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.

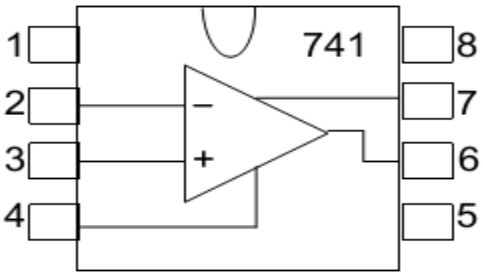

Figure1: Pin configuration of Op-amp.

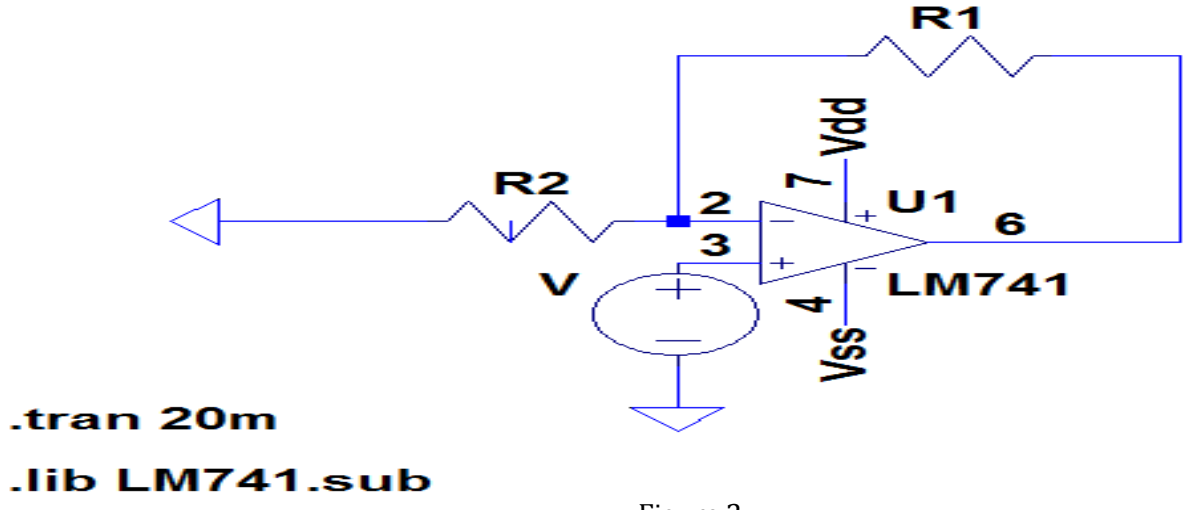

Figure 2

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.

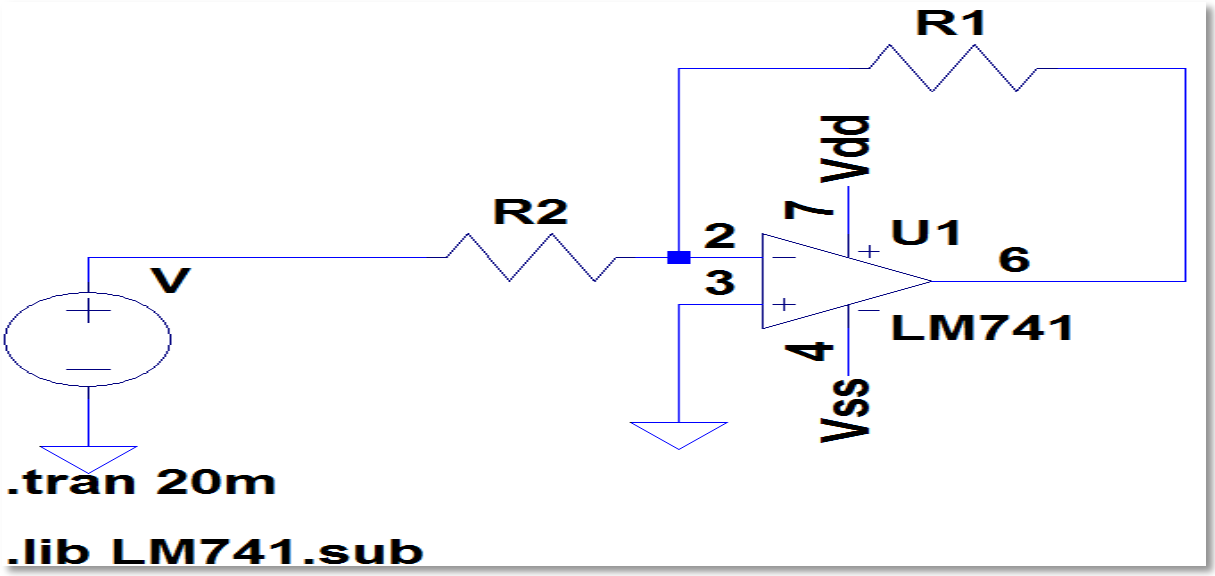

Figure 3

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 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

$$\text{Gain} = \frac{\text{V}_{\text{out}}}{\text{V}_{\text{in}}} = -\frac{\text{R1}}{\text{R2}}$$

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 resisitor 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

$$I = \frac{V}{R2}$$

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(virtualground). 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 $R1_{min} = \frac{12}{2m}$= 6Kohm. Hence, the value of feedback resistor is chosen as greater than 6Kohm in this experiment.

END