**Datasheet for Lab 7: Operational Amplifiers**

Name(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lab kit: \_\_\_\_\_\_\_\_\_ Approximate time on task to complete, to 0.1 hours:\_\_\_\_\_\_\_\_\_\_\_\_

**Prelab**

Watch the *Lab 7 Overview In Class* video at the [video playlist](https://www.youtube.com/playlist?list=PLhNcB8XKcGiIiP4NDENb1QoXSeh_rqn8G) for lab 7. You may also want to view *Lab 7 In the Lab* for video of students working through their questions and on the lab.

**Part 2. Construction and Testing of an Inverting Op-amp**

**Step 3) Record the voltage of the**

**Verification**: Plug in both power supplies as shown in Figure 4 on the lab handout and use a voltmeter to confirm that you are able to read approximately +12V at the red line on the top of the breadboard, and -12V at the red line on the bottom of the breadboard, relative to the reference node (blue line on the top or bottom of breadboard).

 **Table 1. Power Supply Voltages**

|  |  |  |
| --- | --- | --- |
| **Name** | **V, Volts** | **Check, should be** |
| **+12V (red line at top) to ref node (blue line at top)** |  |  **about 12.3V** |
| **-12V (red line at bottom) to ref node (blue line at bottom)** |  |  **about -12.3V** |
| **+12V (red line at top) to ref node (blue line at bottom)** |  |  **about 12.3V** |

If you don’t measure close to the expected values, **STOP!!**
Fix your circuit or get help before proceeding.

Confirm Both LEDs light up when power is applied (Figure 5) \_\_\_\_\_\_\_\_\_\_

**Step 4) Record the range of your variable voltage source at the “0-5V variable” wire on your breadboard while turning the potentiometer shaft with a screwdriver.**

Minimum voltage (should be approx -12V) \_\_\_\_\_\_\_\_\_\_
 Maximum voltage (should be approx. +12V)\_\_\_\_\_\_\_\_\_\_

**If you don’t measure close to the expected values, STOP!!**Fix your circuit or get help before proceeding.

Adjust your variable voltage source to ~ 0.5V and record: \_\_\_\_\_\_\_\_\_\_

**Step 5) Record the results of your inverting op-amp circuit testing.**

**Table 2. Resistor Measurements**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **R1** | **Rf** | **R\_load** |
| **Nominal** | **3300** | **10000** | **1000** |
| **DMM Ohmmeter** |  |  |  |

**Table 3. Inverting Op-amp DC Sweep Measurements**

**Vn should be around 0V when the magnitude of Vin < ~ 3V**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vin (nominal)** | **Vin (measure)** | **IN+ (Vp)**  | **IN- (Vn)** | **Vout** |
| **-5** |  |  |  |  |
| **-4** |  |  |  |  |
| **-3** |  |  |  |  |
| **-2** |  |  |  |  |
| **-1** |  |  |  |  |
| **0** |  |  |  |  |
| **1** |  |  |  |  |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
| **4** |  |  |  |  |
| **5** |  |  |  |  |

Insert a photo of your breadboard here showing the value of Vout when a voltage of 1V is applied to the input of the inverting op-amp.

Open FreeMat and use your data to plot Vout as a function of Vin (this means Vin on the x-axis). Add titles and labels, including units. Include the plot here.

**Inverting Op-Amp Questions**

1. What is the theoretical gain of your op-amp circuit based on the actual resistor values used?
2. What is the actual gain of your op-amp circuit, based on the ratio Vout/Vin in the *linear range* of the plot you created?
3. At what values of Vin does *saturation* begin to occur (the part of the curve that deviates from a straight line)?
4. You should have noticed that IN- (Vn) is zero over most of the range -3V < Vin < 3V. Why is that?
5. Why does Vn not remain equal to Vp when the amplifier is in saturation?

**Step 5) Record the results of your Non-Inverting op-amp circuit testing.**

 To change from an Inverting to a Non-Inverting amplifier, all you have to do is:

1. Remove the ground wire from the V- (or IN-) terminal
2. Connect the variable voltage source (potentiometer) to the V- (or IN-) terminal.
3. Ground the left side of R1.

**Table 4. Resistor Measurements**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **R1** | **Rf** | **R\_load** |
| **Nominal** | **3300** | **10000** | **1000** |
| **DMM Ohmmeter** |  |  |  |

 **Table 5. Non-Inverting Op-amp DC Sweep Measurements**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vin (nominal)** | **Vin (measure)** | **V+** | **V-** | **Vout** |
| **0** |  |  |  |  |
| **1** |  |  |  |  |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
| **4** |  |  |  |  |
| **5** |  |  |  |  |

Insert a photo of your breadboard here showing the output voltage when an input voltage of 1 V is applied.

Open FreeMat and use your data to plot Vout as a function of Vin. Include the plot here.

**Non-Inverting Op-Amp Questions**

1. What is the theoretical gain of your op-amp circuit based on the actual resistor values used?
2. What is the actual gain of your op-amp circuit, based on the ratio Vout/Vin in the linear range of the plot ?

**Part 4. Audio Experiments [OPTIONAL]**

Steps 7 and 8 are provided for 5% Extra Credit.

Please insert any photos or links to audio/video clips you may have created to document these activities.

When you are finished, please estimate the actual time on task you spent completing this lab to 0.1 hours and enter this at the top of the datasheet.