جامعة بيرزيت

BIRZEIT UNIVERSITY

Faculty of Engineering and Technology

Electrical and Computer Engineering Department

ENEE2103

Circuits and Electronics Lab

Experiment No.10 - Pre Lab No.6

Operational Amplifier

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Teaching assistant: Eng. Ismail Abualia.

Section: 5.

Apr 30, 2022

1. Adding Application

- **Connecting the circuit using PsPice:**

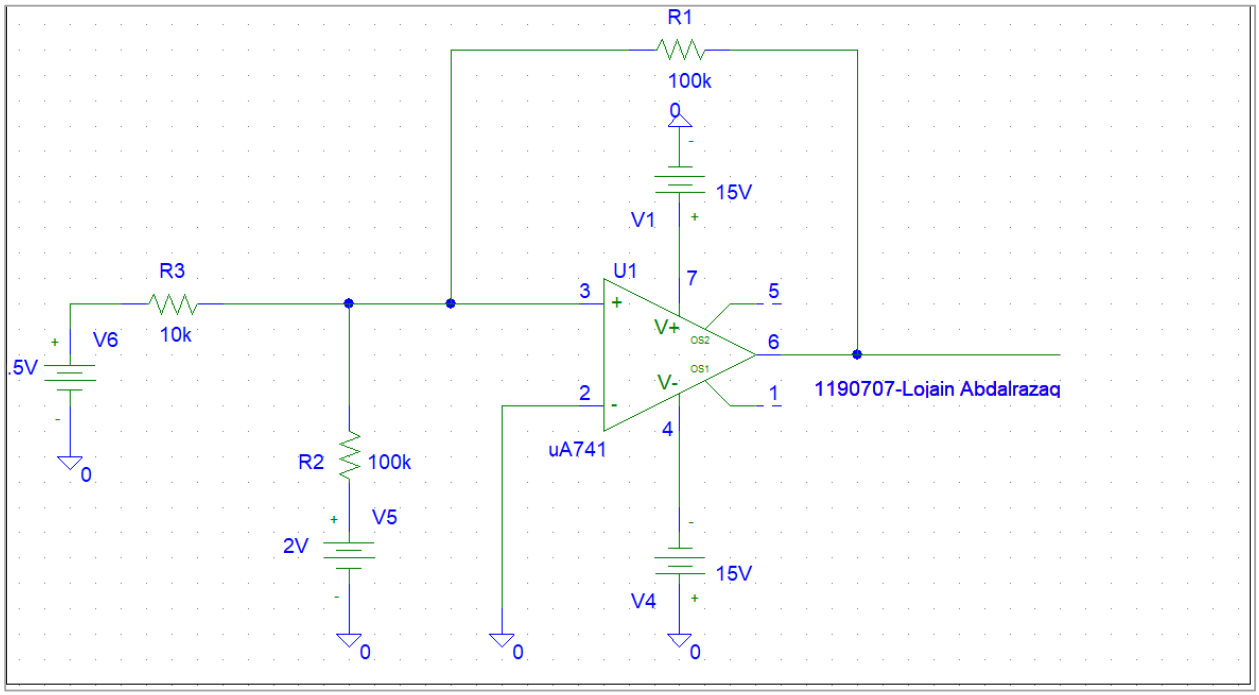

Fig 1: connecting adding application circuit

- **When V1=0.5V , and V2=2V:**

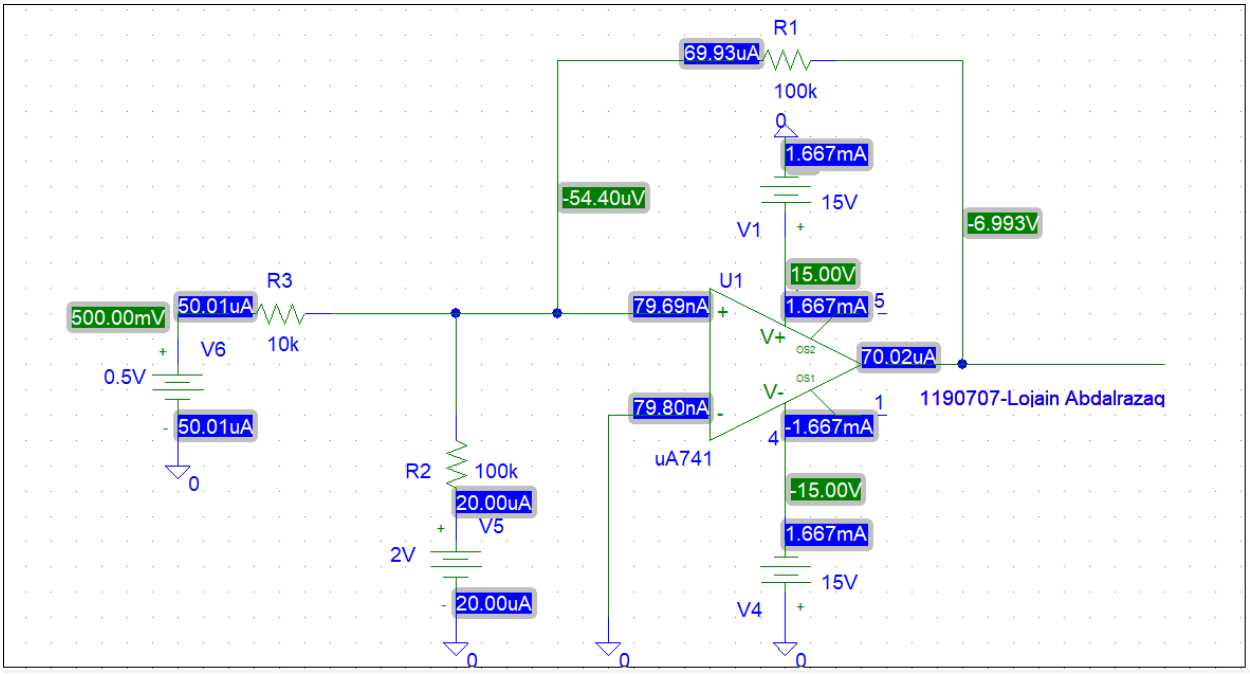

Fig 2: Adding application circuit when v1=0.5 V and V2=2V

- **When V1=0.3V , and V2=4V:**

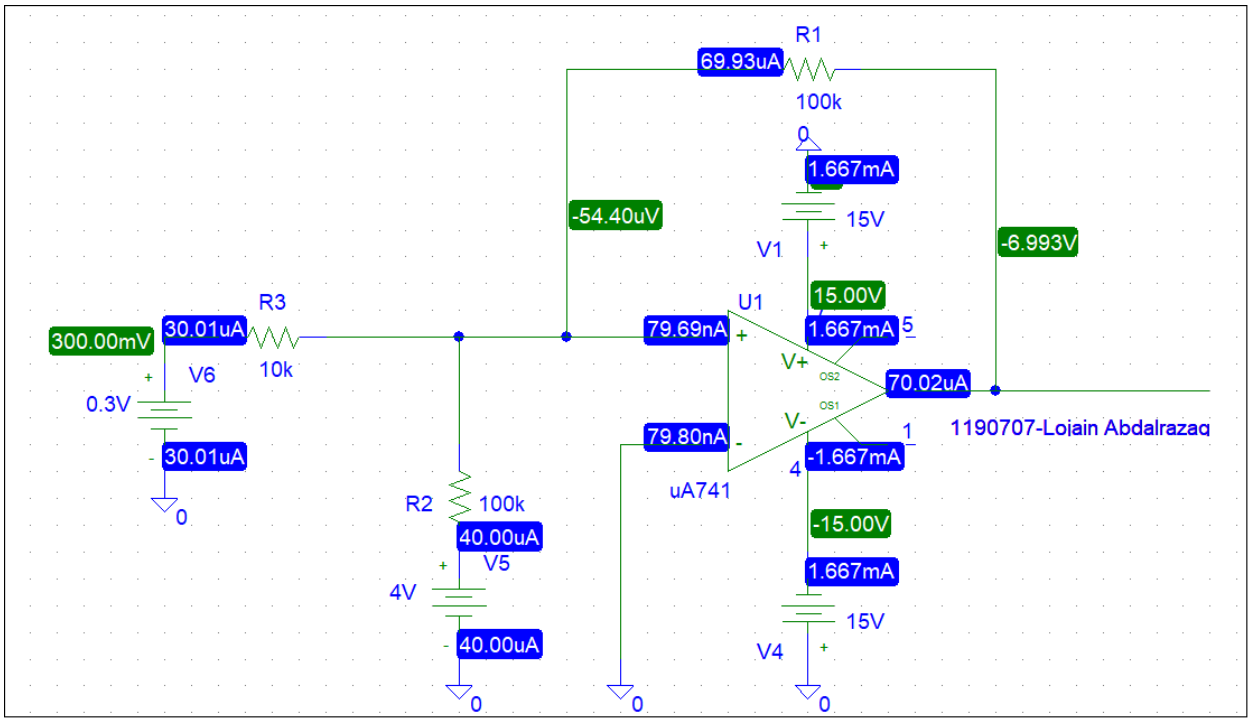

Fig 3: Adding application circuit when v1=0.3 V and V2=4V

- **When V1=-1.5V , and V2=6V:**

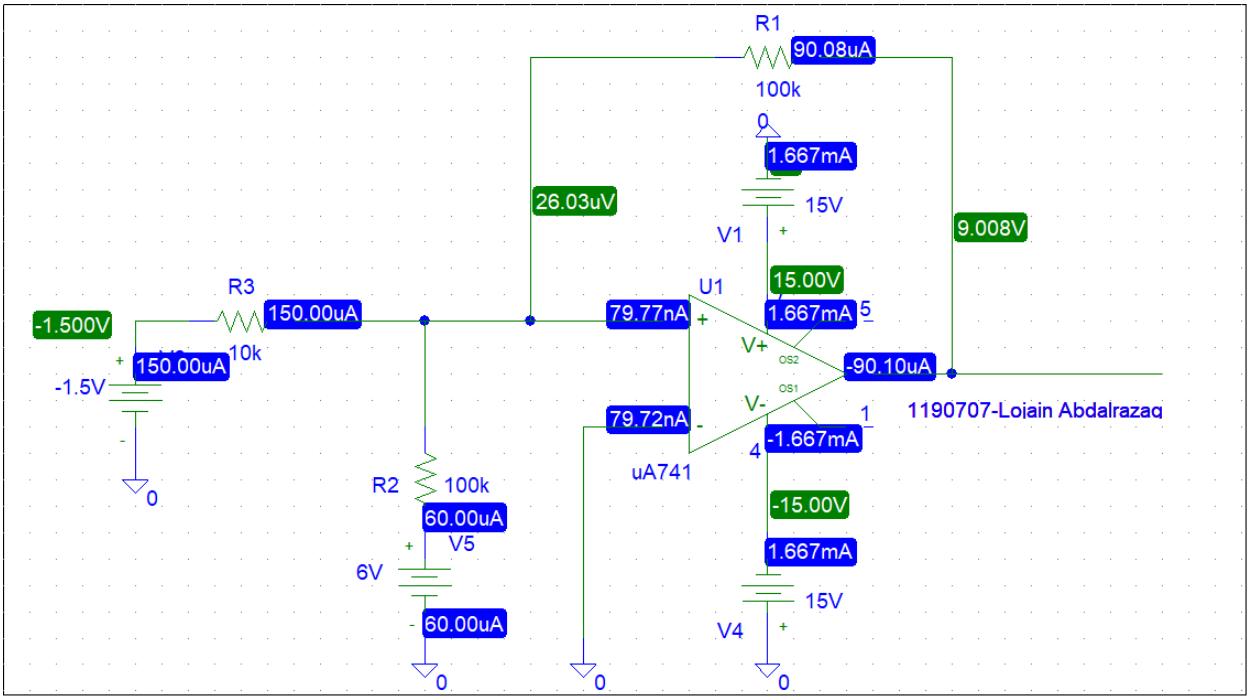

Fig 4: Adding application circuit when v1=-1.5 V and V2=6V

- **Calculated Voltage:**

In the inverting adder circuit, the output voltage can be calculated using the following equation:

$$Vo = -\left(\frac{V1}{R1} + \frac{V2}{R2}\right) \times R_{feedback}$$

1. **V1=0.5V and V2=2V:**

$$Vo = -\left(\frac{0.5}{10k} + \frac{2}{100k}\right) * 100k = -7\ Volt$$

1. **V1=0.3V and V2=4V:**

$$Vo = -\left(\frac{0.3}{10k} + \frac{4}{100k}\right) * 100k = -7\ Volt$$

2. **V1=-1.5V and V2=6V:**

$$Vo = -\left(\frac{-1.5}{10k} + \frac{6}{100k}\right) * 100k = 9\ Volt$$

- **Filling the results in the table:**

Table 1: Results of adding circuit

Input voltage		Output voltage	
V_1	V_2	V_O	Calculated voltage
0.5	**2**	-6.993 Volt	-7 Volt
0.3	**4**	-6.993 Volt	-7 Volt
-1.5	**6**	9.008 Volt	9 Volt

