UNIVERSITY OF LOUISIANA AT LAFAYETTE

CONTROL SYSTEMS

MCHE 474

Lab 2

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MARCH 14, 2016

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V_o = Output Voltage (Volts)
V_i = Input Voltage (Volts)
R_1 = Input Resistance (Ohms)
R_2 = Output Resistance (Ohms)
Ω = Ohms

Introduction

This lab was conducted by utilizing Multisim in order to analyze operational amplifiers, or op amps. The types of op amp configurations analyzed are the inverting, non-inverting, and follower configurations. A summing device was also analyzed.

Theory

An op amp utilizes an amplifier with input and output resistors in order to change the input signal by a factor, called gain. An inverting amplifier changes the input signal's sign, as well as scales the signal by the gain. The equation for an inverting amplifier's gain is shown in Equation 1. The sign of a signal can be changed if desired without altering the signal voltage by running the signal through an inverting amp with a gain of 1.

A non-inverting amplifier does not change the sign of a signal, but does scale the signal by the gain. The gain equation for a non-inverting amplifier is shown in Equation 2. A non-inverting amplifier can be turned into a follower by shorting the output resistor R_2, which results in the gain of the amplifier being 1. While the voltage supplied to any subsequent devices in the circuit is unchanged, a follower will isolate these devices by acting as a signal buffer. Notice that by setting the resistor $R_2 = 0$, the gain is 1, as discussed above.

$$\frac{V_o}{V_i} = -\frac{R_2}{R_1} \tag{1}$$

$$\frac{V_o}{V_i} = 1 + \frac{R_2}{R_1} \tag{2}$$

Op amps can also be used as summing devices, where the voltages fed into the negative and positive inputs of the amplifier are summed together, yielding the answer as the output voltage.

Procedure & Analysis

First, an inverting amplifier was created with $R_1 = 1M\Omega$ and $R_2 = 1k\Omega$, resulting in a gain of -0.002 by Equation 1. This can be seen in Figure 1. Note that the output voltage is as expected by solving for V_o in Equation 1. A non-inverting amplifier was then created with $R_1 = 1k\Omega$ and $R_2 = 2k\Omega$, resulting in a gain of 3 by Equation 2. The output voltage is again as expected by solving for V_o in Equation 2.

The non-inverting amplifier is then changed to a follower by shorting R_2, shown in Figure 3. Note that the gain is simply 1, as discussed in the Theory section. A summing device was then created and is shown in Figure 4. The negative input voltage is 1.8 volts, while the positive input voltage is 6 volts. These two signals are then summed, and the output is 4.2 volts, as is expected.

