Lab 4. Operational Amplifiers

Overview of this Session

In this laboratory you will:

• Continue to use an oscilloscope
• Learn how to construct basic op-amp circuits

Introduction

• The TAs will explain the pin outs of the LM741C op-amp.
• The TAs will explain the layout of the powered protoboard.
• The TAs will show how to use an oscilloscope to verify circuit performance.

Oscilloscope Measurements

4.1 Connect the signal from the function generator to the oscilloscope and determine the type of signal present, the frequency, amplitude, and the DC offset.

Buffer Amplifier

4.2 Construct the buffer amplifier circuit shown below. Connect a 1 KHz, 3 Vp-p sine wave to the input and use the oscilloscope to observe the input and output signals. Compute the voltage gain.

BUFFER AMPLIFIER
Non-Inverting Amplifier

4.3 Construct the Non-Inverting amplifier shown below. Calculate the resistors needed to produce a voltage gain of 11. Connect a 1 K Hz, 0.5 Vp-p sine wave to the input and use the oscilloscope to observe the input and output signals. Compute the voltage gain.

\[ V_{out} = V_1 \left( 1 + \frac{R_2}{R_1} \right) \]
4.4 Construct the Inverting amplifier shown below. Calculate the resistors needed to produce a voltage gain of 15. Connect a 1 K Hz, 0.5 Vp-p sine wave to the input and use the oscilloscope to observe the input and output signals. Compute the voltage gain.

\[
V_{OUT} = V_i \left( -\frac{R_2}{R_1} \right)
\]

\[
R_{STABILITY} = \frac{R_1 R_2}{R_1 + R_2}
\]
Summing Inverting Amplifier

4.5 Construct the Summing Inverting amplifier shown below. Calculate the resistors such that the input $V_1$ has a gain of 5 and the input $V_2$ has a gain of 10. $V_1 = 1.0$ VDC and $V_2 = 0.1$ Vp-p, sine wave. Use the oscilloscope to observe the input and output signals. Compute the voltage gain.

$$V_{\text{OUT}} = -\left(V_1 \left[\frac{R_1}{R}\right] + V_2 \left[\frac{R_3}{R_2}\right]\right)$$

$$R_{\text{STABILITY}} = \text{the smaller of } \frac{R_1R_3}{R_1 + R_3} \text{ or } \frac{R_2R_3}{R_2 + R_3}$$
LM741
Operational Amplifier

General Description
The LM741 series are general purpose operational amplifiers which feature improved performance over industry standards like the LM709. They are direct plug-in replacements for the 709C, 7031, MC1459 and 748 in most applications. The amplifiers offer many features which make their application nearly foolproof: overrange protection on the input and output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

Connection Diagrams

Dual-in-Line or S.O. Package

Ceramic Flatpak

Typical Application
Offset Nulling Circuit
4.1 Draw the waveform shown on the oscilloscope. What is the name of this waveform? What is the amplitude, frequency, and DC offset? Show all your calculations.

4.2 Draw the input and output waveforms. Compute the voltage gain.

4.3 Draw the input and output waveforms. Show resistor calculations. Compute the voltage gain.
Lab 4. Operational Amplifiers Answer Sheet

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TA init:________________________    Date:______________________________

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