- **Writing The expression relating Vo to V1 and V2:**

→ Using the following equation:

$$\boldsymbol{Vo = -\left(\frac{V1}{R1} + \frac{V2}{R2}\right) \times R_{feedback}}$$

→ By entering the Rf into the brackets:

$$\boldsymbol{Vo = -\left(\frac{V1 * R_{feedback}}{R1} + \frac{V2 * R_{feedback}}{R2}\right)}$$

$$\boldsymbol{Vo = -\frac{V1 * R_{feedback}}{R1} - \frac{V2 * R_{feedback}}{R2}}$$

So, the $\boldsymbol{X} = \frac{-R_{feedback}}{R1} = \frac{-100K}{10K} = -10$ and $\boldsymbol{Y} = \frac{-R_{feedback}}{R2} = \frac{-100K}{100K} = -1$

Finally, the expression relating Vo to V1 and V2 is:

$$\boldsymbol{Vo = -10V1 - V2}$$

2. Voltage Follower Application

- **Connecting the circuit using PsPice:**

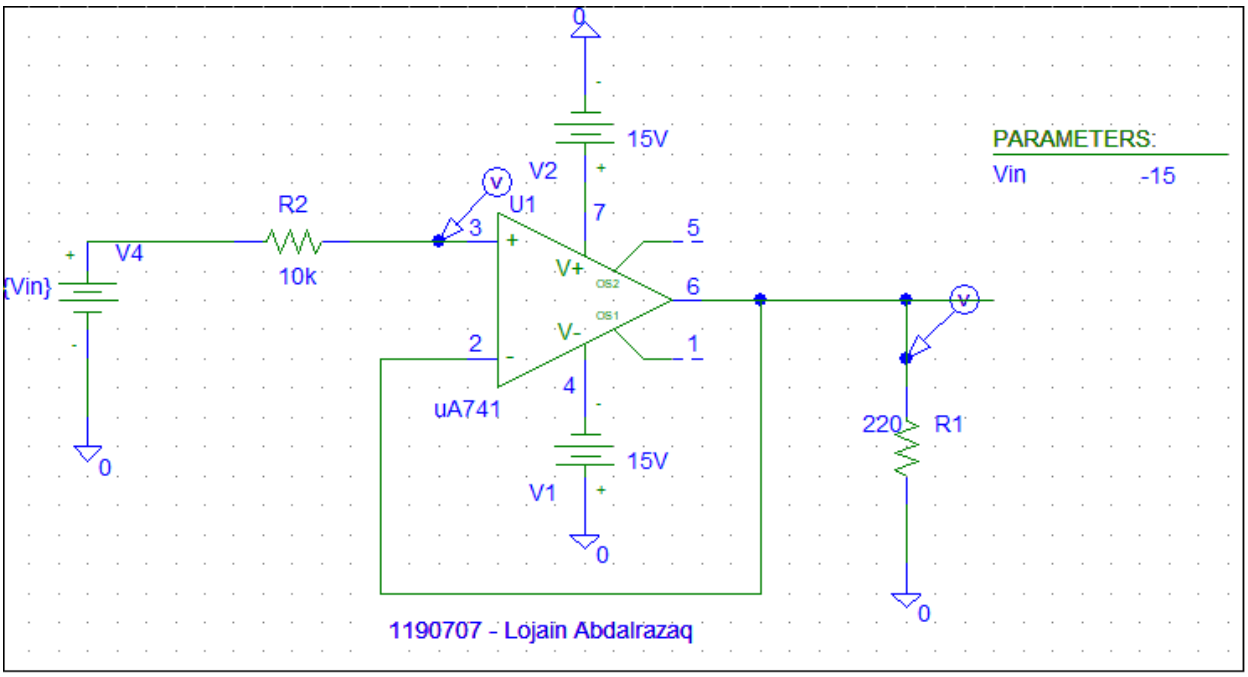

Fig 18: connecting the circuit using PsPice

- **Plotting Vo and observe the relationship between Vo and Vi:**

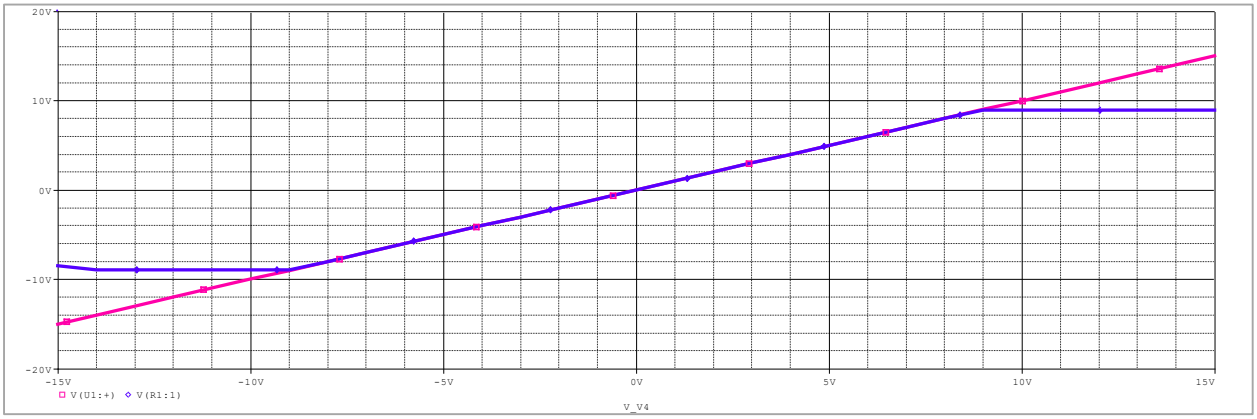

Fig 19: The relation between Vo and Vi

- **Plotting Io and observing its behavior:**

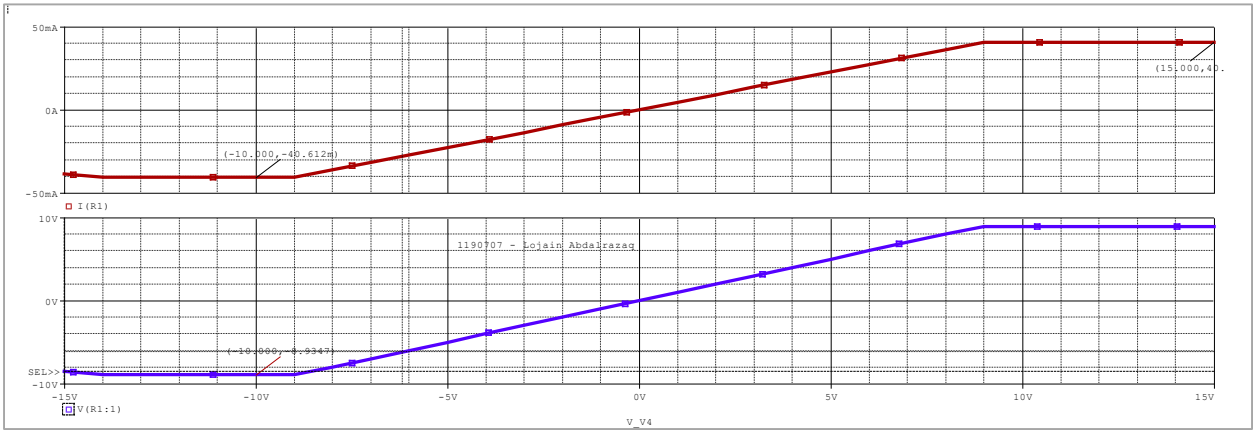

Fig 20: The output current Plot

➔ It is noticed that the current limit at 40 mA and this lead to voltage limit at 8.9347 V.

- **Replacing the 220 ohm with 10k:**

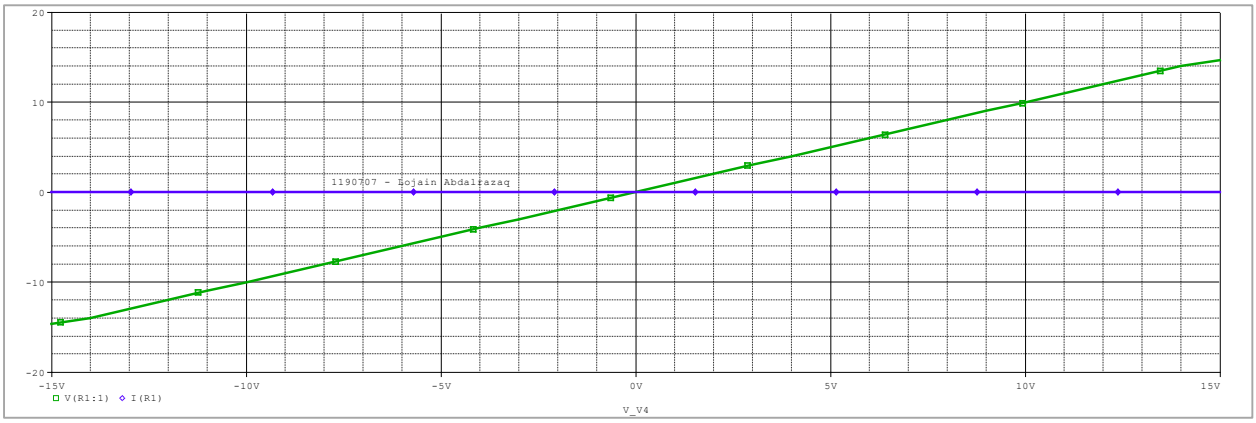

Fig 20: The output current Plot when R=10k

➔ It is noticed that there is no current limit.

