Experiment 5

Op-Amp Circuits

EGT 243 - AC Circuit Analysis

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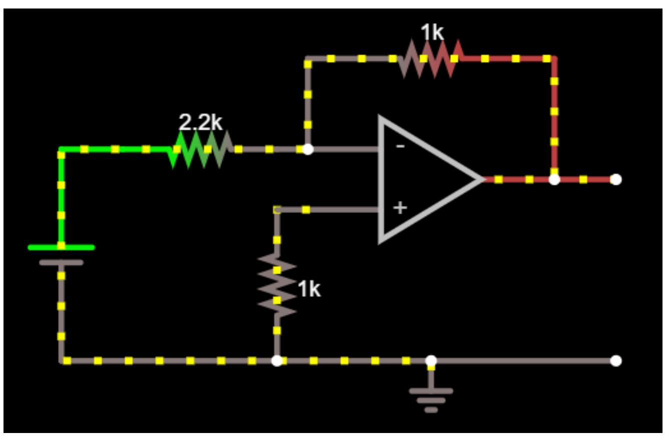
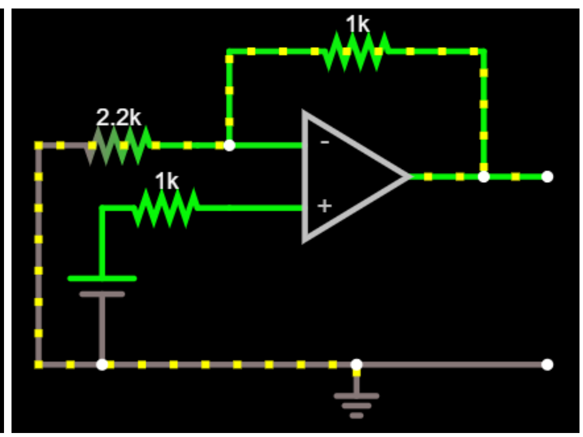
Introduction
The purposes of this experiment are as follows: allow students to build a physical circuit using multiple different components, build familiarity with lab equipment and the mentioned components, and utilize the learned formulae to compute theoretical circuit values, then test those values against real-world models.

Required Components
- 1KΩ Resistor (x2), 2.2KΩ Resistor, 10KΩ Resistor, 1MΩ Resistor, 0.1uF Capacitor
- MC1458 Op-Amp
- Breadboard with Jumper Wires
- Function Generator
- Power Supply
- Oscilloscope
- Multimeter

Schematic Design


^ Used in part 1



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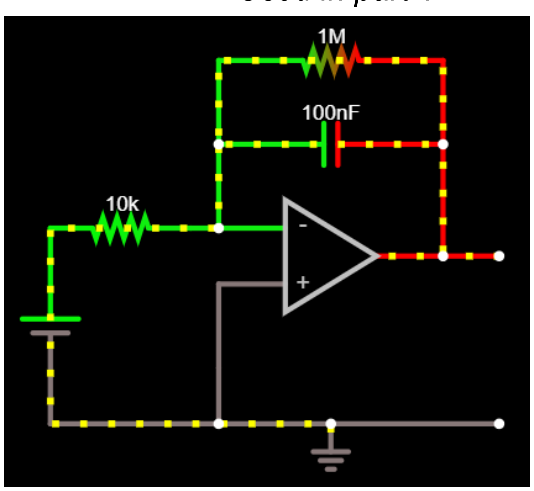

