Lab 2
Non-ideal DC characteristics of Op-Amps (and a little AC)

Pre-Lab

1. Find the data sheets for the LM 741 and the LF 411. `www.digikey.com` is a possible source.
2. Derive the relationship between offset voltage and output voltage for non-inverting amplifiers.
3. Research how to use the offset nulling circuitry on the 741 and 411 op-amps.
4. Design the circuit in step 8.

Input offset voltage

1. Using a LM 741 op-amp, build an inverting voltage amplifier with a gain of 1000 using a feedback resistor of 100 kΩ. Measure the relationship between the output and the input for several positive and negative input voltages. You may use a voltage divider to create small voltages or a very low-frequency square-wave from the function generator.
2. Verify that the measured gain (the slope) is close to the designed value.
3. What is the output for zero input voltage. What does that imply for the offset voltage? How does the inferred offset voltages compare with the data sheet? You may also wish to ask other students for their measured offset voltage values and include those in your report as well to get a better feel for the variability of the offset voltage.
4. Attach the nulling circuitry, describe how to use it to null the output, and show that you can null the offset voltage.
5. At the end of the lab (to ensure you make it through the bias current and slew rate parts) repeat steps 1-3 for the LF 411. How do the LM 741 and LF 411 compare with respect to offset voltage?

Input bias current

6. Build a voltage follower (buffer) with the LM 741, but instead of a short between output and negative input, insert a large resistor (experiment in the 1 MΩ to 30 MΩ range).

7. Ground the input, and measure the output. What does this imply for the bias current, and the direction of the bias current? Make sure your resistor is large enough that the output reflects mostly the bias current and less the offset voltage.

8. Design a circuit which eliminates the bias current (assume the negative input current you just measured is the bias current).

9. What is the residual voltage? What does this imply about the offset current?

Slew Rate

10. Build a inverting amplifier with a gain of 10 using the LM 741.

11. Apply a sinusoidal or square-wave input of high enough frequency and amplitude that the signal becomes triangular. What is the slew rate of the LM 741?

12. Repeat for the LF 411. Compare the two amplifiers and compare with the data sheets.