Experiment 2  
Topic: Electronic Circuits  
Week B Procedure

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Op-Amp Circuit

Overview: In this laboratory exercise, you will use a proto board to construct a non-inverting amplifier using an LM301 integrated circuit (IC). The primary purpose of this lab is to teach you how to use IC chips in a circuit.

Non-inverting amplifier

In this portion of the lab, you will construct the op-amp circuit shown in Figure 1 using $R_2 = 1 \, \text{k}\Omega$. You will then measure $V_{out}$ as a function of the other resistor $R_1$, thus filling out the Table 1. Please refer to the pin out diagram shown in Figure 2 to aid you in the construction of your circuit. A step-by-step guide to constructing the circuit is provided below.

Show TA your circuit BEFORE applying powering to your circuit.

1. Insert the LM301 chip into the proto board as demonstrated during lecture. Orient the Op-amp such that the dot is in the upper left corner. If you are at all uncertain about this or any of the following steps, ask the TA or Prof. Ott for help!

2. Insert the 30 pF capacitor between pins 1 and 8. This capacitor will reduce high frequency noise and increase stability.

3. Locate the 1 kΩ resistor. Using the Craftsman 82345 digital multimeter, measure its resistance and record the value here: $R_2 =$ _______________. This resistor will be used for $R_2$ in the op-amp circuit.

Table 1

<table>
<thead>
<tr>
<th>$R_1$ (Ω)</th>
<th>$R_1$ (measured)</th>
<th>$V_{out}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>470</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1k</td>
<td></td>
<td></td>
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<tr>
<td>2k</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10k</td>
<td></td>
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</tbody>
</table>

Figure 1: Circuit diagram for the non-inverting amplifier.

Figure 2: Pin-out for the LM301 op-amp chip.
Carefully, insert it into the proto board in the correct position. One end should be connected to ground, and the other end should be connected to inverting input (pin 2).

4. Connect the output ‘T’ on the Tektronix AFG 3021 function generator to the non-inverting input of the circuit using a BNC-to-minigrabber cable by doing the following: Connect a wire to the non-inverting input (pin 3), and grab onto it with the red minigrabber. Connect another wire to ground and grab onto it with the black minigrabber.

5. Connect the other side of ‘T’ on the function generator to Channel 1 of the Tektronix DPO 3012 oscilloscope.

6. Connect Channel 2 of the oscilloscope to the output of the circuit using a different BNC-to-minigrabber cable.

7. Pick a resistor from the remaining pile. Measure its resistance and record the value in Table 1.

8. Insert this resistor into proto board as R1 to form the circuit shown above. One end should be connected to the output (pin 6), and the other end should be connected to inverting input (pin 2).

9. Refer to the pin-out (Fig. 2). Using different colored wires, connect pins 4 and 7 to the -10V DC and +10V DC, respectively, power supplies on the proto board.

10. Show the TA your circuit.

11. Turn on the power supply and set the voltages to +10V DC and -10V DC.

12. Turn on the function generator and set the output to be a 1 kHz sine wave with a peak-to-peak amplitude of 1V peak-to-peak (Vpp).

13. Press the “auto set” button on the right hand side of the oscilloscope. You should see a sine wave appear. Measure the peak-to-peak amplitude of Channel 2 of the scope and record its peak-to-peak amplitude in Table 1 next to the value of R1. If Vpp on the function generate is significantly different than the oscilloscope, ask the TA for help.

Note, \( V_{in} = \frac{V_{pp}}{2} \sin(2 \pi f t) \).

14. Measure the peak-to-peak amplitude of Channel 1 of the scope and record it here:

\[ V_{in} = \text{__________}. \]

15. Repeat steps 7 – 10 until you have completely filled out Table 1.

**Deliverables:** Please include the following items in your technical memo.

1. The equation relating \( V_{out} \) to \( V_{in} \) for a non-inverting amplifier. (i.e. what is the theoretical gain in terms \( R_1 \) and \( R_2 \)?)
2. Using the data from Table 1, make plot of the gain $V_{out}/V_{in}$ vs. $R_1$. Perform a linear fit to the data and compare the extrapolated slope and intercept to the theoretical equation.