Lab 7

Operational Amplifiers – Basic Characteristics and Applications

Objective

The objective of this lab experiment is to learn how to use the operational amplifier (op-amp). In this experiment some of the basic characteristics of the op-amp would be examined and then some of its applications like the Inverting amplifier, Non inverting amplifier will be experimented.

Theory Overview

The Operational Amplifier (Op Amp) is an extremely useful device, as we will see in this lab. With the addition of a few external components, an extraordinary variety of functions can be implemented. The Op Amp is an active element that needs to be supplied with power to operate. A common way to supply this power is shown in Figure 1(a). Two power supply voltages are used, with equal values denoted by V_{cc} and V_{DD} (or $\pm V_{CC}$) (often in the range of 5 V to15 V). The common node between the supplies is the ground node. The op amp's output voltage is taken between the output terminal and the ground node. The remaining two terminals are the input of the op amp. An interesting property of the op-amp is that the output voltage is only a function of the difference of the two input Terminals. Figure 1(b) shows the top view of widely used OpAmp type known as the 741. It comes in a package, with metal pins.

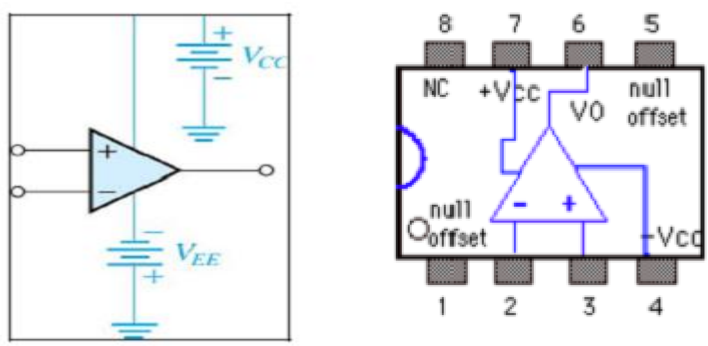

Figure 1 (a) and (b)

The most basic function of the op amp is the voltage amplification. However, the output voltage of a real op amp is limited to the range between certain limits that depend on the internal design of the op amp. As shown in Figure 2, when the output voltage tries to exceed these limits, clipping occurs.

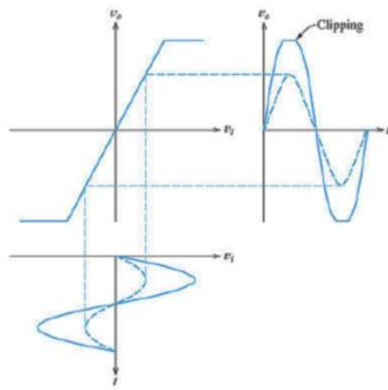

Figure 2

Equipment:

1. Digital multimeter
2. Variable DC power supply
3. Protoboard

Components

1. 100kΩ
2. 10kΩ
3. 741 op-amp

Procedure

Inverting amplifier

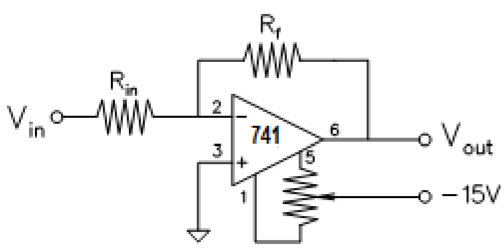

Figure 3

1. The input offset voltage of op-amps can introduce significant output errors. Many op-amps (351, 741) have additional pins for adjusting the offset to zero. Wire the circuit shown with R_f = 100 kΩ and R_{in}= 10kΩ (gain ≃ 10); connect input to common, and adjust the balance potentiometer until the op-amp output is nearly zero (≤ 1mV). Set DMM to an appropriate scale. Prior to every other experiment in this lab, check in the same manner whether the op-amp remains balanced (it should!)
2. For five or more values of V_{in}, in the range ±0.7V calculate the value of V_{out} using the following formula for voltage gain of Inverting amplifier and write them in Table 1:
$$Av=V_{out}/V_{in}= -R_f/ R_{in}.$$
3. Measure the value of V_{out} for each value of V_{in} as mentioned above, using a DC voltmeter and write the results in Table 1. Find the % age error.

V_{in}	Calculated V_{out}	Measured V_{out}	% error

Table 1

4. Set the Function generator at a frequency of 1 kHz and apply as input V_{in} to the inverting amplifier. Use the two channels of the scope to monitor the inverting input V_{in} of the op-amp and the output V_{out}. Slowly increase the amplitude of the input signal, starting near zero. Observe the phase difference between the input and output. Keeping the amplitude of the input low and constant, vary its frequency. Observe the reduction in output amplitude as frequency increases.

Non – Inverting Amplifier:

5. Set up the non-inverting amplifier circuit of Figure 4 with R_1 = 10 k. With a 1 kHz sinusoidal input having different amplitudes, calculate the output with R_2 = 100k and with R_2= 10k using the formula and write the results in front of each input in Table 2:

$$A_v = V_{out}/V_{in} = 1 + R_2/R_1$$

6. Measure the output with an oscilloscope and write them in front of each input in the table. Find the % age error.

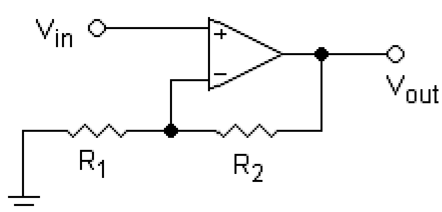

Figure 4

V_{in}	Calculated V_{out}	Measured V_{out}	% error

Table 2