Electronics Lab 03: Operational Amplifiers

Adam Stammer

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I. PURPOSE

Not Requested

II. CONCLUSIONS

Not Requested

III. THEORY

There are multiple practical ways to hook up operational amplifiers. One of the most common is an inverting voltage amplifier. We can see a diagram of this below 1.

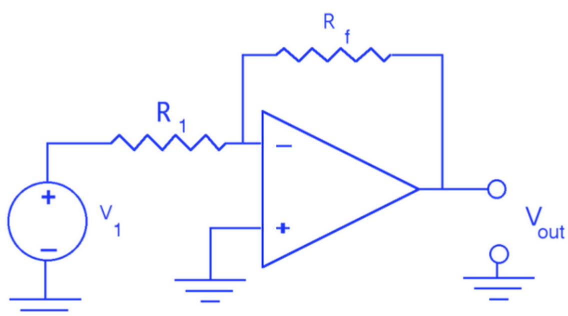

FIG. 1. Inverting Voltage Amplifier

Using nodal analysis we can find the output voltage (V_0). One of our golden rules of operational amplifiers states that no current flows in or out of the input terminals of the amplifier. Knowing this we can say that 1

$$I_1 = I_2 \tag{1}$$

From here we can use Ohms Law [$I = \frac{V}{R}$] to say that

$$I_f = \frac{V_o - V_-}{R_f} \tag{2}$$

$$I_1 = \frac{V_- - V_s}{R_1} \tag{3}$$

It's a simple matter of substitution from here. First we use our other golden rule to know that V_- is equal to V_+ which is connected to ground. So the equation can be rewritten as seen below [4].

$$\frac{V_o}{R_f} = \frac{-V_1}{R_1} \tag{4}$$

Some simple algebra later and we'll have a practical equation to find V_o.

$$V_o = -V_s \frac{R_f}{R_1} \tag{5}$$

We only need our golden rules to solve for V_o in Circuit 2 [2].

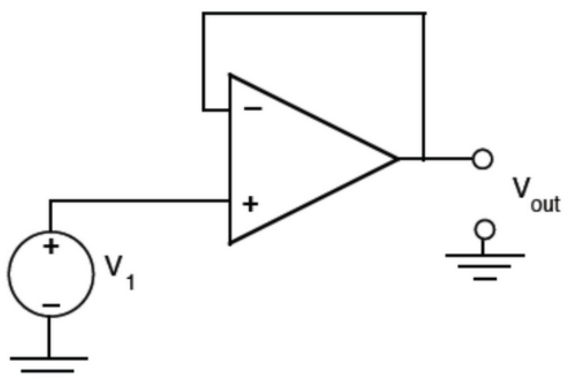

FIG. 2. Voltage Follower Circuit

$$V_o = V_1 \tag{6}$$

With a very similar process as with Circuit 1 [1] we can solve Circuit 3 [3].

$$V_o = V_1 \frac{R_2 + R_1}{R_2} \tag{7}$$

IV. DATA

Not Requested

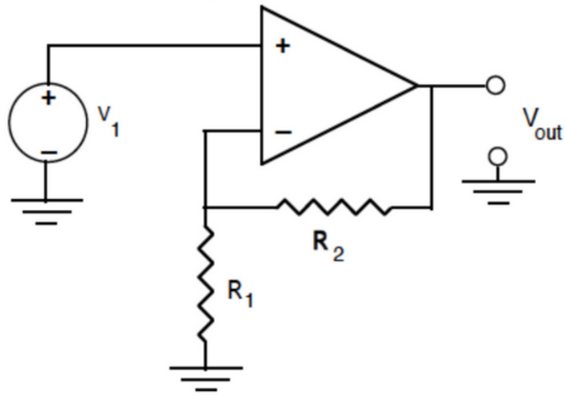

FIG. 3. Non-Inverting Voltage Amplifier

V. ANALYSIS

Taking the data gathered from one of our circuits we can graph it and look for a useful pattern or trend. The data taken from the voltage follower can be seen graphed in a scatter plot below [4].

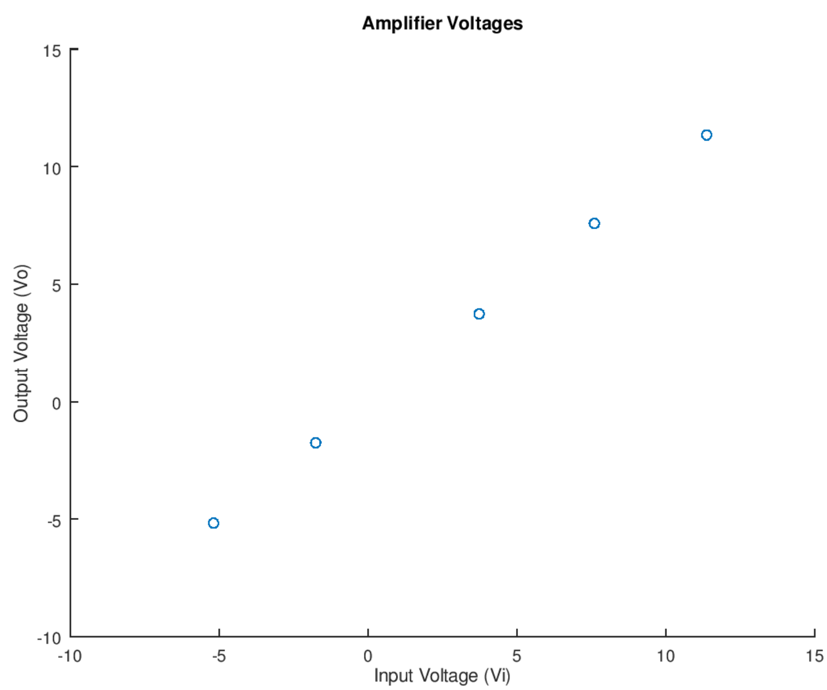

FIG. 4. Amplifier Voltage Graph

Voltage gain is defined as $\frac{V_o}{v_i}$. Since this is a graph of V_o vs V_i we know that the slope of this line should indeed be the gain of the circuit. Throughout the graph the slope appears to remain constant, implying that the gain of the circuit does not depend on the input voltage of the circuit. The same trend can be found in the data collected of the other circuits as well.

This is a very valuable thing to know, because we would otherwise need to accommodate, in our designs, for a variation based on the input.

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