PreLab4 Report

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PART ONE: Thoery

1. Review the section on op-amp circuits in the textbook.
2. Briefly explain why one can assume Vp=Vn for an ideal Op-Amp. What connection has to be present for this to occur? __/3pt

we regard the two input terminals as virtual short circuit because of the high input impedance of an ideal op. (which means that there is no current and no voltage drop.

A feedback connection can make the op adjust it's output to ensure that the difference between two inputs are low enough to make $V_p=V_n$

PART TWO: LF347

1. Read the datasheet for the operational amplifier LF347N which will be used in our lab. __/5pt

1) As for the 14–led LF347N used in the lab, totally there are (4) operational amplifiers in a chip.
2) In the 14–led LF347N, which pin numbers and labels are the positive or negative power supply connections?

Positive supply label: ($V_{cc}+$) Pin: (4)

Negative supply label: ($V_{cc}-$) Pin: (11)

NOTE: The operational amplifier is an active component and requires power. If you fail to connect the power connections, it will not work.

3) Complete the table below with the information from datasheet for the operational amplifier LF347N. __/4pt

Input impedance	Input voltage range	Supply voltage	Open-loop gain	Output voltage
$10^{12}\Omega$	±15V	±18V	Min: 25 15 Typ: 100	Min: ±12 V Typ: ±13.5V

PART THREE: Voltage Follower Circuit (Buffer Circuit)

Figure 1 shows the circuit schematic for a voltage follower circuit. It employs negative feedback whereby the inverting input vin is equal to the output voltage vout. Since the op-amp input resistance is very high, voltage followers are useful because they serve as a buffer that connects two circuits together.

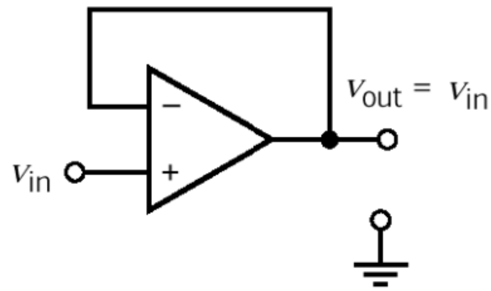


Figure1. Schematic of buffer

1. Voltage divider with a resistor load, without buffer. As shown in Figure.1, a Voltage Divider consisting of (R1, R2) is a simple series resistor circuit, where Vs=3Vdc, $R_1=R_2=10k\Omega$.

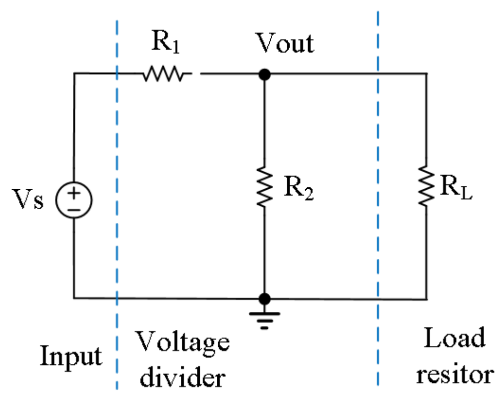


Figure2. Schematic of Voltage Divider Circuit, without buffer

1) Simulate the circuit in Figure2 to find the value for Vout, without the load resistance R_L in the circuit, or R_L =20kΩ. __/2pt

without R_L: $V_{out}=1.5V$ with $R_L=20k\Omega$ $V_{out}=1.2V$

2) Simulate the circuit in Figure2 to find the value for Vout, with the load resistance R_L =2kΩ. __/2pt

with $R_L=2k\Omega$ $V_{out}=429mV$

2. Voltage divider with buffer

As shown in Figure3, the Voltage Divider circuit, which on the left of the buffer, sees a high resistance load and therefore is not affected. When the buffer is used, the op-amp will supply the current. Without the buffer, the operation of the Voltage divider would be altered by the current that is drained by the loading circuit (R_L here) .

