Università degli studi di Trento

Group **MAR01**

REPORT OF THE EXPERIMENTS PERFORMED IN THE COURSE OF PHYSICS LABORATORY III

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Experiment 1

Basic circuits with an operational amplifier

In this experiment we have built five different circuits. The first is an open loop circuit with the operational amplifier uA741, the goal was to find the maximum voltage outputed by the op-amp. The last four circuits are in closed loop configuration with a negative feedback, they consist in a follower, a non inverting amplifier, an inverting amplifier and a weighted summing amplifier. We have measured the voltage input and the voltage output of every circut.

1.1 Materials

- Operational amplifier uA741
- Resistors, nominal value: 100 Ω, 220 Ω
- Power supply RIGOL DP831A
- Waveform generator RIGOL DG1032
- Multimeter RIGOL DM3068
- Oscilloscope AGILENT 54261A

1.2 Experiment setup

In the first four circuits the output of the waveform generator was a sine wave of 100Hz frequency and a peak-peak voltage of 100mV. We measured the waveform output signal and the output voltage v_o of the op-amp. The measurements were performed using an oscilloscope triggered externally, the signal acquired is an 8 cyles average. The voltage supply of the op-amp was set to $v_{cc} = 15$V for all the circuits.

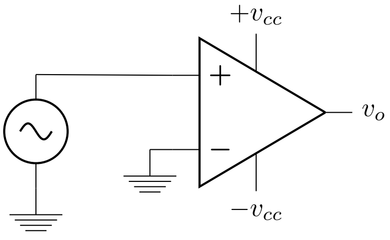

Figure 1.1: Open loop circuit

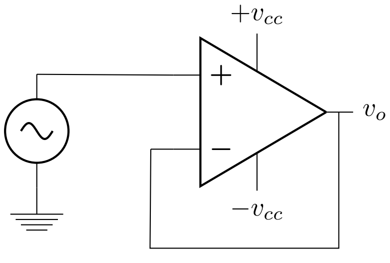

Figure 1.2: Follower

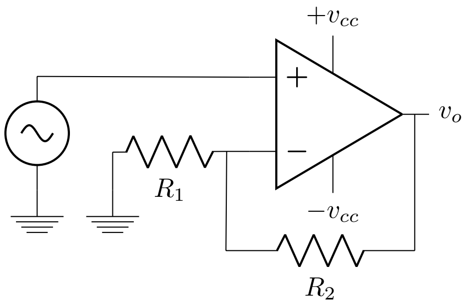

Figure 1.3: Non inverting amplifier

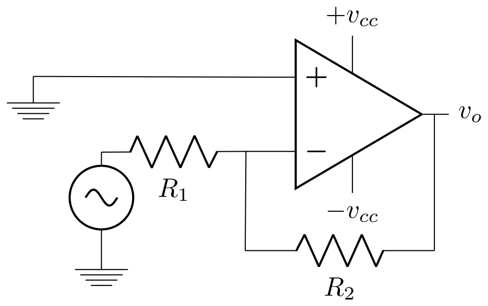

Figure 1.4: Inverting amplifier

For the last circuit we used another sine wave signal with the same 100Hz frequency and a different peak-peak voltage. The oscilloscope's setting and the measurement taken was the same as before. The values of the resistor are: $R_1 = 99.89 \pm 0.02$, $R_2 = 218.37 \pm 0.04$, $R_3 = 99.89 \pm 0.02$, measurement made with the multimeter.

