OPERATIONAL AMPLIFIERS
Experiment 4 – Operational Amplifiers

In this experiment we will study some of the basic uses of operational amplifiers. The main purpose of the device is to amplify the signals, so some of the most common amplifier configurations will be studied. These include the inverting, non-inverting, integrating and differentiating amplifier circuits.

As we discussed in the lecture, the standard 741 op-amp consists of 8 pins (see Figure 1 and Figure 2). Only five pins are used in operational amplifiers circuits. The operational amplifier is powered up by a split supply, usually $\pm 12\, V$, at pins 7 and 4. Pin 2 represents the inverting input, pin 3 – non-inverting input. The output is read on pin 6. Pins 1, 5 and 8 are not used.

![Figure 1: 741 – top view](image1)

![Figure 2: 741 – schematic](image2)

**Inverting Op-Amp**

Set up the Inverting Op-Amp circuit with negative feedback as shown in the Figure 3. Remember, to power up the operational amplifier by a split supply (2 DC power sources). Use signal generator for the input signal. Observe the output voltage with the oscilloscope.

First analyze the circuit using the measured resistances of your actual components (show all your work!). Calculate the expected gain factor $G$. Use DC input and output measurements to get the experimental value of the gain factor.

Repeat the gain measurements using the peak-to-peak values of the sine wave. Make a note on how your gain measurements compare to the expected value. Make plots of the corresponding input and output signals. Repeat with triangular input.

Find the maximum output swing by slowly raising the swing of the input sine wave. Report the changes in the output signal shape. What limits the maximum swing of op-amp?

Perform the frequency scan: using peak-to-peak measurements for input and output to find the gain factor for each data point, plot gain as function of frequency for the sine wave. (Take three measurements per frequency decade and represent your plot with the frequency axis in log format). How does the op-amp gain factor depend on frequency of your input?
**Non-Inverting Op-Amp**

In your previous set-up, change the feed-back loop to make a non-inverting amplifier as shown in Figure 4. Repeat the circuit analysis for this setup by using the “golden rules” first (determine expected $G$), and then by measuring peak-to-peak voltages for input and output signal (same as in the inverting amplifier part).

Record the input and output behavior for this circuit in response to different signal shapes. Do your results agree with your expectations?

**Integrating Amplifier**

Set up the circuit shown in Figure 5. Remember to properly power up your op-amp before taking the measurements. Repeat the circuit analysis for this setup by using the “golden rules” first (determine $G$, $Z_{in}$), and then by measuring peak-to-peak voltages for input and output signal (same as in the inverting amplifier part).

Record the input and output behavior for this circuit in response to different signal shapes. Do your results confirm that this circuit behaves as signal integrator? Are the signal amplitudes consistent with your expectation?

**Op-Amp Differentiator**

Set up the circuit shown in Figure 6. Repeat the circuit analysis for this setup by using the “golden rules” first (determine $G$, $Z_{in}$), and then by measuring peak-to-peak voltages for input and output signal (same as in the inverting amplifier part).

Record the input and output behavior for this circuit in response to different signal shapes. Do your results confirm that this circuit behaves as signal differentiator? Are the signal amplitudes consistent with your expectation?