3. Comparator Application

- **Connecting the circuit using PsPice:**

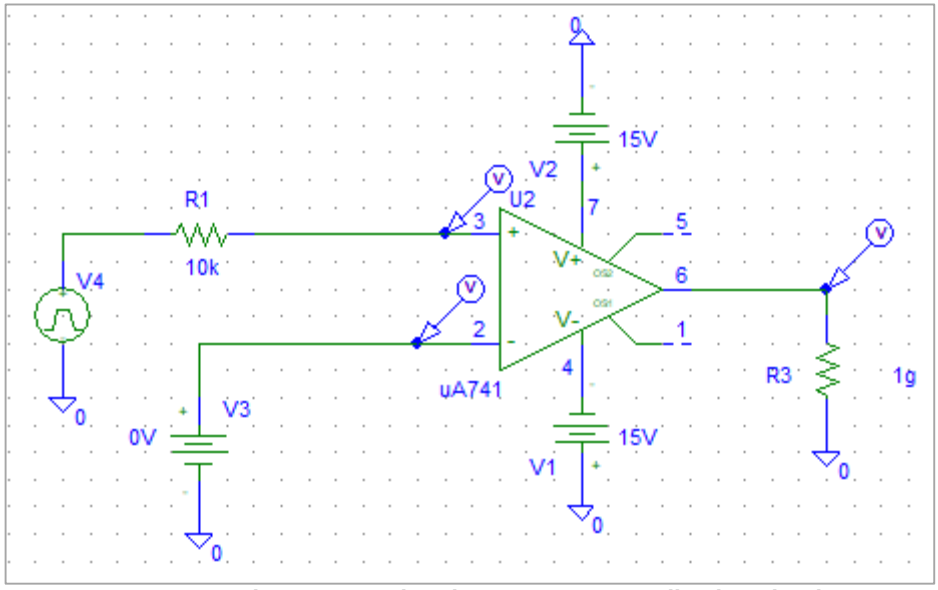

Fig 5: connecting the comparator application circuit

- **When V1=0V:**

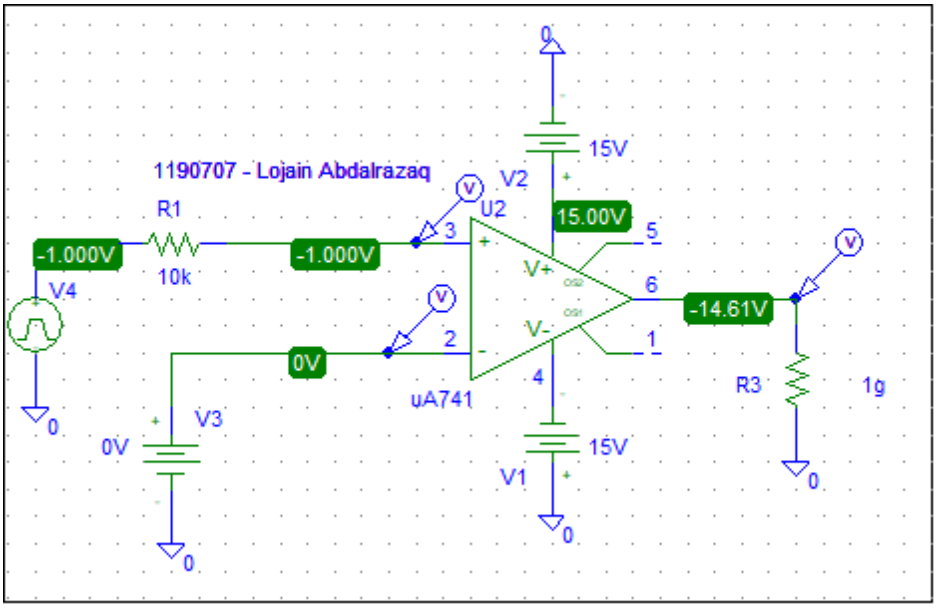

Fig 6: When V1=0V

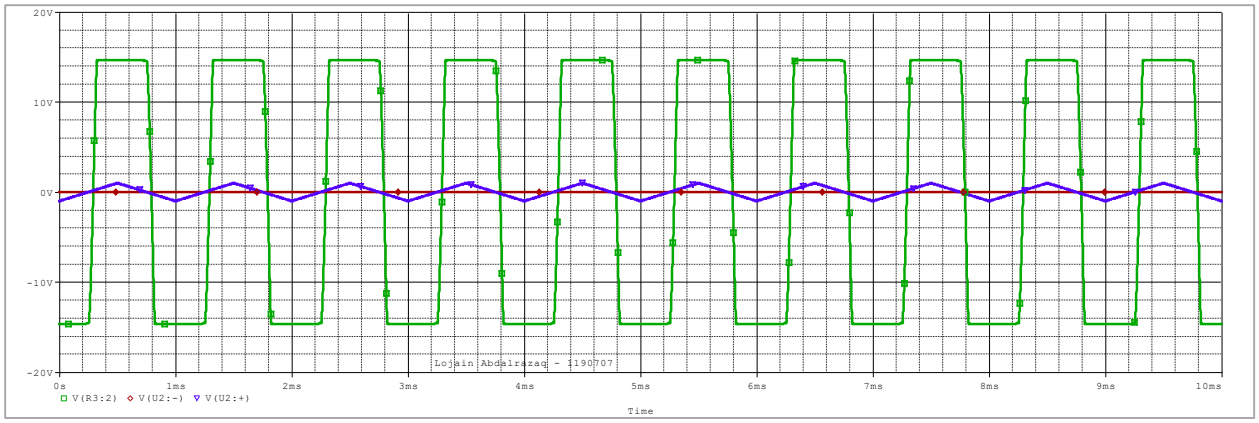

Fig 7: The voltage simulation When V1=0V

- **When V1=0.98V:**

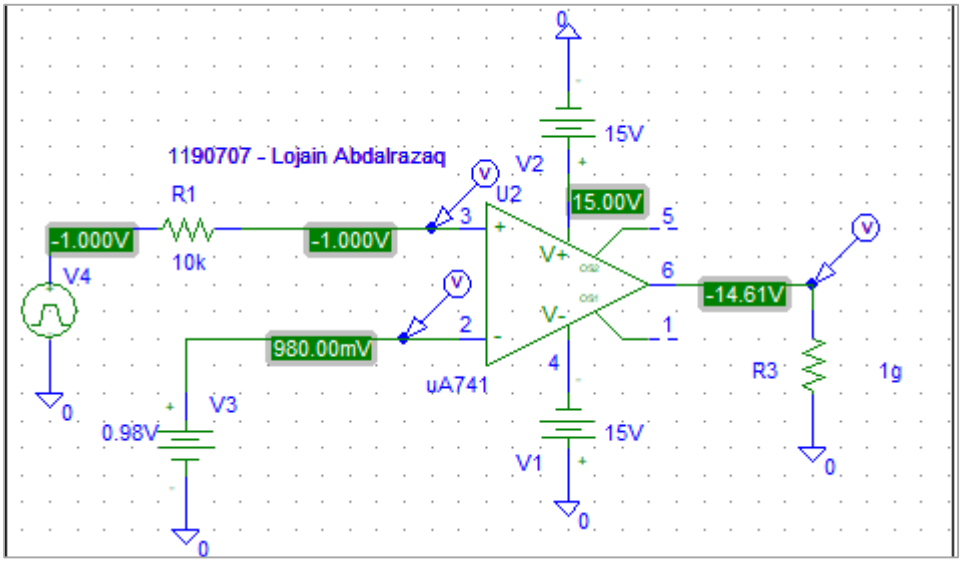