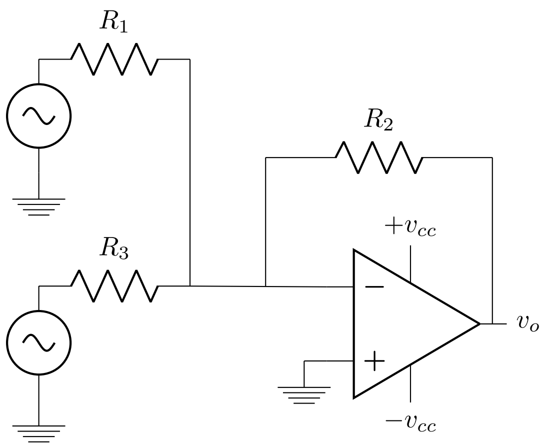

Figure 1.5: Weighted summing amplifier

1.3 Data analysis

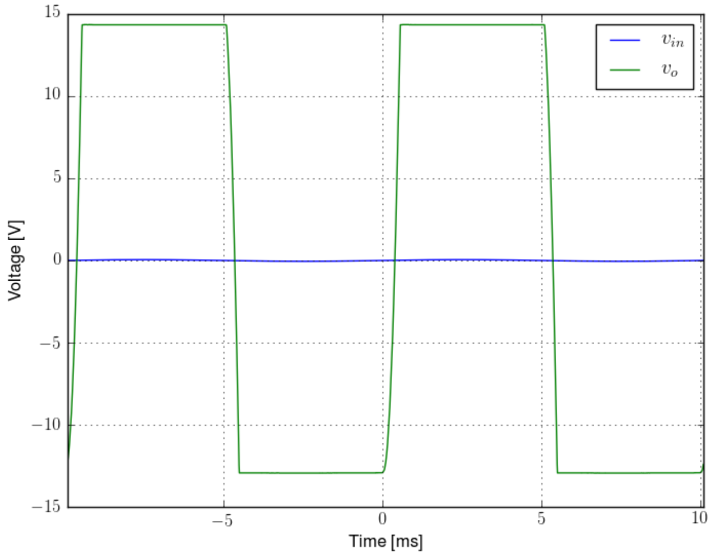

Figure 1.6: Open loop configuration

In the open loop configuration we get an output (visible in the figure one) that has a max absolute value of 14.35 ± 0.16[1] V and changes sign with the input. This is what we can expect from the ideal model of the op-amp as justified from the equation $v_o = A_{ol}(v_+ - v_-)$ where A_{ol} tends to infinity. In the physical case the output voltage is costrained by the saturation voltage that's determinated by the voltage applied to the op-amp.

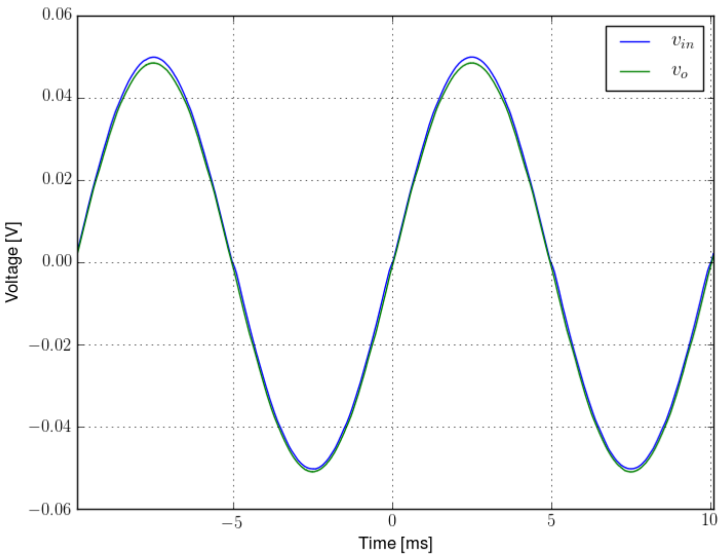

Figure 1.7: Emitter follower

In the emitter follower we expect, ideally, an output voltage equal to the input one. But we can

[1] Error based on oscilloscope's 8 bit resolution

see in the plot a small discrepancy between the two signals: that is determined, as before, by the non-ideality of the op-amp.

