Electric Circuits I

Laboratory 4: Operational Amplifier Circuits

Objective:

- To design and implement an inverting amplifier.

PRELAB:

1. Design an inverting amplifier with a voltage gain of 6 using an LM741C op-amp chip (or equivalent) with power supply voltages of ± 15 volts for V_{cc+} and V_{cc-}, a 12 kΩ feedback resistor and other standard 5% resistance values. Draw a circuit diagram, showing the op amp pin numbers so that you will be able to easily implement the circuit.

2. The operational amplifier, or op-amp, circuit shown in Figure 1 is proposed as an ohmmeter to measure unknown resistances. Find a value for R_1 so that the voltmeter connected to the output will read the resistance in kilo-ohms (i.e. 1 V = 1 kΩ, 2 V = 2 kΩ) when the voltage source is 1V.

EQUIPMENT AND COMPONENTS:

- NI ELVIS II board.
- Resistors: 1 kΩ, 12 kΩ, and others depending upon your design
- LM741C op-amp or equivalent part.

Laboratory Procedure:

General purpose 741 op-amps can be found in either a single or dual op-amps (747) package. Use the data sheets for wiring information on the op-amp.

Important Note: Please remember to ***turn off all power supplies to* your circuit *before making modifications to your circuits***, such as when you move the test resistor in Figure 1 in and out of the circuit, since that eliminates the critical feedback path. Failure to turn off all power supplies will probably damage your op-amp in some way resulting in unpredictable behavior of your circuit.

Part A

A1. Assemble the inverting amplifier on the breadboard as designed in the pre-lab with power supplies adjusted to ± 15 V.

A2. Connect a third power supply adjusted to +1 V to the input of the amplifier and measure the output voltage.

A3. Calculate the DC voltage gain.

A4. Measure the current flowing into the inverting amplifier circuit and find the input resistance of the circuit by the ratio of input voltage to current.

A5. With the input voltage set to 0 (shorted out) measure the output “error” voltage.

A6. Replace the DC input voltage source with a sinusoidal input source at a frequency of 1 kHz and an amplitude of 1 V. View this input voltage and the amplifier output voltage on an oscilloscope. Slowly increase the amplitude of the sinusoidal input until the output no longer looks sinusoidal. What causes this change in the output?

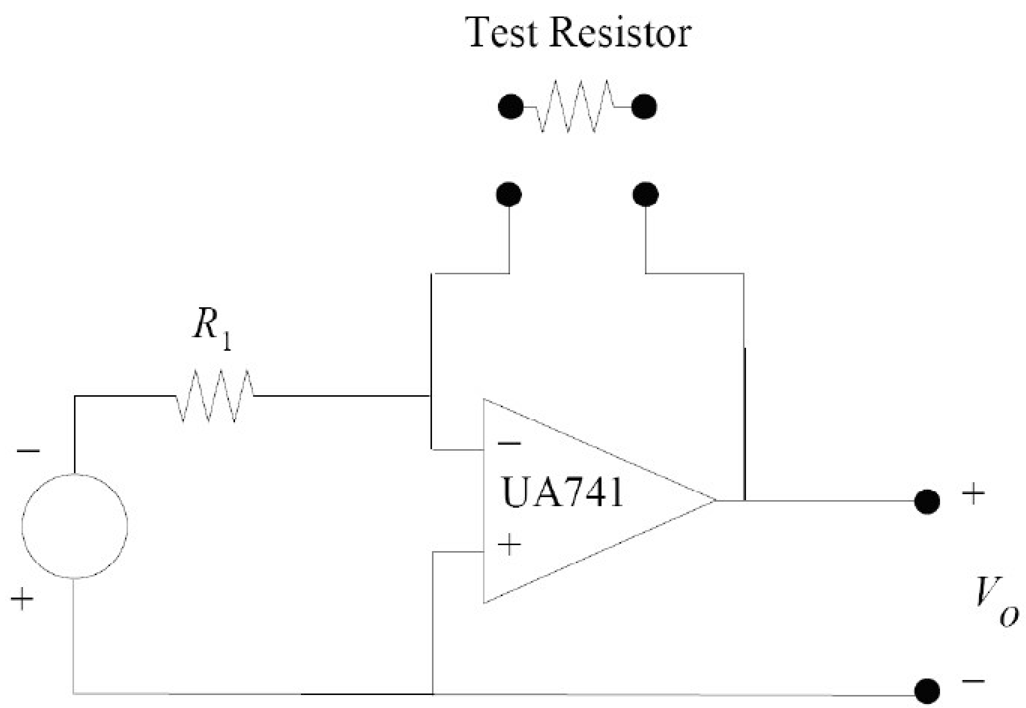

Figure 1

Part B

B1. Create the circuit shown in Figure 1 with R_1=1 kΩ, and perform the following experiment.

B2. Using a DMM, measure the resistances of five different resistors (using the decade box) between 200 Ω, 500 Ω, 1 kΩ, 2kΩ and 5 kΩ.

B3. Measure the resistance of each of the five resistors using your op-amp ohmmeter. (*Turn off all power supplies before making any modifications to your circuit*).

B4. Calculate the percentage error in resistance measurements between your op-amp ohmmeter and the DMM for each of the five resistors.

Laboratory Report:

Include all measurements, computations, and answers to questions from the laboratory procedure. Clearly label all steps.