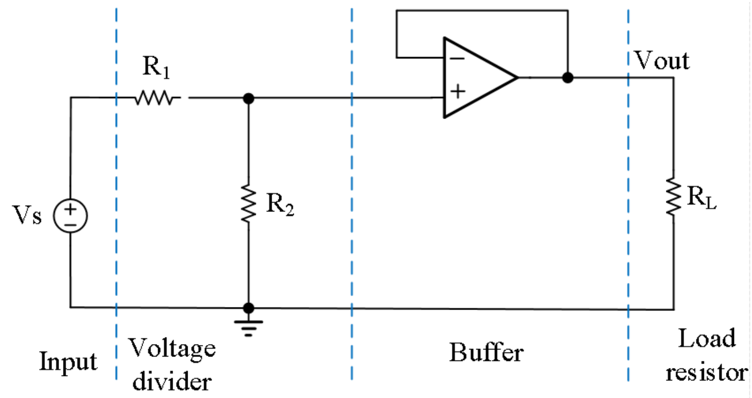
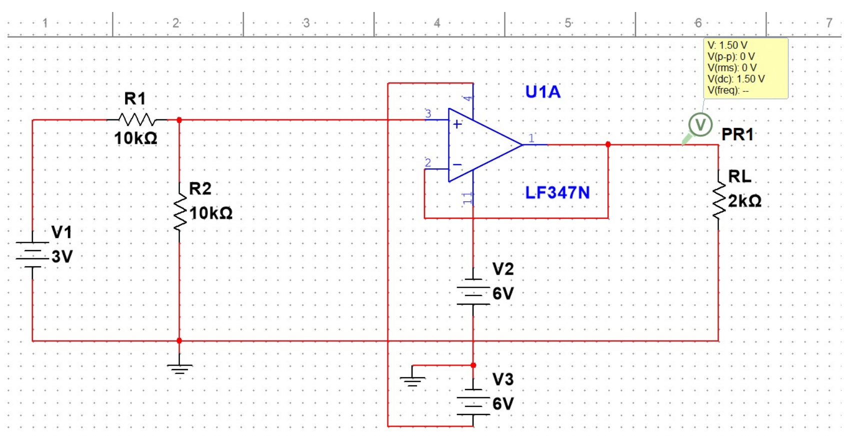


Figure3. Schematic of Voltage Divider Circuit, with buffer

1) Simulate the circuit in Figure3 to find the value for Vout, with the load resistance R_L =2kΩ

2) Take a screenshot of the schematic, in which the simulation result of Vout is displayed. __/2pt

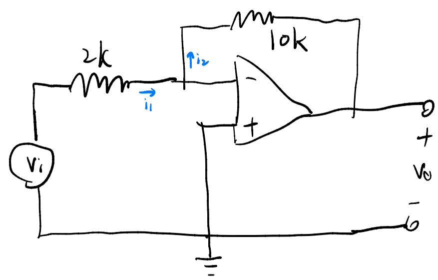


PART Four: Inverting Amplifier

1. Design an inverting amplifier with an input impedance of 2k, |gain|=5. Assume the operational amplifier is ideal, find and label the value of the other components in the schematic, show how you got your results. __/4pt

for an ideal op. we have $i_1 = i_2 \Rightarrow \frac{V_i - V_1}{R_1} = \frac{V_1 - V_0}{R_f}$, $V_1 = V_2 = 0$, $\frac{V_i}{R_1} = -\frac{V_o}{R_f}$

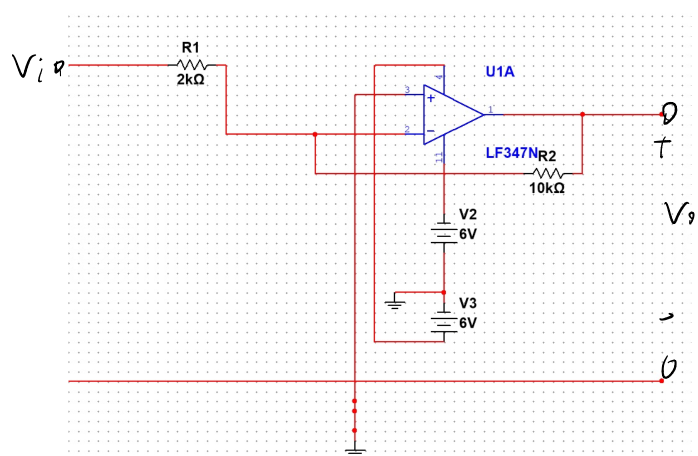
$\Rightarrow V_o = -\frac{R_f}{R_1} V_i$ if $R_1 = 2k$ we can choose $R_f = 10k$ to make $|gain| = \left|\frac{10k}{2k}\right| = 5$



2. Simulate the inverting op-amp circuit which you design in step3 using Multisim

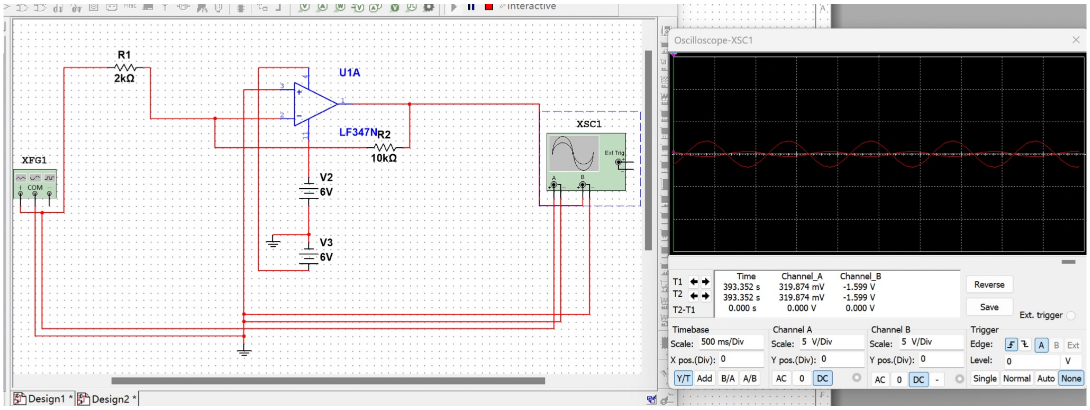
1) Construct the inverting op-amp circuit you design in Multisim (use the LF347N by selecting the "place components"->" analog" button and typing "LF347N" in the component box) , and the two dc power supply for op amp LF347N is ±6V, both with respect to ground. Take a screenshot in the space below. __/3pt

Note: The connection of these power supplies is crucial because if they are connected incorrectly, the circuit will probably be not work.

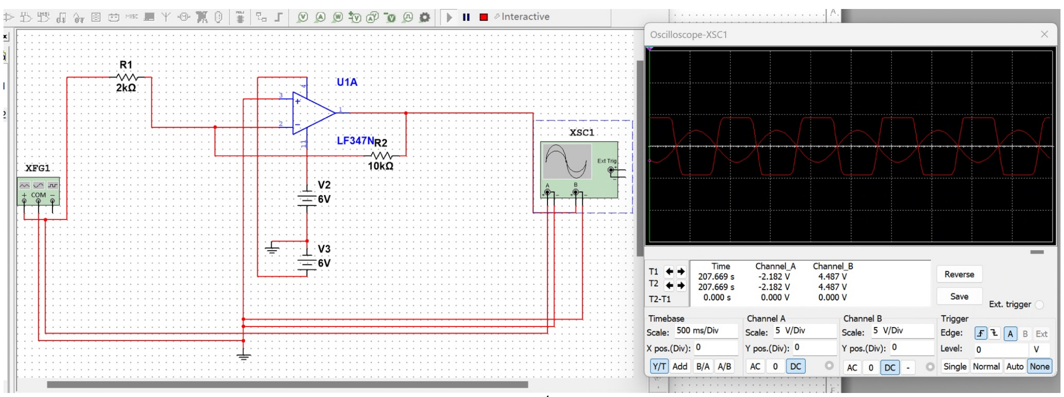


2) Setup a 0.8Vpp, 1kHz sine wave as the input signal, and plot the transient signal at the output in the space below. Carefully measure your circuits gain. Does the gain agree with the design value? __/3pt

The gain agree with the design value



3) Setup a 5Vpp, 1kHz sine wave as the input signal, and plot the transient signal at the output in the space below. Describe the output signal and explain the reason. $-V_{cc} \le V_o \le V_{cc}$ __/4pt