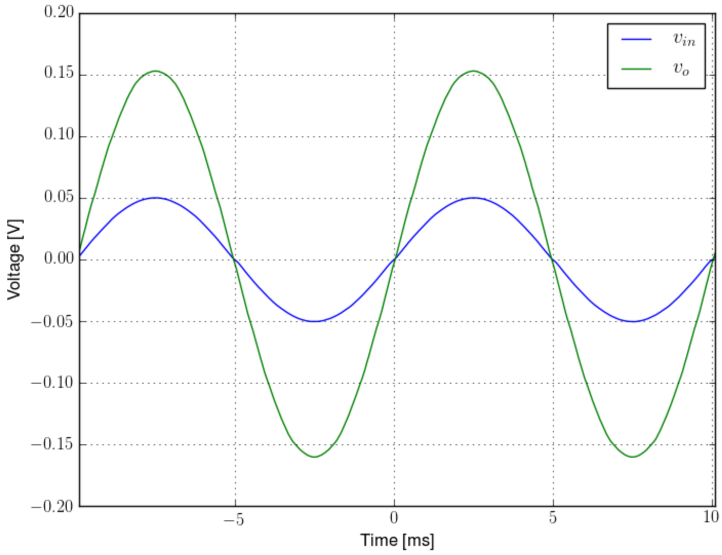

Figure 1.8: Non-inverting amplifier

In the non-inverting amplifier configuration we expect the output to be: $v_o = v_{in}(1 + \frac{R_2}{R_1})$. We can see the measured output is compatible with the theoretical value avalable in the table().

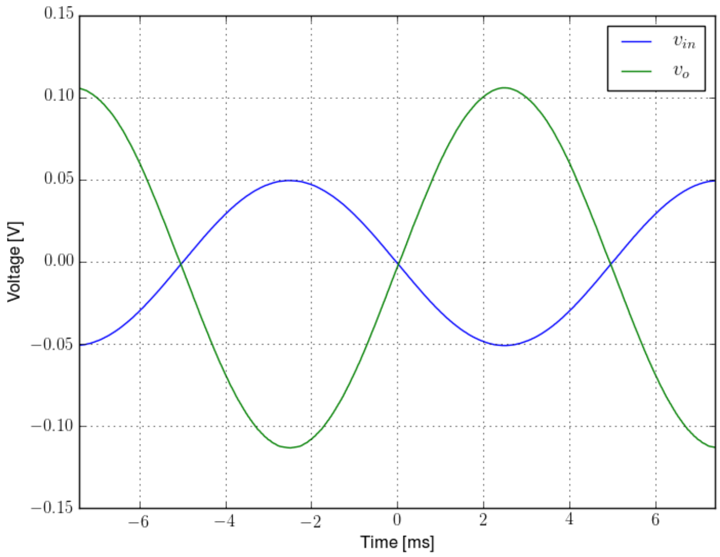

Figure 1.9: Inverting amplifier

In the circuit x the output should be : $v_o = -v_{in}\frac{R_2}{R_1}$. We see in the table x that the experimental value is compatible.

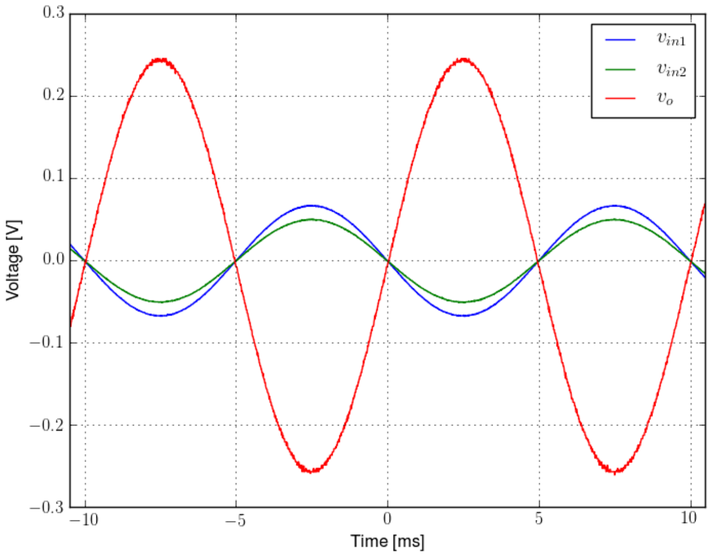

Figure 1.10: Weighted summing circuit

In the circuit y we used two inputs for aquiring an output voltage. This configuration sums these signals using the resistors R_1 and R_2 as weights, giving as output $v_o = -R_3(\frac{v_1}{R_1} + \frac{v_2}{R_3})$, that we correctly measured.