NEUB CSE 214 LAB 6

North East University Bangladesh
Department of CSE
Course no: CSE 214
Experiment no: 06
Experiment Name: Introduction to op-amp

CAUTIONS:

1. **Don't switch on the supply of the circuit until you have verified the circuit carefully**
2. **Take readings of apparatus carefully**
3. **Take care of any bare circuit elements in energized condition**
4. **Never try to touch bare live wires**

Objective

The objective of this experiment is to implement circuit and sketch the output of Inverting amplifier, Non-inverting amplifier and Voltage follower.

Theory

In this laboratory experiment, you will learn several basic ways in which an op-amp can be connected using –ve feedback to stabilize the gain and increase the frequency response. The extremely high open-loop gain of an op-amp creates an unstable situation because a small noise voltage on the input can be amplified to a point where the amplifier in driven out of its linear region. Also unwanted oscillations can occur. In addition, the open-loop gain parameter of an op-amp can vary greatly from one device to the next. Negative feedback takes a portion of output and applies it back out of phase with the input, creating an effective reduction in gain. This closedloop gain is usually much less than the open-loop gain and independent of it.

Closed – loop voltage gain, ACL

The closed-loop voltage gain is the voltage gain of an op-amp with external feedback. The amplifier configuration consists of the op-amp and an external –ve feedback circuit that connects the output to the inverting input. The closed loop voltage gain is determined by the external component values and can be precisely controlled by them.

Non inverting amplifier

An op-amp connected in a closed-loop configuration as a non-inverting amplifier with a controlled amount of voltage gain is shown in Fig 1.

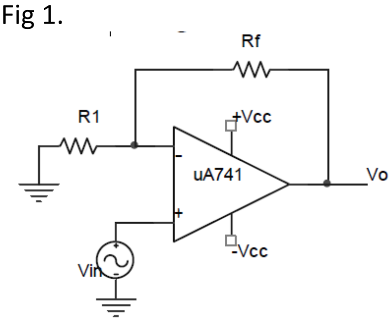

Figure 1 Non-inverting op-amp circuit

The input signal is applied to the non-inverting (+) input. The output is applied back to the inverting (-) input through the feedback circuit (closed loop) formed by the input resistor R1 and the feedback resistor Rf. This creates –ve feedback as follows. Resistors R_1 and R_f form a voltagedivider circuit, which reduces V_O and connects the reduced voltage V_f to the inverting input. The feedback is expressed as

$$V_f = \left(\frac{R_1}{R_1 + R_f}\right) V_o$$

The difference of the input voltage, V_{in} and the feedback voltage, V_f is the differential input of the opamp. This differential voltage is amplified by the gain of the op-amp and produces an output voltage expressed as

$$V_o = \left(1 + \frac{R_f}{R_1}\right) V_{in}$$

The closed-loop gain of the non-inverting amplifier is, thus

$$A_{CL(NL)} = 1 + \frac{R_f}{R_1}$$

Notice that the closed loop gain is

- independent of open-loop gain of op-amp
- set by selecting values of R1 and Rf

Voltage follower

The voltage follower configuration is a special case of the non-inverting amplifier where all the output voltage is feedback to the inverting input by straight connection, as shown in fig. 2. The coltage gain is expressed as

$$A_{CL(VF)} = 1 + \frac{0}{\infty} = 1$$

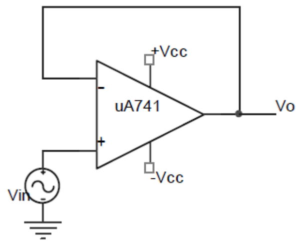

Figure 2 Voltage follower op-amp circuit

Inverting amplifier

An op-amp connected as an inverting amplifier with a controlled amount of voltage gain is shown in fig. 3.

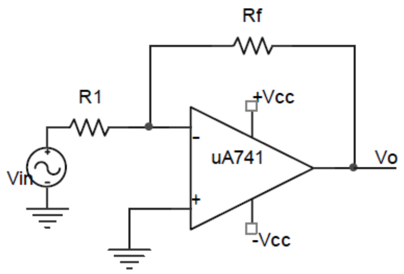

Figure 3 Inverting amplifier op-amp circuit

The input signal is applied through a series input resistor R_1 to the inverting input. Also, the output is fed back through R_f to the same input. The non-inverting input is grounded. An expression for the output voltage of the inverting amplifier is written as

$$V_o = -\frac{R_f}{R_1} V_{in}$$

The –ve sign indicates inversion. The closed-loop gain of the inverting amplifier is, thus

$$A_{CL(I)} = -\frac{R_f}{R_1}$$

Apparatus Needed

- Trainer Board
- UA 741 op-amp
- Resistors
- Function generator
- DC Voltmeter
- DC Ammeter
- DC power supply
- Connecting wires

Procedure

1. Design a non-inverting amplifier for the gain of 21. Let R_1=1k Assemble the circuit.
2. Feed sinusoidal input of amplitude 100mV and frequency 1KHz.
3. Observe the input voltages and output voltage on an Oscilloscope.
4. Assemble a voltage follower circuit.
5. Feed sinusoidal input of amplitude 100mV and frequency 1KHz.
6. Observe the input voltages and output voltage on an Oscilloscope.
7. Design an inverting amplifier for the gain of 20. Let R_1=1kΩ. Assemble the circuit
8. Feed sinusoidal input of amplitude 100mV and frequency 1KHz.
9. Observe the input voltages and output voltage on an Oscilloscope.

Report

1. Plot all the graph from steps 3,6 and 9.
2. Comment on the learnings from this LAB