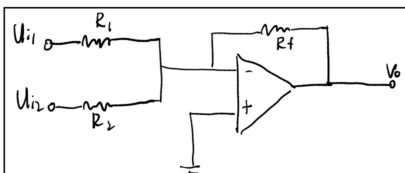
the output voltage $V_o = 5\times2.5 = 12.5V > 6V$, don't satisfy $-V_{cc} \le V_o \le V_{cc}$

which means that the operational amplifier operates outside the linear range

Thus $V_o \neq 5V_i$

3. Op amps can be used to sum signals. Construct a Summing Amplifier whose output equals: $u_o = -(2u_{i1} + u_{i2})$, in which Rf =10kΩ, dc power supply for op amp LF347N is ±6V, both with respect to ground.

1) Find the value of the remaining components, show how you got your results. __/4pt



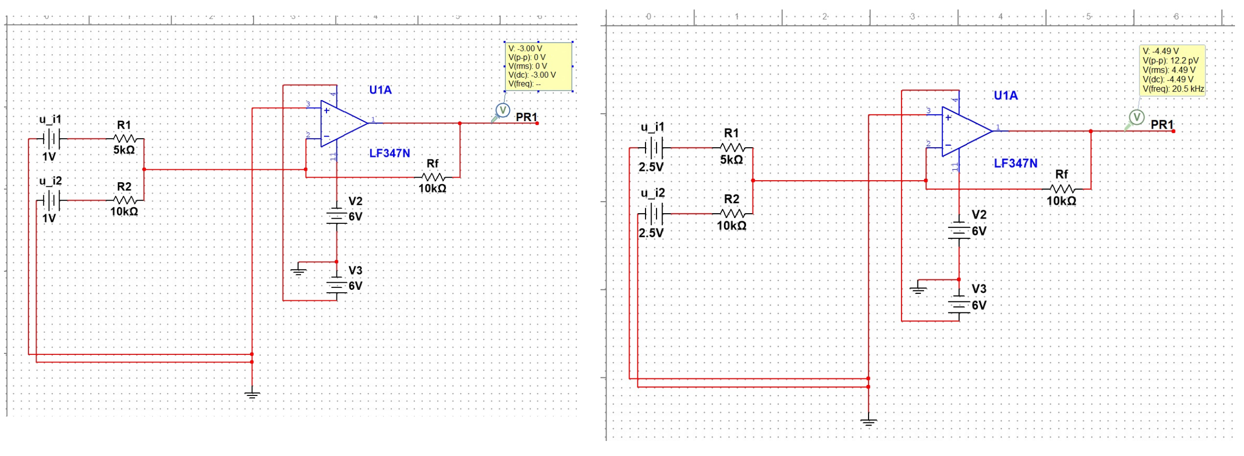
$$\frac{U_{i1}}{R_1}+\frac{U_{i2}}{R_2}+\frac{V_o}{R_f}=0$$

$$V_o = -\left(\frac{R_f}{R_1}U_{i1}+\frac{R_f}{R_2}U_{i2}\right)$$

$$\frac{R_f}{R_1}=2 \qquad R_1=\frac{R_f}{2}=5k\Omega$$

$$\frac{R_f}{R_2}=1 \qquad R_2=R_f=10k$$

2) Construct and simulate the inverting Summing Amplifier circuit you design by Multisim (use the LF347N by selecting the "place components"->" analog" button and typing "LF347N" in the component box), and the two dc power supply for op amp LF347N is ±6V, both with respect to ground. Take a screenshot in the space below. Finally, fill the blank. __/3pt



U_{i1}	U_{i2}	U_o
1 (V)	1 (V)	−3.00 (V)
2.5 (V)	2.5 (V)	−4.49 (V)

4. When U_{i1}=2.5V, U_{i2}=2.5V, Does the output still equals to $u_o = -(2u_{i1} + u_{i2})$? Why? __/3pt

No longer. Since $|-(2U_{i1}+U_{i2})| = |-(2\times2.5+2.5)| = |-7.5V| > 6V$

Which means that the operational amplifier operates beyond it's linear range.

Thus. $U_o \neq -2(U_{i1}+U_{i2})$