University of Rochester

Department of Electrical & Computer Engineering

ECE111 Laboratory #5 Simple 741 Op-Amp Ckts

Weeks of October 30 and 31, 2014

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Write-ups must provide a detailed description of the exercise, including diagrams of all circuits and descriptions of all procedures. With your write-up, include the separate typed Executive Summary. Your grade will be based in part upon conciseness, grammar, and spelling. **Late work will not be accepted.**

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## Operational Amplifiers

We’re going to assemble circuits, using op-amps, to have gains of -10 and +10, and also as a voltage comparator.

## Laboratory Procedures

In the lab, get resistors and an LM741 Op-Amp (Pin connection shown below) and resistors Ri and Rf from the bins at the front of the lab. Set them up on your breadboard, remembering that the Op-Amp must be connected to positive and negative power supplies, called +VCC and -VCC, on pins 7 and 4 respectively. Set the A and B power supplies to "Series", turn the voltage magnitude to 12V, and use the + output from the A supply as +VCC, and the - output from the B supply as -VCC. The + output from B and the - output from A are connected together internally, and one of the two must be connected to your circuit ground. NOTE: The so-called DIP package the 741 is in is intended for use with this breadboard and will straddle the gap between vertical nodes perfectly.

series-vs

The connection of the Power Supplies to get +Vcc and –Vcc.

Set up the resistors and Op-Amp to make an inverting configuration with a gain of –10, as in the circuit below:

lab5

Pick Rf/Ri=10, Ri has 2 limitations on it: 1. It should be big enough to assure no more than 1 mA of current is drawn from Vin, and 2. It should be larger than the total resistance of the potentiometer.

Connect the “ends” (terminals 1 and 3) to +12V and -12V respectively. Terminal 2 will then have a variable voltage on it, depending on the position of the knob on the potentiometer. (Quick: When Terminals 1 and 3 are connected as described, and Terminal 2 is not connected to anything, how much current is flowing from Terminal 1 to Terminal 3? How much power is being dissipated in the potentiometer?)

Check all connections before you turn on the power supply, and keep an eye on the board when you first turn it on. If the op-amp gets warm or hot, TURN OFF THE POWER IMMEDIATELY! Ask a TA to help you check the circuit before turning power on again.

Connect the black terminal of a Multimeter to Ground (the middle of the power supplies) and the red terminal to Terminal 2 of the Potentiometer. Verify that turning the knob changes the voltage on Terminal 2, and that it can range from +12V to -12V.

Complete the Table for the Inverting Amplifier in the Appendix to this lab.

Now turn off the power and convert the circuit to be a Non-Inverting Amplifier with a gain of 10, as shown in the diagram below:

lab5b

Check all connections before you turn on the power supply, and keep an eye on the board when you first turn it on. If the op-amp gets warm or hot, TURN OFF THE POWER IMMEDIATELY! Ask a TA to help you check the circuit before turning power on again.

Again, fill out the table for the Non-Inverting Amplifier in the Appendix.

Now, let’s set up a circuit without feedback as a Comparator, as shown in the diagram below:

lab5c

Select the value of the current limiting resistor RL to limit the current through the LED to 20 mA when the output is the maximum possible. (Assume the voltage drop across the LED will be 1 V.)

Check all connections before you turn on the power supply, and keep an eye on the board when you first turn it on. If the op-amp gets warm or hot, TURN OFF THE POWER IMMEDIATELY! Ask a TA to help you check the circuit before turning power on again.

Make a note of the voltage at the inverting input, pin 2, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Now, put the red lead of the voltmeter on the noninverting input, pin 3, and turn the knob of the potentiometer. Verify that the LED lights when the voltage at pin 3 just barely exceeds the voltage at pin 2, and stays on as pin 3 goes higher to its limit. Then verify that the LED goes off when the voltage at pin 3 is just less than that at pin 2, and the LED stays off as pin 3 goes to its negative maximum.

If you have time, try reversing the connections to pins 2 and 3 (pin 3 fixed and pin 2 variable) and verify that the sense reverses.

**+**

**-**

741

2

3

7

4

6

11

22

33

44

55

66

77

88

LM 741 Op Amp pin connections.

APPENDIX

Partner Names

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Complete the table below:

INVERTING AMPLIFIER:

Rf: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Rin: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ R1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
| Predicted Vin | Measured Vin | Predicted Vout | Measured Vout |
| 0V |  |  |  |
| 0.1V |  |  |  |
| 0.2V |  |  |  |
| 0.5V |  |  |  |
| 1.0V |  |  |  |
| 2.0V |  |  |  |
| -0.1V |  |  |  |
| -0.2V |  |  |  |
| -0.5V |  |  |  |
| -1.0V |  |  |  |
| -2.0V |  |  |  |

COMMENTS:

Complete the table below:

NON-INVERTING AMPLIFIER:

Rf: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Rin: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
| Predicted Vin | Measured Vin | Predicted Vout | Measured Vout |
| 0V |  |  |  |
| 0.1V |  |  |  |
| 0.2V |  |  |  |
| 0.5V |  |  |  |
| 1.0V |  |  |  |
| 2.0V |  |  |  |
| -0.1V |  |  |  |
| -0.2V |  |  |  |
| -0.5V |  |  |  |
| -1.0V |  |  |  |
| -2.0V |  |  |  |

COMMENTS:

