Experiment-7

Basic Operational Amplifier circuits

Hardware Exercise Objectives:

1. To build inverting amplifier, non-inverting amplifier, differentiator and integrator using Op-Amps

Equipment/Components Required:

1. OP-Amp µA 741
2. Resistors of suitable values
3. Capacitors of suitable values
4. Regulated power supply
5. Arbitrary Function Generator
6. Digital Storage Oscilloscope

Steps:

Inverting Amplifier

1. Wire up the inverting amplifier circuit shown in the figure 1, with R_1 =1 k, R_2 =10 k. Remember to connect the supply (±15 V). Apply a sinusoidal input with a peak of 0.1V and frequency 1 kHz. Observe V_i and V_o on the oscilloscope and confirm that the magnitude and phase of Vo is what you would expect.
2. Increase the input amplitude from 0.1V to 2 V, and observe the output waveform. Explain your observation.
3. Keep the input amplitude at 0.5 V, and increase the frequency until the output waveform becomes triangular. From the waveform, calculate the slew rate and compare it with the data sheet of the op amp you are using.
4. Record the gain of the amplifier versus frequency for 10 Hz < f < 1MHz. Take sufficient number of readings in the frequency range where the gain changes significantly with frequency. For each frequency point, measure both input and output amplitudes. (It is important to keep track of the input amplitude since the output of the function generator may drop slightly at high frequencies.)
5. Record the frequency response (same as Step 4) for R_1 =1 k, R_2 =100 k. Plot the frequency response for R_2 =10 k and that for R_2 =100 k together (same graph), with the gain in dB and frequency on log scale.

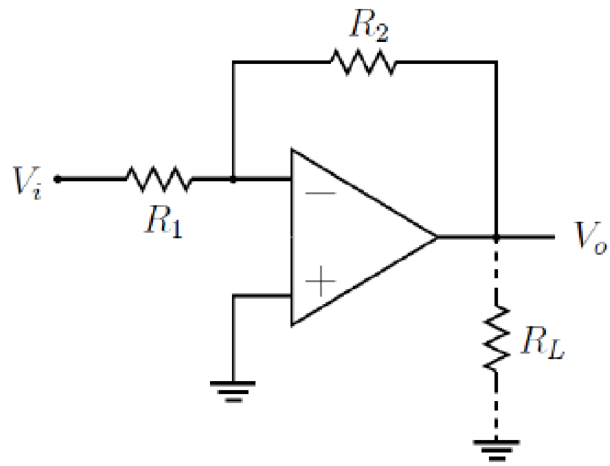

Figure 1. Circuit of an inverting Amplifier

Non Inverting Amplifier

Repeat the steps of the inverting amplifier for the non-inverting amplifier circuit shown in the figure 2.

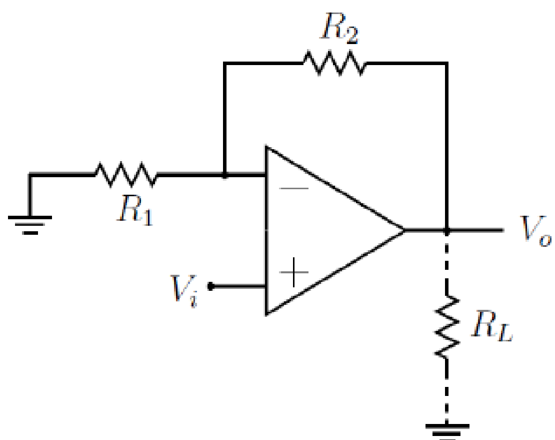

Figure 2. Circuit of a non-inverting Amplifier

Integrator

1. Wire up the integrator circuit shown in the figure 3 with R=10 k, C =0.01 μF, R′ =470 k. Note that R′ is used to prevent the op amp from entering saturation (because of a non-zero DC component in the input voltage or the op amp bias current). Verify that, with a square wave input (±2 V, 1 kHz), the output voltage is triangular.

2. With a square wave input, what is the output waveform? Compute the frequency at which an input square wave of ±2V will produce an output voltage going from −2V to +2 V. Verify experimentally.

3. Keep the input voltage as in step 2. Replace R′ with a 500 k pot. Change the pot from minimum to maximum, and observe its effect on the output waveform. Explain your observation.

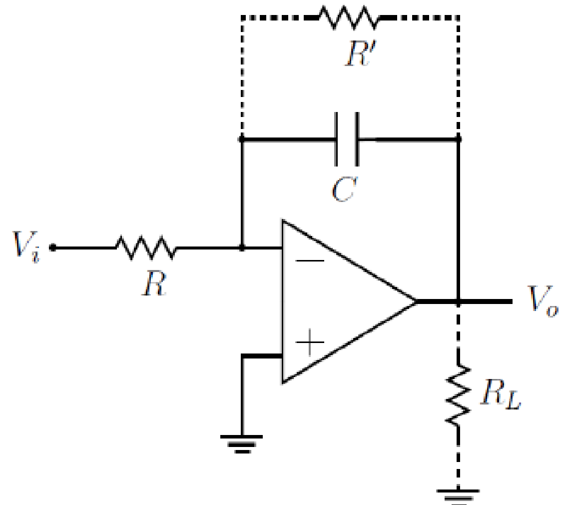

Figure 3. Circuit of an integrator

Differentiator

1. For the differentiator circuit shown in the figure 4 with a triangular wave input (±2 V, 2.5 kHz), R=10 k, C =0.01 μF, what do you expect for $V_o(t)$?

2. Wire up the circuit and observe Vo(t). Is it close to your expectation?

3. Connect a small capacitor C′ =0.001 μF in parallel with R, and observe $V_o(t)$.

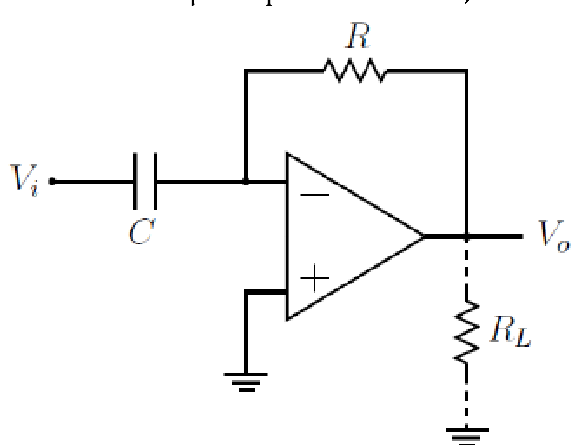

Figure 4. Circuit of a differentiator