Lab 1
Amplifiers, input/output resistance, cascades, and frequency response

Pre-Lab

1. Find the LM741 data sheet, for example on `www.digikey.com`.
2. Design the amplifier in question 1.
3. Design the amplifiers in question 5, derive an expression for A_{vo} of the cascade, and compute the expected value.
4. Design the amplifiers in question 6.

Input and Output Resistance

1. Using a LM 741 op-amp, build an inverting voltage amplifier with a gain of approximately 100, and input and output resistances of $1\,\mathrm{k}\Omega$ (Hint: the circuit is a regular inverting amplifier followed by a series resistor). Measure the resistors and compute an actual expected gain, A_{vo}.
2. Attach the function generator directly to the input, and the output directly to a voltage-meter or the oscilloscope input. Plot the output as a function of the input (use the function generator DC offset) for several different input voltages. What does this imply about the source (function generator) and load (meter or function generator) resistances?
3. Sketch and carry out an experiment to measure the input and output resistances of the amplifier using DC signals. You can use the function generator's DC offset with one or more suitable series resistors at the input. On the output attach one or more suitable load resistors. Compare the results to the actual value of the $1\,\mathrm{k}\Omega$ resistors you attached.

Frequency Response

4. Measure the frequency response of the amplifier. Use a small-amplitude sinusoidal input, gradually increasing the frequency until the gain has dropped significantly (at least by a factor of 10). Plot the gain and phase difference between input and output as a function of frequency. Compare to your expectation. Is the low-frequency gain what you expect? Is the high-frequency on a log-log scale what you expect? What is the bandwidth?

   NOTE: At high frequency you must use a small amplitude input signal. If you notice any distortion of the output causing it to look triangular, reduce the input signal amplitude.

Amplifier cascades

5. Build a two-stage amplifier cascade consisting of two inverting amplifiers, each with a gain of 10 and each with input and output resistances of 1 kΩ. Measure A_{vo} of the cascade.

6. Modify the gains of the individual amplifiers (keeping them identical) to produce an A_{vo} of approximately 100. Measure the new gain and confirm it is 100.

7. What is the bandwidth of the cascade? You can measure this without plotting the full frequency response. Compare the measured bandwidth of the two-stage amplifier with a theoretical value that you computed based on the bandwidth of the single-stage amplifier.