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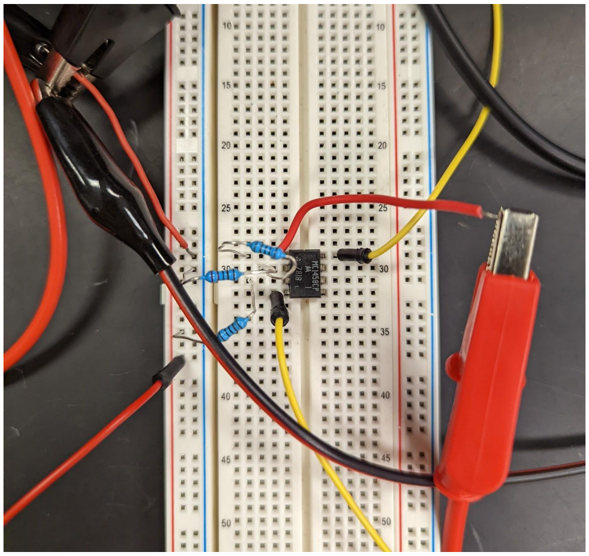
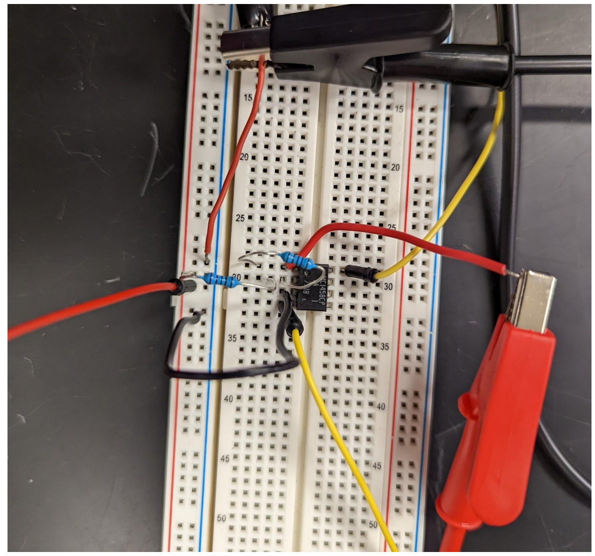
Component Layout



^ *Used in part 1*



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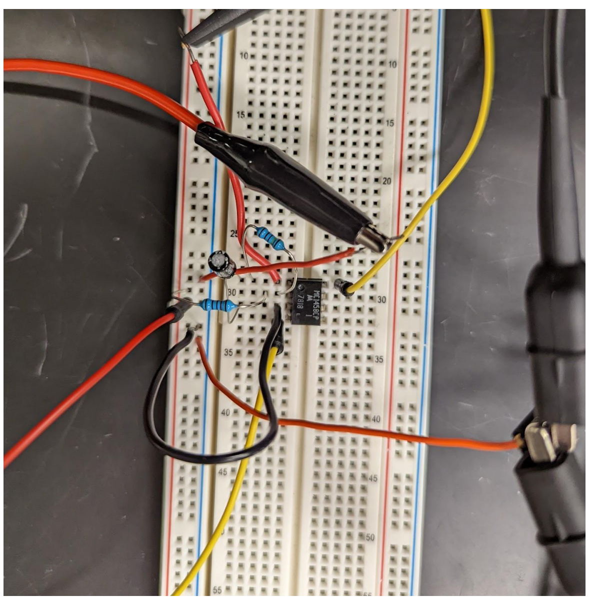


^ *Used in part 3*

Procedure

Part 1:

1. Build the given circuit with two 1KΩ resistors, a 2.2KΩ resistor, and an MC1458 op-amp.
2. Connect the 9V and -9V from the power supply to the supply-in of the amplifier.
3. Connect 5V from the power supply to the input of the amplifier.
4. Read the amplifier output voltage with the multimeter.

Part 2:

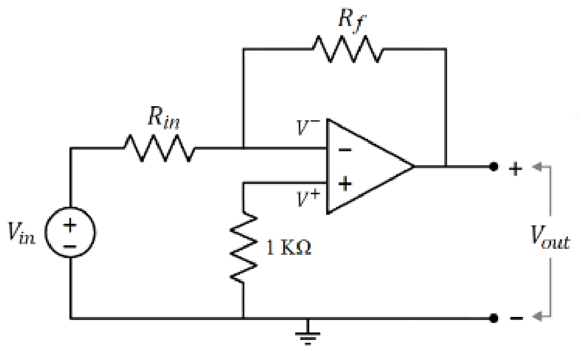
1. Build the given circuit with two 1KΩ resistors, a 2.2KΩ resistor, and an MC1458 op-amp.
2. Connect the 9V and -9V from the power supply to the supply-in of the amplifier.
3. Connect 5V from the power supply to the input of the amplifier.
4. Read the amplifier output voltage with the multimeter.

Part 3:

1. Build the given circuit with a 10KΩ resistor, a 1MΩ resistor, a 0.1uF capacitor, and an MC1458 op-amp.
2. Connect the 9V and -9V from the power supply to the supply-in of the amplifier.
3. Connect the function generator output to the input of the amplifier.
4. Switch between the sine and square waveforms on the function generator.
5. Observe the resulting waveforms on the oscilloscope.
6. Take a photo for each wave type.

