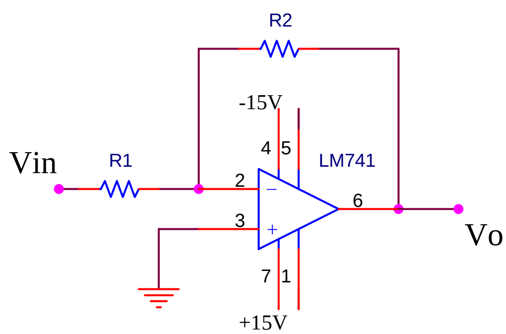
ENG 100 Lab 4. Operational Amplifier Circuits

The purpose of this lab is to introduce several common operational amplifier circuits. Operational amplifiers (op amps) are widely used for analog signal conditioning. Common signal conditioning operations include amplification (or attenuation) and filtering. You will examine amplification in this lab.

For most signal conditioning designs, the ideal op amp model can be used to determine the circuit characteristics. The ideal opamp model assumes infinite input resistance (R_{in}), zero output resistance (R_o), and infinite gain (A). You will, however, see nonideal behavior in some of your measurements.

PRELAB: Bring the equations for the gain for the inverting and non-inverting amplifiers to lab.

I. Inverting Amplifier



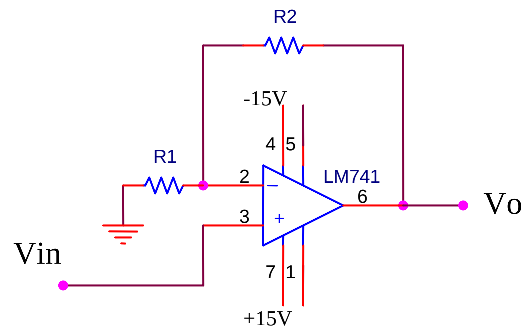
1. Design the amplifier circuit shown above for a gain of –10 using R1=1 kΩ Build the circuit using a LM741 op amp, as shown below. The complete spec sheet for the LM741 is on the class website, if you would like to look at it. Power the op amp with ±15 VDC from the power supply. **Don't connect anything to the offset null terminals (pins 1 & 5) on the op amp.**

2. Connect the function generator to the input. Measure the output for a sinusoidal input signal, V_{in}, of 1.0 Vpp at 1000 Hz. Sketch the input and output signals (label your axes). Measure the gain V_O/V_{in}.

3. For V_{in} =0 V (i.e., disconnect the function generator and connect V_{in} to ground), measure the output voltage with the DMM. This is the DC output offset voltage. Ideally, this would be zero.

4. Compare your experimental results with the theoretical prediction of gain using the ideal opamp assumptions and explain any differences.

II. Noninverting Amplifier



1. Design the circuit above for a gain of +11 using R1=1 kΩ. Build this noninverting amplifier circuit with an LM741. Leave the offset null pins disconnected.

2. Measure the output for a sinusoidal input signal, V_{in}, of 1.0 Vpp at 1000 Hz. Sketch the input and output signals (label your axes). Measure the gain V_O/V_{in}.

3. For V_{in} =0 V (i.e., disconnect the function generator and connect V_{in} to ground), measure the output voltage with the DMM. This is the DC output offset voltage. Ideally, this would be zero.

4. Compare your experimental results with the theoretical prediction of gain using the ideal opamp assumptions and explain any differences.

III. Frequency Response

Assuming an ideal op amp, the gain of the two circuits above would be constant, independent of frequency. However, this is not a good assumption at higher frequencies.

1. Using your noninverting amplifier with a gain of +11: measure the output for a sinusoidal input signal, V_{in}, of 1.0 Vpp at 1000 Hz. Increase the input frequency (and maintain a constant input amplitude) until the output voltage drops by 3dB (i.e., the output voltage amplitude falls to 0.707 times the output voltage amplitude at 1000Hz). Record this frequency, which is the bandwidth of the circuit.

2. Repeat the measurement above for an amplifier with a gain of 2.2. (Keep R1=1 kΩ, change R2 to change the gain.)

3. Compute the product of the low-frequency (i.e., 1000Hz) gain and the bandwidth for each of the last two circuits. What do you observe?

Updated: 5/1/07