Faculty of Engineering & Technology Electrical & Computer Engineering Department

ENEE2103

CIRCUITS AND ELECTRONICS LABORATORY

Prelab V

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Section : 2

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Date :5.6.2023

Adding Application

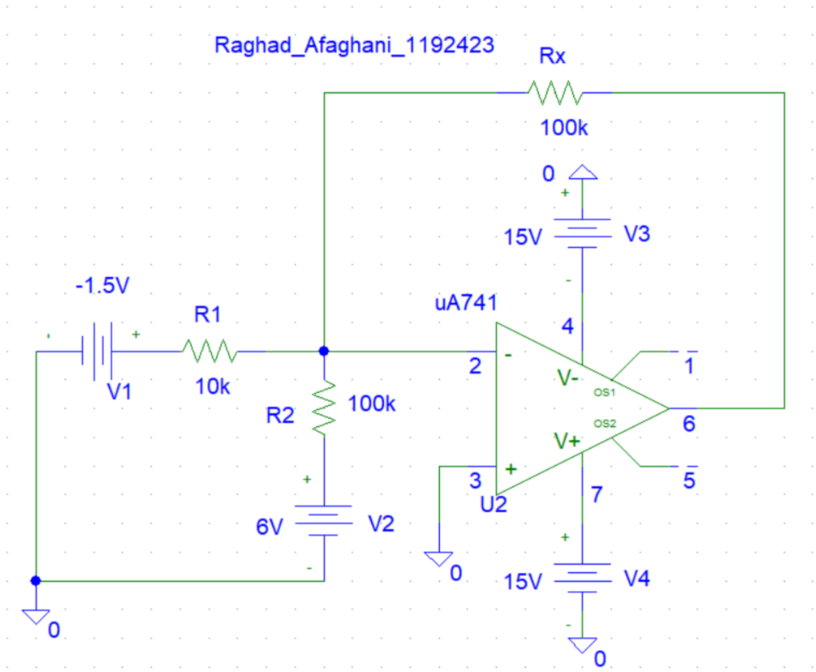


Figure 1. Adding Circuit

Input voltage		Output voltage	
V_1	V_2	V_O	Calculated voltage
0.5	**2**	-6.991	-7
0.4	**3**	-6.991	-7
0.3	**4**	-6.991	-7
-0.9	**4**	5.008	5
-1.1	**5**	6.008	6
-1.5	**6**	9.008	9

Table 1. Values of Vo

Based on the previous results, the circuit behaves as an inverting adder; thus,

$$Vo = -\left(\frac{R3}{R1}V1 + \frac{R3}{R2}V2\right).$$

Voltage Follower Application:

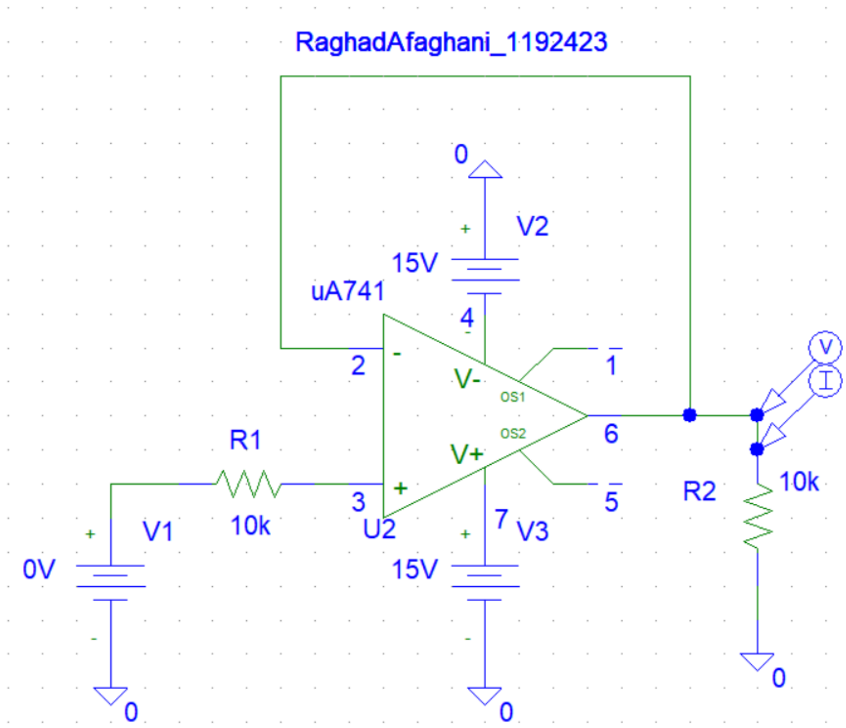
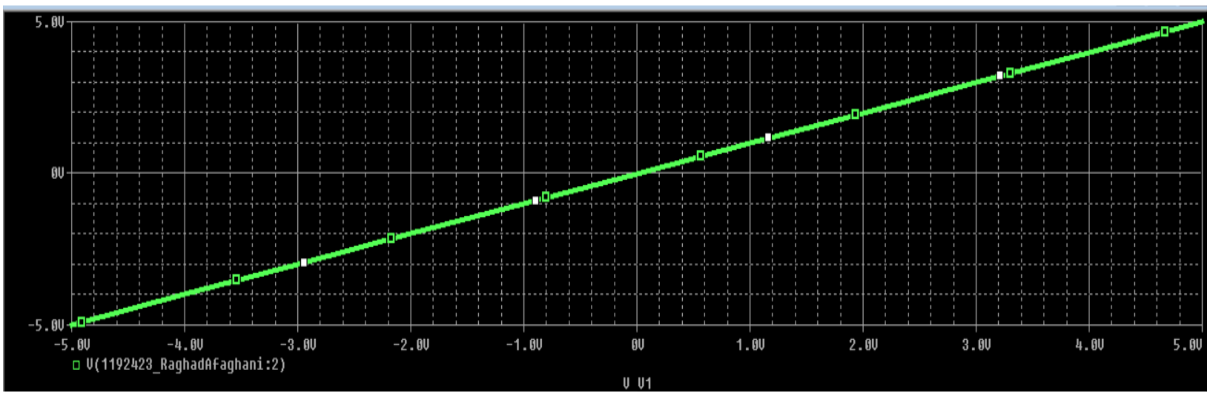


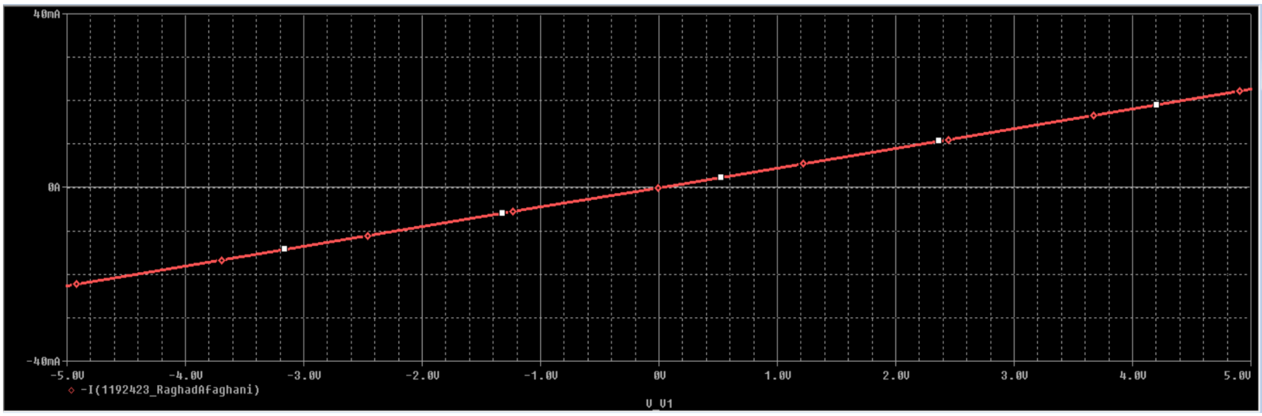
Figure 2. Voltage Follower Circuit

Perform DC sweep For DC voltage source V_I, plot V_O and observe the relationship