Fig 8: When V1=0.98V

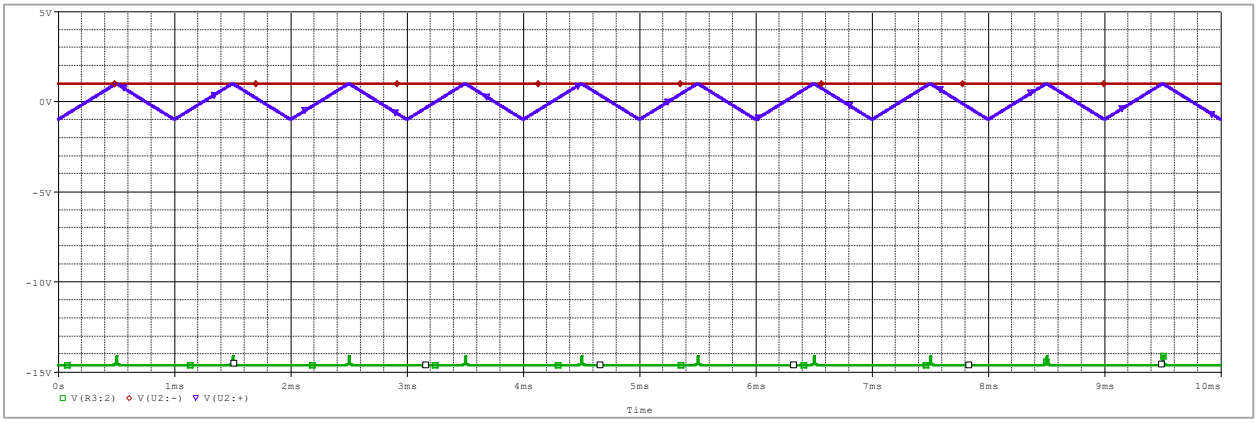

Fig 9: The voltage simulation When V1=0.98V

- **When V1=-0.98V:**

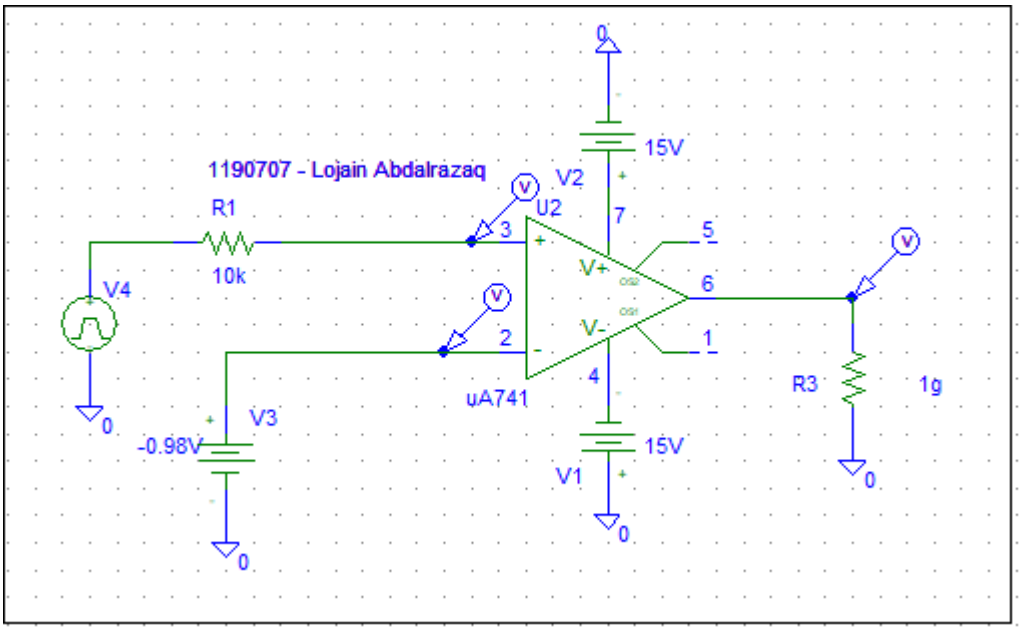

Fig 10: When V1= -0.98V

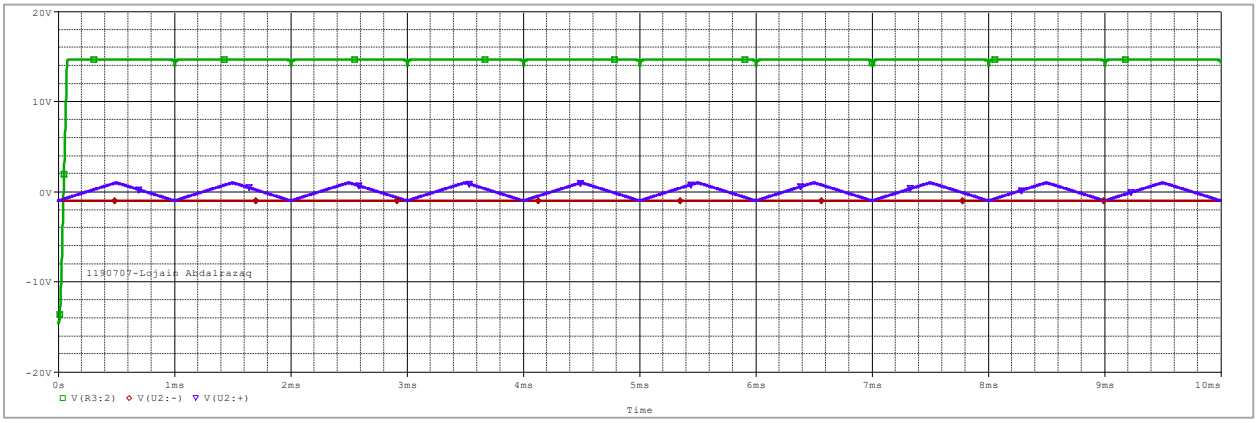

Fig 11: The voltage simulation When V1= -0.98V

4. Integrator and Differentiator

- **Integrator:**

- **Connecting the circuit using PsPice:**