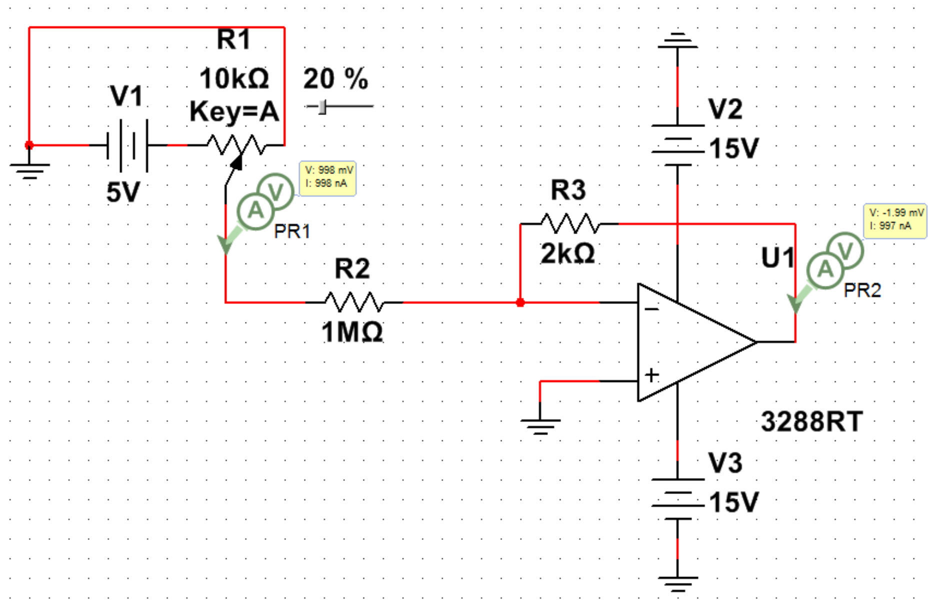

Figure 1: Inverting Amplifier

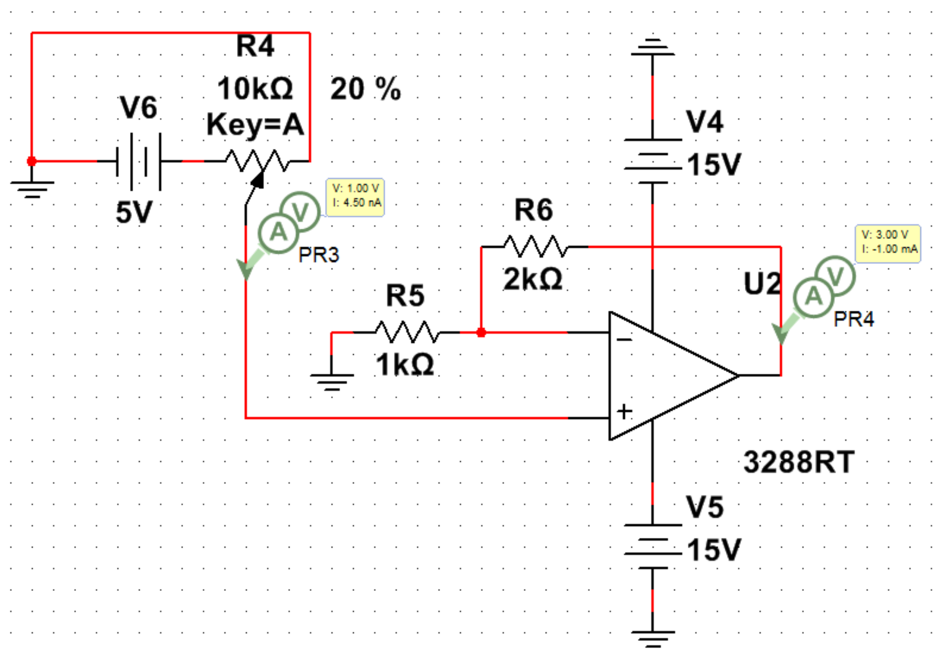

Figure 2: Non-Inverting Amplifier

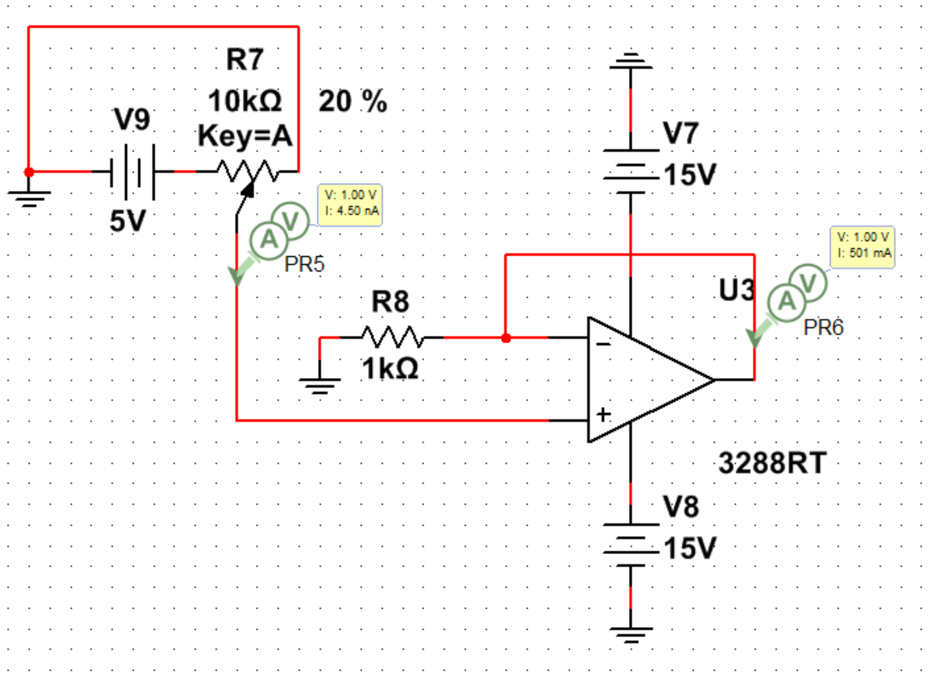

Figure 3: Follower Device (Signal Buffer)

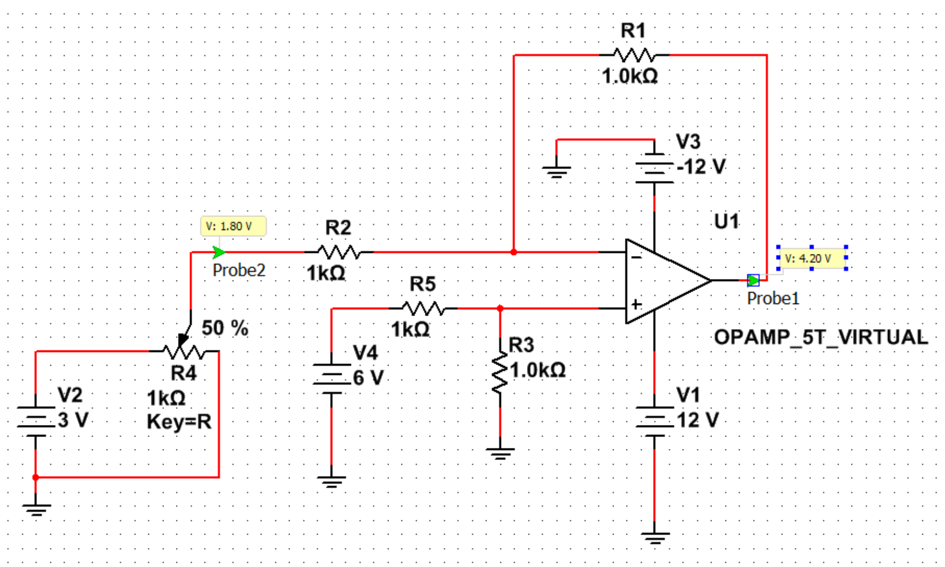

Figure 4: Summing Device

Conclusion

The exercises conducted in this lab reinforce the theory learned in the classroom. It is shown that electric circuits can be modeled and analyzed in Multisim. The circuits created in this lab are commonplace in electronic circuits, and the creation of these circuits in Multisim helps the student to further understand what is really happening in these circuits. The first hand experience simulating these circuits supplements the information previously learned about amplifiers, and is very beneficial.