6.2 Laboratory Procedure / Summary Sheet

Group: ____ Names: __________________________ ______________________________

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An op amp requires connection to two different voltage levels from an external power supply, usually +15V and -15V, both of which can be provided by a triple-output power supply.

NOTE - Before connecting +15V and -15V supplies to an op amp circuit, be very careful to first set each voltage level on the power supply separately. To do this using older power supplies like the HP 6235A, first press the +18 button and turn the +/-18 VOLTAGE knob to adjust both voltages together. Then press the -18 button and turn the TRACK VOLTAGE knob to adjust the -18 voltage relative to the +18 value. **Also, make sure you know where the voltages should be attached before making any connections. Also check both carefully and readjust if necessary before attaching. If the voltages are set too high by mistake, or if they are connected improperly, you can easily damage the op amp.**

(1) We will examine the usefulness of the high input impedance of the op amp by constructing the simple circuit known as the voltage follower. Begin by building the circuit shown in Figure 6.5a consisting of a voltage divider (R_1, R_2) and a load resistance (R_3) where R_1=R_2=R_3=10kΩ. Use V_{in}=5Vdc. Calculate the expected value for V_{out}, with and without the load resistance in the circuit:

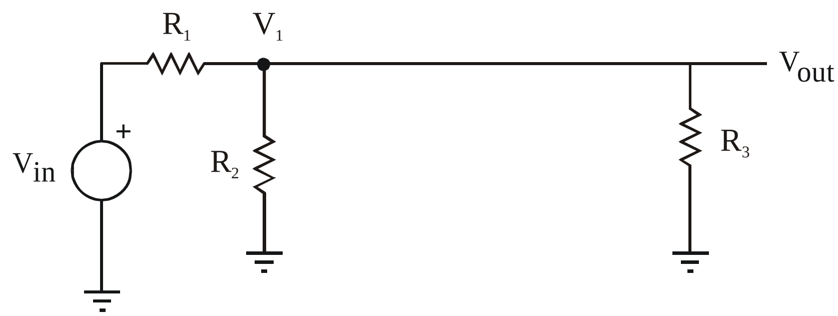
voltage	calculated	measured
V_{out} (w/o R_3)		
V_{out} (w/ R_3)		

Then insert the op amp follower between the voltage divider and the load resistor as shown in Figure 6.5b. Be sure the op amp has the proper power supply connections as well as the signal connections shown in the figure. Again calculate the expected value for V_{out}, with and without the load resistance in the circuit

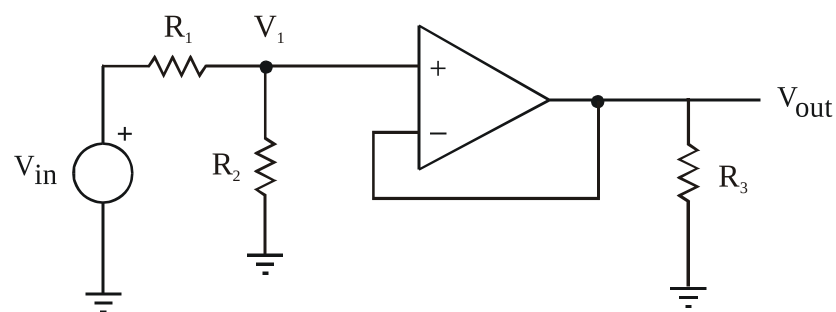
voltage	calculated	measured
V_{out} (w/o R_3)		
V_{out} (w/ R_3)		

Explain the differences among the voltages measured in the two circuits.

You should be able to see now that the follower isolates the left part of the circuit from the right part. The follower effectively changes a high impedance output to a low impedance output. The result is that the output of the voltage divider is not changed by different load resistors.



(a) without op amp follower

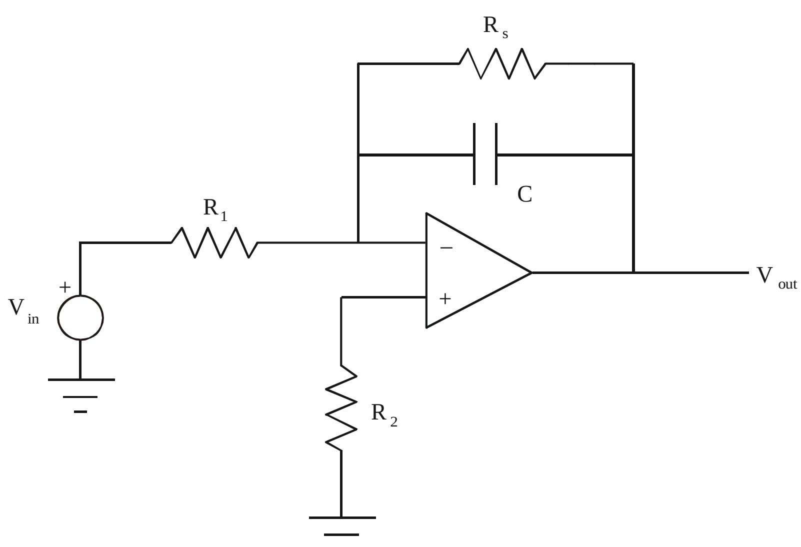


(b) with op amp follower

Figure 6.5 Voltage Divider Driving Load Resistor

(2) Construct an inverting amplifier (see Figure 5.7 in the textbook) with a gain of -10 and use it to determine the maximum output swing voltage in the following way. First, apply a 1 V_{pp} 1kHz sinusoidal signal. Then, increase the amplitude of the input slowly and note where the sinusoidal output is first distorted as you increase the input voltage. Be sure to use resistors in the kΩ range (e.g., 10kΩ). Consider the input and output currents to explain why large resistance values are necessary.