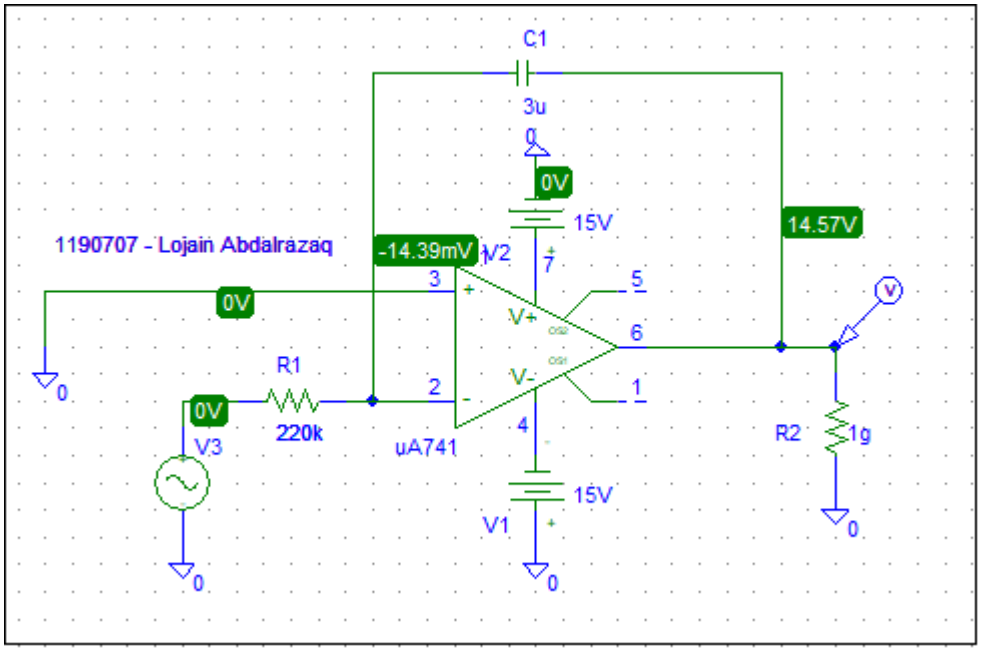

Fig 12: Connecting the Integrator circuit

- **Plotting the output voltage:**

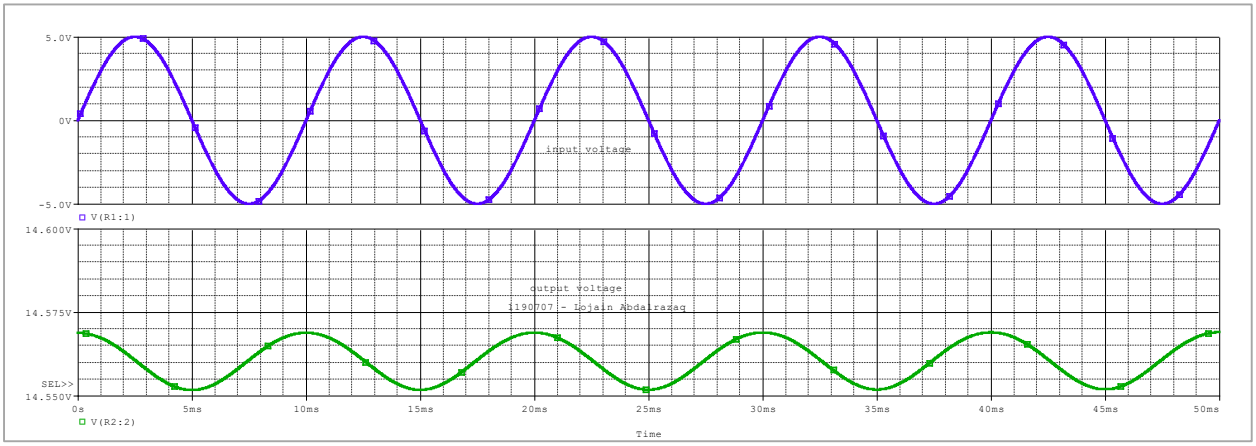

Fig 13: The output voltage simulation

- **Differentiator:**

- **Connecting the circuit using PsPice:**

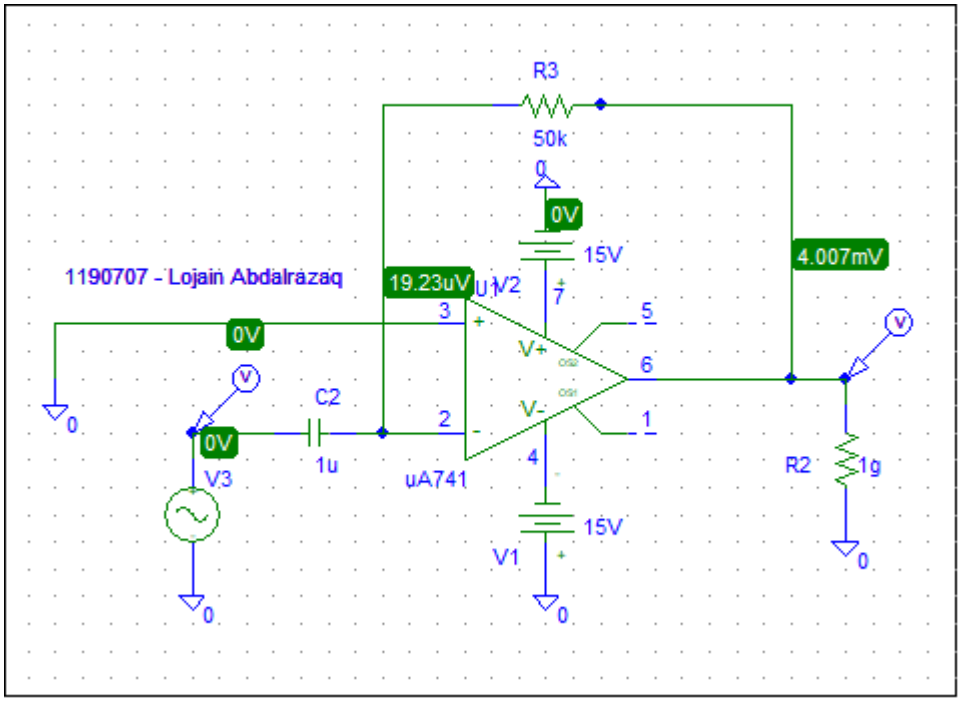

Fig 14: Connecting the differentiator circuit

- **Plotting the output voltage:**

