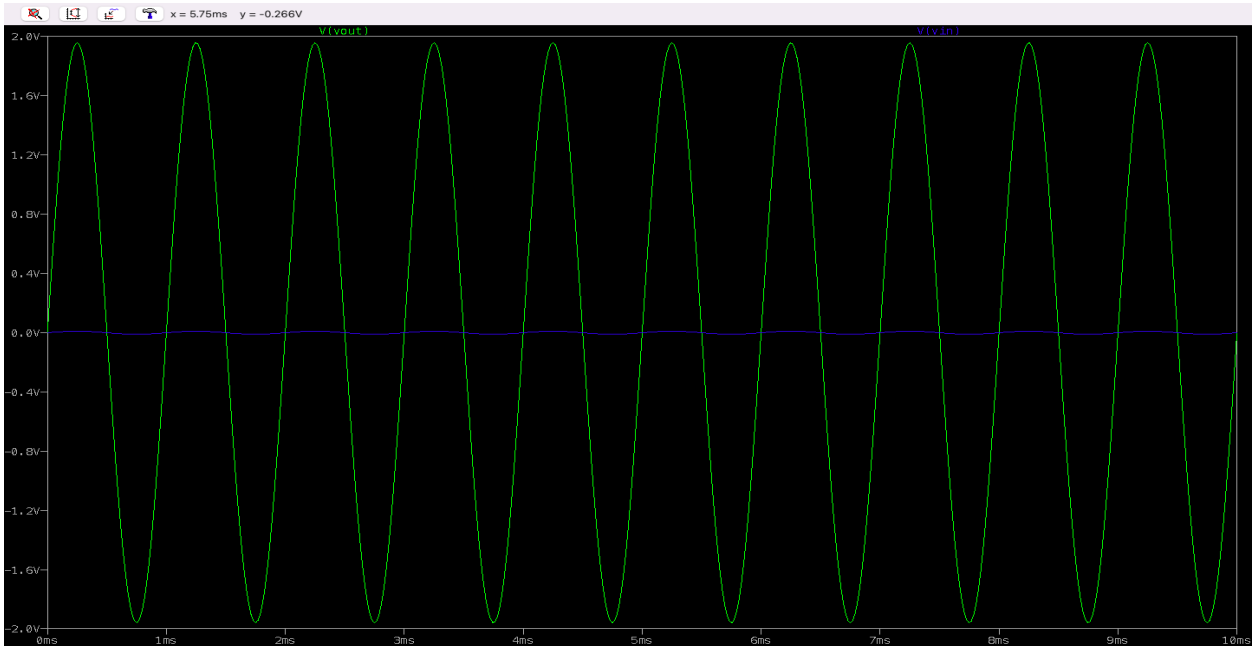

Figure 7 : Part 2 Input vs Output (verifies gain factor of 200)

Conclusion

This lab helped illustrate the working of an ideal operational amplifier. The output waveforms are proof of the input signal being amplified by a gain factor. For the second circuit, our output is the same input sine wave except its amplitude has been increased from 10mV to 2v. This proves that our calculated gain was 200. Another way to think about it, is that every input point translates to the input point times 200 for the output.

This lab also helped illustrate the concept of gain. There is open loop gain (A) this is the gain factor of just the op amp itself. Closed loop gain is the overall gain of the circuit. For there to be closed loop gain there must be negative feedback. This is when the output is connected to the non inverting terminal of the operational amplifier.