Phy 415/515 Lab #8 2009 Operational Amplifiers

No prelab, but the homework questions should be done before this lab.

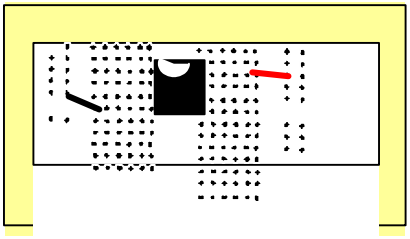

Figure 1. The Breadboard.

___1.Set up

___1.1.Power supply and Wavetek

Create columns on the breadboard for +15, -15, and ground. Connect a bnc cable from the Wavetek function generator "hi" output to the breadboard bnc input and create a column on the breadboard for it. Set the Wavetek on dc (not sinusoid).

___1.2.Computer

Set both computer probes to measure the output of the wavetek. If necessary calibrate the sensors.

___2. Op Amp

___2.1. Power

Plug the op amp into the breadboard so that the pins 1-4 are on one side of a break between the rows, and pins 5-8 on the other, as shown in Figure 1. Using the pin diagram shown in Figure 2, connect the ± 15 Volts to the op amp. This step provides power to the op amp, and, like plugging in the power supply, is generally left out of instructions but it won't work without it.

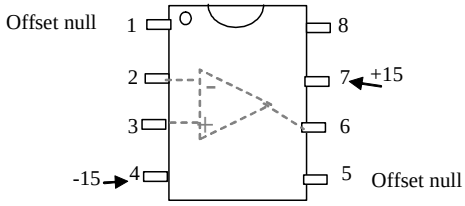

Figure 2. Top view of 741 op amp. Pin 4 should be connected to -15 and pin 7 to +15. Pin 3 is the noninverting input, Pin 2 the inverting input and pin 6 the output.

___2.2. Inputs

Connect the inverting input (pin 2) to ground. Connect the wavetek to the non-inverting input (pin 3). Use the voltmeter to observe the output of the op amp (pin 6). Try to adjust the wavetek so that the output is zero. (This should be extremely difficult if not impossible. Is this consistent with a very large gain? When the difference between the inputs is (relatively) large, the output saturates to a "rail" --one of the power supply voltages.)

___2.3. Voltage divider

Make a 1 million to one voltage divider with a 10 MΩ and a 10 Ω resistor between the wavetek and ground. Try to adjust the input so the output is zero if you use one millionth of the wavetek output as the input. Is the gain more than 10^6?

___3. Follower

___3.1. Circuit

Build the op amp follower in Figure 3. The input comes directly from the wavetek (not a voltage divider). Observe the output with the computer probe and plot the input versus the output as you sweep the dc offset. What is the **gain?**_____Print the plot.

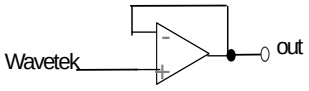

Figure 3. The op amp follower.

___3.2. Follower with Voltage divider input

Wire a 1:1 voltage divider on the wavetek from two 1 M resistors. Measure the output with the probe. Use as the input to the follower. With the wavetek voltage set at 6 volts, what is the output voltage? _____Does the follower have a higher input impedance than the computer voltage probe?_____

___3.3. Time varying input

Set the wavetek to a 100 Hz sinusoidal output. Obsere the output versus time on the computer. Print the plot. Observe whether the output follows if you change the waveform to square wave or triangle wave. (You can set the computer to redisplay immediately so

you don't have to keep hitting collect, or you can use the oscilloscope if you prefer). Since the computer sensors will not work beyond ±6 volts, turn the power supply voltage down to ± 5 Volts to observe clipping when you adjust the dc offset or amplitude. Return the power supply voltage to ± 15 Volts.

___4. Inverting Amplifier

___4.1. Circuit and gain

Build the inverting amplifier of Figure 4. Connect the wavetek to "in". Return the wavetek to dc, and observe the output on the computer. Plot the output versus the input and determine the gain (slope)._____ Is it $-R_2/R_1$? _____**Print** the plot.

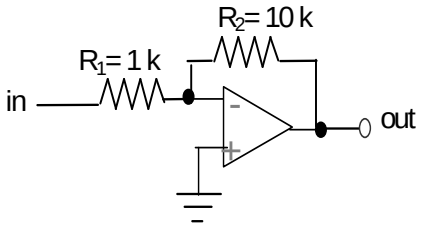

Figure 4. The inverting amplifier.

___4.2.Inputs

Adjust the wavetek so the output of the amplifier is about 5 volts. Use the voltmeter to measure the output of the wavetek (it should be about -0.5 V) and the voltage between the inverting and non-inverting inputs on the op amp (it will be zero). Why?

___4.3.Changing the feedback

Change the feedback resistor R_2 to produce a gain of 15. R_2=_____

___4.4.Amplifier with Voltage divider input

Replace the 10k feedback resistor. Set the wavetek output to 1 volt and use the 50:50 voltage divider with the two 10 MΩ resistors as the input to the amplifier instead of the wavetek directly. What is the output? Why? (A similar problem is in homework 5). Remove

___4.5. Time varying signal

Observe the output with time-varying input. Turn the power supply voltage down to ± 5 Volts to observe clipping when you adjust the dc offset or amplitude. What happens if the dc offset is not zero? _____Why? Return the power supply voltage to ± 15 Volts.

___5. Non-Inverting Amplifier

___5.1. Circuit

Build the non-inverting amplifier of Figure 5. Return the wavetek to dc, and observe the output on the computer. Plot the output versus the input, save the graph, and determine the gain . Is it $(1+ R_2/R_1)$?

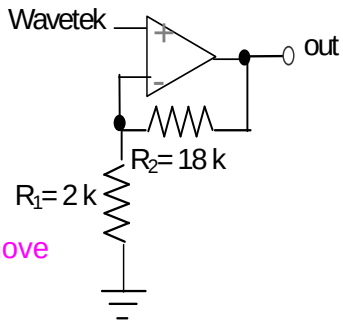

Figure 5. The non-inverting amplifier. Note that the non-inverting input has moved relative to Figure 4.

___5.2.Amplifier with Voltage divider input

Using the 50:50 voltage divider from two 10M resistors, set the wavetek output to 1 Volt. What is the output? Why? Remove

___5.3. Time varying signal

Obseve the output with time-varying input. Turn the power supply voltage down to ± 5 Volts to observe clipping when you adjust the dc offset or amplitude. Return the power supply voltage to ± 15 Volts.