

ELE2EMI 2007

Laboratory 4: Applications of Operational Amplifiers

Equipment

1. 5V power supply
2. Protoboard
3. Signal generator
4. Single strand hook-up wire
5. Four operational amplifiers
6. One 10 k Ω potentiometer
7. One 15 k Ω resistor
8. Six 22 k Ω resistors
9. Two 39 k Ω resistors
10. One 100 k Ω resistor
11. Four 1 nF *nonpolar* polyester capacitors

Aim

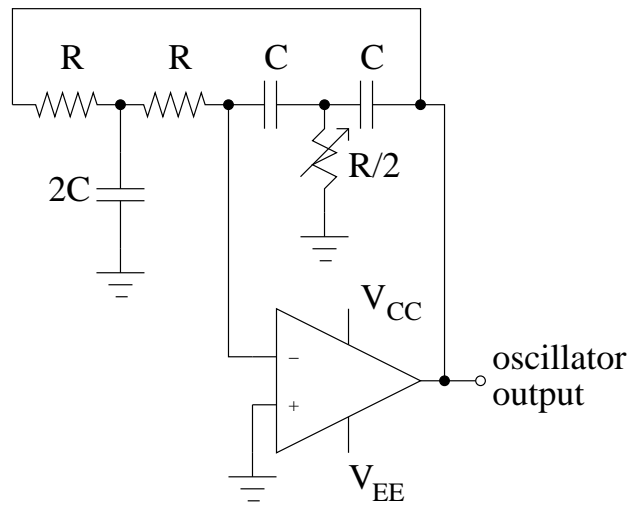
The aim of this laboratory is to gain hands-on experience of using operational amplifiers. You will build a simple oscillator, a simple amplifier, a comparator, and an adder. These four circuits will gradually be connected together.

1 Oscillator

Build the oscillator circuit shown below. Use the following values:

- $R = 39 \text{ k}\Omega$
- $C = 1 \text{ nF}$ (nonpolar)
- $V_{CC} = +10 \text{ V}$
- $V_{EE} = -10 \text{ V}$
- $R/2 = 10 \text{ k}\Omega$ potentiometer in series with a 15 k Ω resistor.

Measure the amplitude and frequency of its output. **Verify** that the frequency is roughly $f_0 = \frac{1}{2\pi RC}$.



The purpose of the oscillator circuit is to produce a 4 kHz sine wave. If it does not function correctly, use a commercial signal generator instead.

2 Comparator

Build the comparator circuit shown below, with:

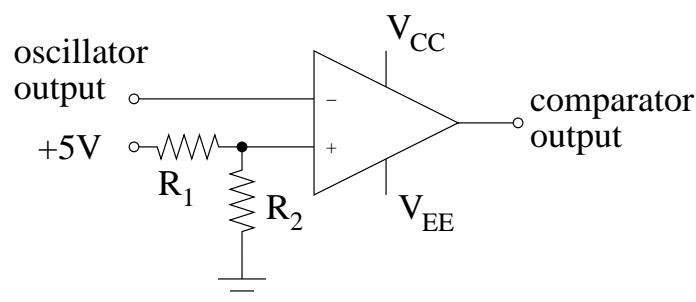
- $R_1 = 100 \text{ k}\Omega$
- $R_2 = 22 \text{ k}\Omega$

Connect the output of the oscillator to the input of the comparator.

Display the output of the comparator on an oscilloscope.

What can you see as you change the values of the resistors?

Why does that occur?



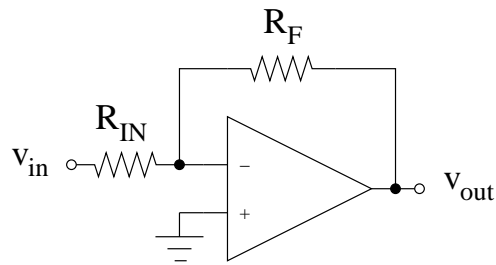
3 Inverting Amplifier

Design an inverting amplifier whose gain is -0.22 using the following circuit ($R_{IN} = 100 \text{ k}\Omega$), by determining the correct value for the feedback resistor R_F .

Build it.

Verify your circuit by comparing its output to its input.

Use the output of the comparator as the input to the amplifier.



4 Adder

Design the adder circuit shown below, by *choosing the values of the resistors* so as to implement this operation:

$$y = x_1 + 2x_2$$

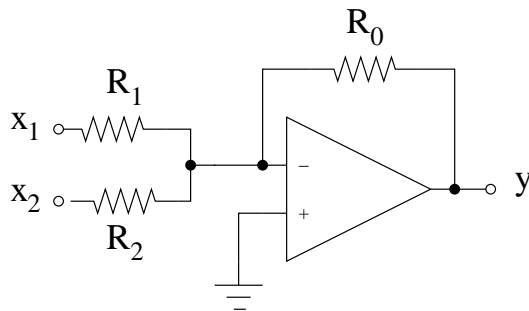
where y is the output, and x_1 and x_2 are the two inputs.

Build the adder.

Connect the output of the amplifier to input x_2 of the adder.

Connect a signal generator to input x_1 .

Verify your circuit by comparing the output of the adder to its input.



5 Report

Your laboratory report should show:

1. All experimental details, including:
 - (a) Each circuit diagram;
 - (b) the input and output waveform on the same set of axes;
 - (c) the derivation of the unknown resistor value in each circuit.
2. The procedures you use to verify circuits 3 and 4.

Your report is due by the start of the next laboratory session.