EXPERIMENT

OPERATION AMPLIFIER AS (NON)INVERTING AMPLIFIER AND CURRENT SOURCE

OBJECTIVE

To study and perform operational amplifier application: Non inverting Amplifier, Inverting Amplifier and Voltage to Current converter (or current source).

TASKS

1. Non-Inverting Amplifier (Breadboard, LTSpice and Hand analysis)
   a) Set up the circuit as shown in figure 2 on breadboard. Opamp IC is 741 and has the following pin configuration, figure 1. The positive supply, VDD is +12V and negative supply VSS is -12V.

   ![Figure 1: Pin configuration of Op-amp.](image1.png)

   ![Figure 2](image2.png)
b) **DC Amplifier**  
R1=10Kohm and R2 =33Kohm.  
Make the voltage source V as a DC source. The DC source can be taken from the function generator, by making frequency 0Hz, amplitude 0V and changing the DC offset knob. Change the DC offset from 0 to 3V at a step of 1V. Measure and record the output voltage at pin 6 using the CRO.

c) **AC Amplifier**  
Make the voltage source V as a ac source (DC offset must be set to zero) of 1V and frequency 1KHz using the function generator. R1=10 Kohm and R2 =33Kohm. Measure and record the output voltage at pin 6 using the CRO. Change the amplitude to 2V and 3V and record the output.

d) **AC+DC Amplifier**  
Make the voltage source V as a mixed (AC+DC) source. DC offset = 1V and AC = 0.1V (*by using 20 db attenuation button*). Measure and record the output voltage at pin 6 using the CRO. Change the AC amplitude to 0.2V and 0.3V and record the output.

e) **LTSPICE**  
Implement the circuit in LTSpice and Repeat steps 1(b), (c) and (d). Don't forget to include the.lib LM741.sub command.

f) **Hand Analysis**  
The theoretical gain of the inverting amplifier using opamp is  
\[ \text{Gain} = \frac{V_{out}}{V_{in}} = 1 + \frac{R1}{R2} \]  
In the present circuit, Vin is V and Vout is the output voltage at pin 6.

g) Record and compare the results found in experiment, LTSpice and analytically.

2. **Inverting Amplifier**

a) Set up the circuit as shown in figure 3 on breadboard.

![Figure 3](image)

b) **DC Amplifier**  
R1=220Kohm and R2 =100Kohm.  
Make the voltage source V as a DC source. The DC source can be taken from the function generator, by making frequency 0Hz, amplitude 0V and changing the DC offset.  
Measure and record the output voltage at pin 6 using the CRO. Change the DC offset from 0 to 3V at a step of 1V. Measure and record the output voltage at pin 6 using the CRO.
offset knob. Change the DC offset from 0 to 3V at a step of 1V. Measure and record the output voltage at pin 6 using the CRO.

c) **AC Amplifier**
Make the voltage source V as a ac source (DC offset must be set to zero) of 1V and frequency 1KHz using the function generator. R1=220Kohm and R2 =100Kohm. Measure and record the output voltage at pin 6 using the CRO. Change the amplitude to 2V and 3V and record the output.

d) **AC+DC Amplifier**
Make the voltage source V as a mixed (AC+DC) source. DC offset = 1V and AC = 0.1V (by using 20 db attenuation button). Measure and record the output voltage at pin 6 using the CRO. Change the AC amplitude to 0.2V and 0.3V and record the output.

e) R1=100Kohm and R2 =220Kohm.
Repeat steps 2(b), (c) and (d).

f) **LTSPICE**
Implement the circuit in LTSpice and Repeat steps 2(b), (c), (d) and (e). Don’t forget to include the.lib LM741.sub command.

g) **Hand Analysis**
The theoretical gain of the inverting amplifier using opamp is
\[
\text{Gain} = \frac{V_{\text{out}}}{V_{\text{in}}} = -\frac{R_1}{R_2}
\]
In the present circuit, Vin is V and Vout is the output voltage at pin 6.

h) Record and compare the results found in experiment, LTSpice and analytically.

3. **Current Source**

a) Set up the circuit as shown in figure 3 on breadboard(R2 =10kohm and R1 = 33Kohm) and make the voltage source V as a DC source of 5 V. Measure the current through the resistor R2 using multimeter.

b) Now set the resistor R1 equal to 220Kohm and 100Kohm and measure current through resistor R2 using multimeter.

c) **LTSPICE**
Implement the circuit in figure 3 in LTSpice and repeat steps 3(a) and (b).

d) **Hand Analysis**
The theoretical equation for the current passing through the resistor R2 is
\[
I = \frac{V}{R_2}
\]
Any constant current can be generated by choosing appropriate voltage source, V and resistor, R2.

e) Record and compare the results found in experiment, LTSpice and analytically

**Important Note:** the IC uA741 supplies an output short circuit current of 2mA. The inverting terminal of the op-amp is at 0V (virtual ground). Thus the feedback resistor, R1 must be so chosen that the current supplied by op-amp is not greater than 2mA. This sets a lower bound on the value of R1 to be chosen \( R_{1\text{min}} = \frac{12}{2m} = 6\text{Kohm} \). Hence, the value of feedback resistor is chosen as greater than 6Kohm in this experiment.

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**END**

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