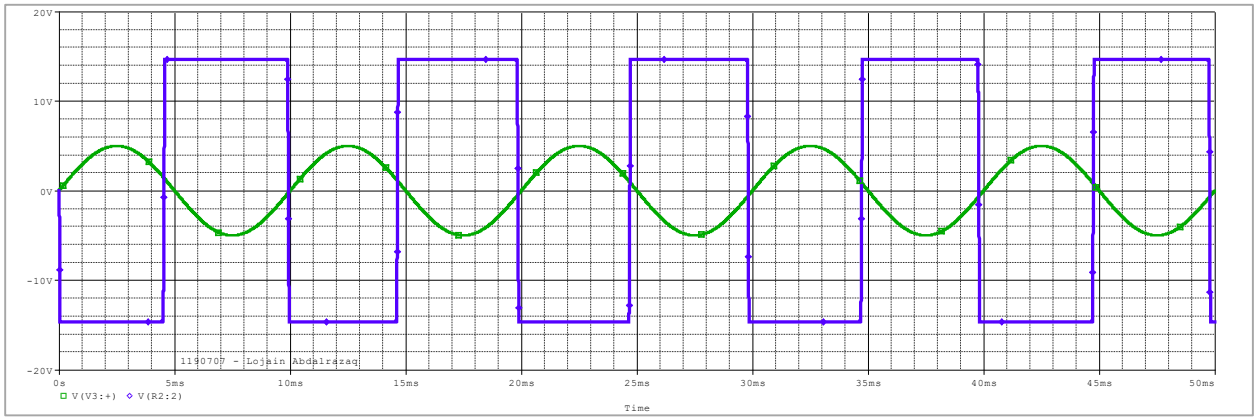

Fig 15: The input and output voltage simulation

5. To investigate the effect of adding hysteresis:

- **Connecting the circuit using PsPice:**

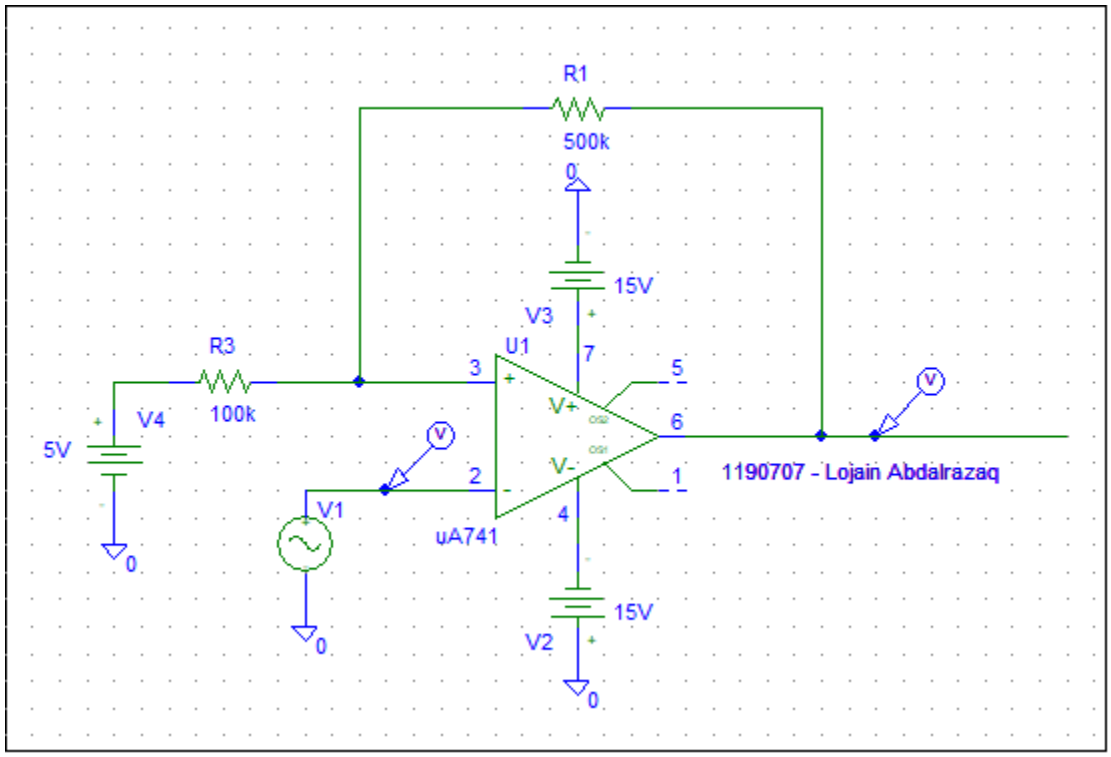

Fig 16: Connecting the circuit using PSpice

- **Plotting the input and output voltage:**

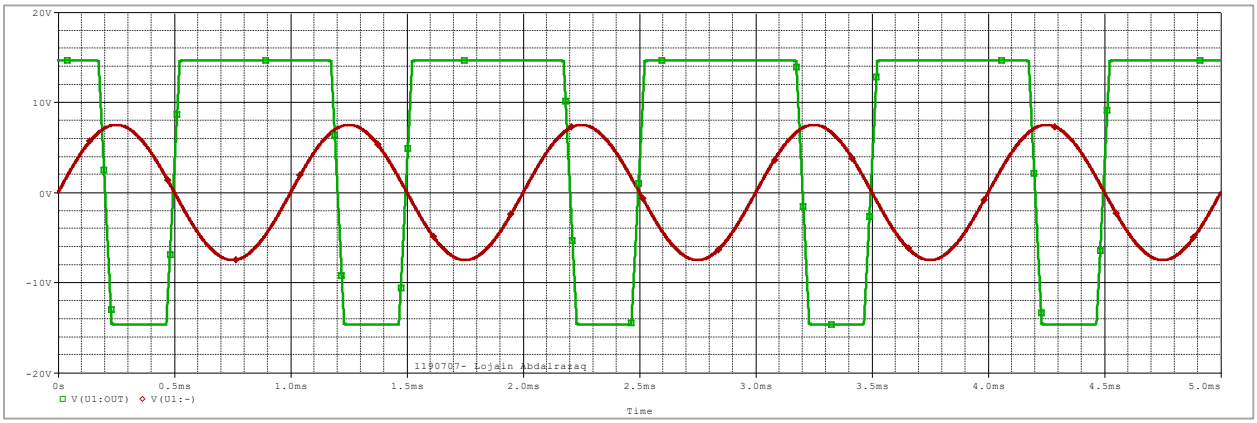

Fig 17: The input and output voltage simulation