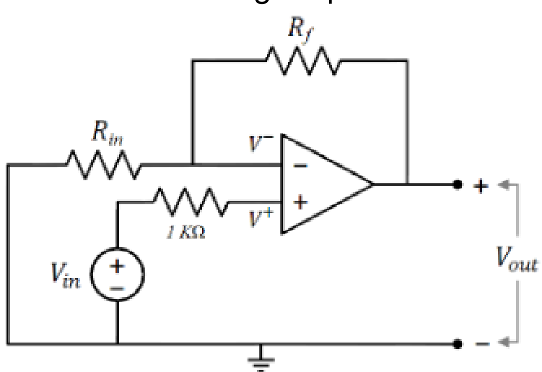
Calculations

Part 1: Inverting Amplifier



- $V_{out} = (-R_f / R_{in}) * V_{in}$
  - $PV_{out} = (-1000 / 2200) * 5 = -2.27V$

Part 2: Non-Inverting Amplifier



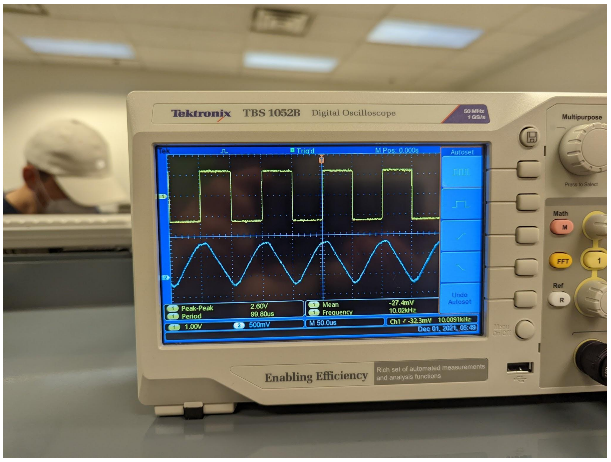
- $V_{out} = (1 + (R_f / R_{in}) * V_{in}$
  - $PV_{out} = (1+ (1000 / 2200)) * 5 = 7.27V$

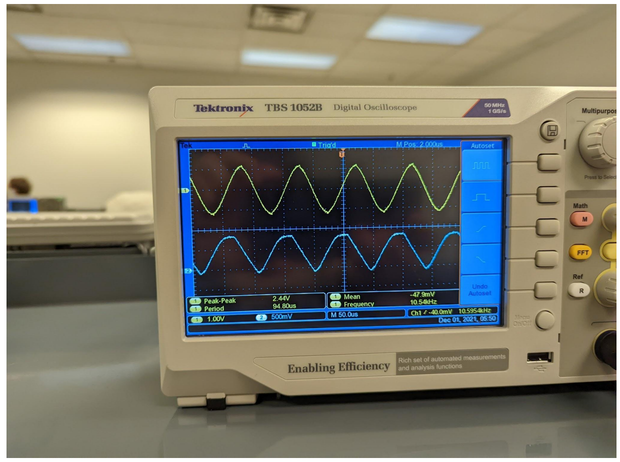
Experimental Results

Part 1: Inverting Amplifier		
Input Voltage (V_{in})	*Predicted Output Voltage (PV_{out})*	*Measured Output Voltage (V_{out})*
5V	-2.27V	-2.26V

Part 2: Non-Inverting Amplifier		
Input Voltage (V_{in})	*Predicted Output Voltage (PV_{out})*	*Measured Output Voltage (V_{out})*
5V	7.27V	7.15V

Part 3: Integrator Amplifier





Discussion
The different Op-amp circuits were able to give us a good understanding of how operational amplifiers work in a circuit. Through circuit analysis we were able to accurately predict the voltage output for both the inverting and non-inverting amplifier circuits. We did have a little trouble getting the second and third circuits to read correctly on the multimeter but that was mainly caused by the faulty equipment. Replacing such equipment before trying other values in the circuit would yield better results.

Conclusion
In conclusion, through the use of operational amplifiers, a function generator, an oscilloscope, and a multimeter we were able to get hands-on experience. Through experimentation we were able to see the versatility of op-amps and how to predict their voltage output using circuit analysis. One optimization to this lab would be having functional reading equipment, we were able to get it to work but some of the circuits caused a little trouble. Overall we were able to learn about the several uses of Op-amps in this experiment.

References
Principles of Electric Circuits: Conventional Current Version, 10th Edition, Thomas L. Floyd, Pearson, 2019. (ISBN-13: 9780134879482)

Appendices
1A. Ohm’s Law - a law stating that electric current is proportional to voltage and inversely proportional to resistance. (Oxford Languages, 2021)
1B. Breadboard - a construction base for practicing electronic circuits.
1C. Falsad Online Circuit Simulator: https://www.falstad.com/circuit/