(3) Construct the modified integrator shown below. Normally, the shunt resistor (R_s) is selected such that $R_s \geq 10\ R_1$. Also, the product R_1C is chosen to be approximately equal to the period of the applied input voltage signal. Apply a 1 KHz, 1 $V_{p\text{-}p}$ square wave. Use the following component values: C = 0.1 μF, R_s = 100 kΩ, and $R_1 = R_2$ = 10 kΩ. Justify these selections.



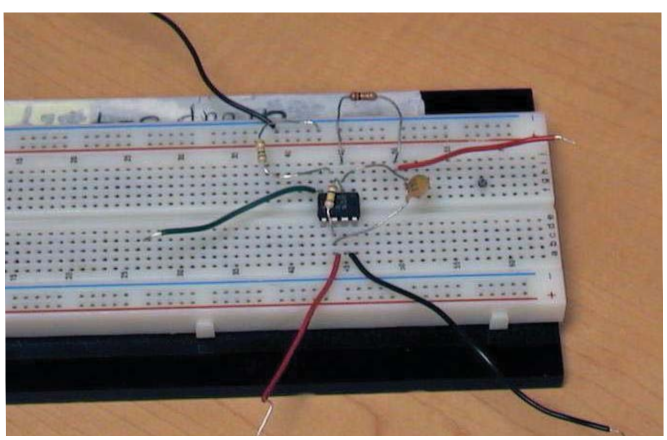


Figure 6.6 Integrator

(4) For the circuit above, determine experimentally the frequency range over which the circuit functions as an integrator. To do this systematically, adjust the input signal to be a 1 V_{pp} square-wave with no DC offset. As you vary the frequency over a wide range you will notice that the output will deviate from the expected triangular wave (integrated square wave). Determine and report the approximate frequency below which the circuit does not operate as an integrator (i.e., the output is not a sharp triangular wave).

(5) Construct the difference amplifier shown below with a gain of 1 using R_1=R_F=10kΩ. Use 15V_{dc} for V_1 and 5V_{dc} for V_2. Explain what you would expect at the output V_{out} and note any discrepancies in your measurement.

Now attach a 1V_{pp} 1kHz sine wave to both inputs, and again explain what you would expect and note any discrepancies with the measured signal.

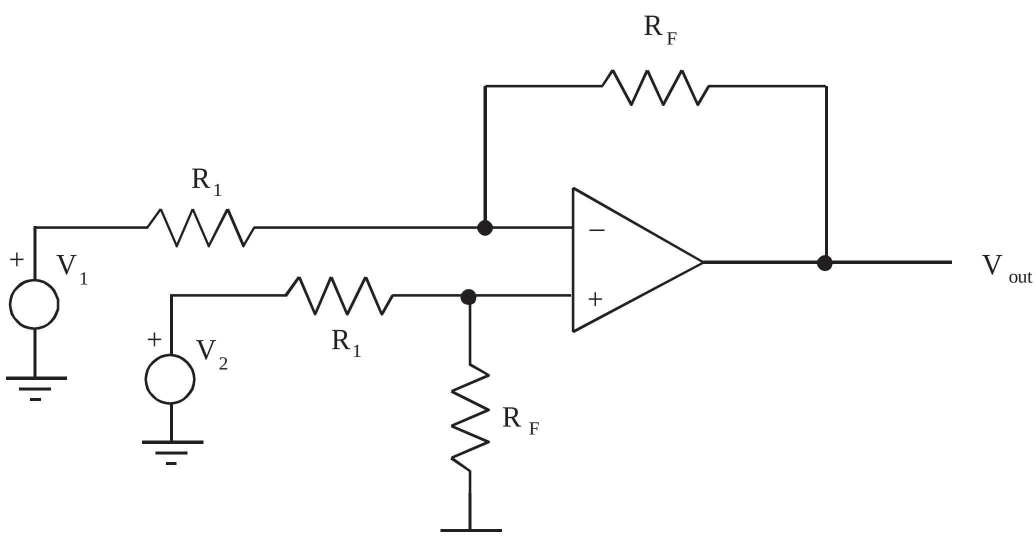


Figure 6.7 Difference Amplifier

LAB 6 QUESTIONS

Group: ____ Names: ____________________________ ________________________________

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(1) Find the specifications for the 741C op amp in the TI (uA741C) and/or National Semiconductor (LM741C) Linear Data Book and/or online. Record the values for each of the characteristic parameters listed below. Also, discuss the significance of each parameter.

- input impedance

- output impedance

- maximum gain

- output voltage swing

- short circuit output current

(2) Explain how the voltage follower "isolates" the input from the output, and explain why this might be useful.

(3) What is the fall-off frequency (approximate bandwidth) of a 741 op amp circuit designed with a closed loop gain of 100?

(4) The output of the difference amp was not exactly zero when the inputs are of equal magnitudes. Suggest possible causes for this discrepancy.