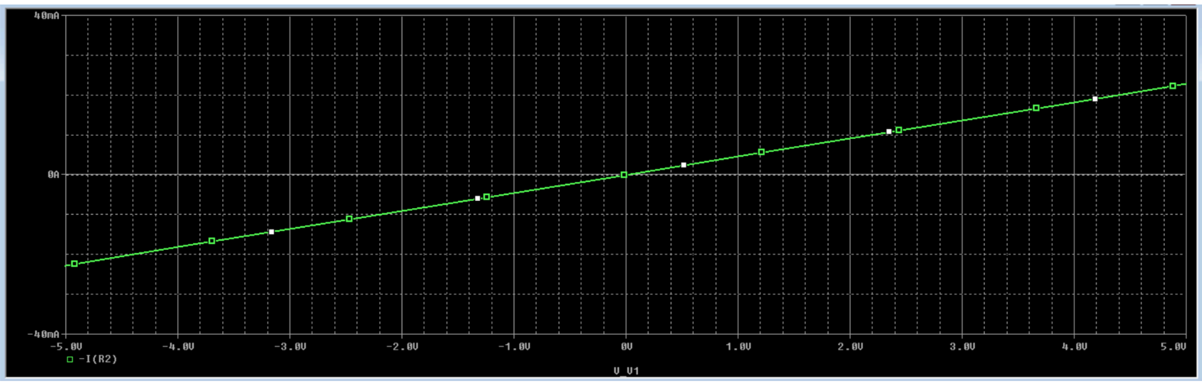
The previous simulation demonstrated that there is a linear relationship between VI and VO, indicating that the circuit functions as a buffer circuit.

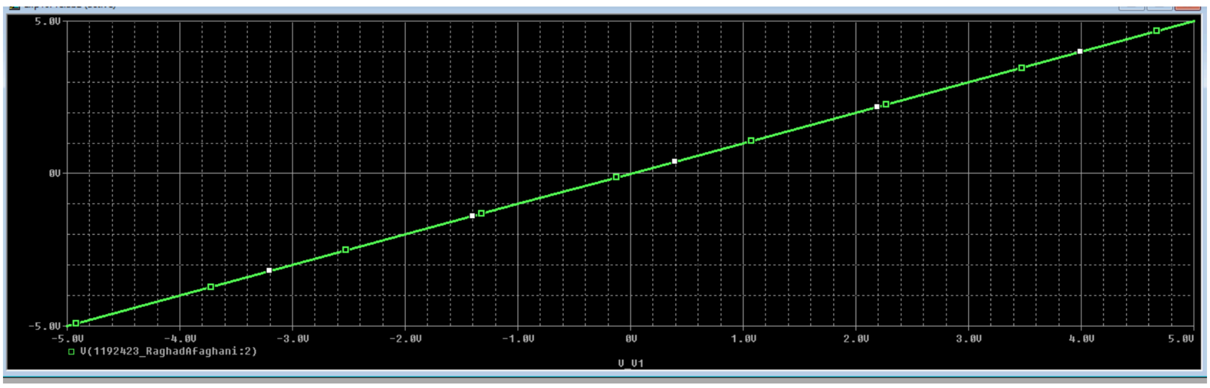
Plot Io



The behavior of I_O is depicted in the preceding graph, which can be expressed mathematically as $I_O = \frac{V_O}{R}$.

When the 220-ohm resistor replaced by 10 k ohm:





From the preceding figures, it can be observed that the value of VO remains unaffected by variations in the value of R. Nevertheless, when a higher resistor value of R=10k ohm is employed, I_O is diminished, indicating an inverse relationship between I_O and R.

Comparator Application:

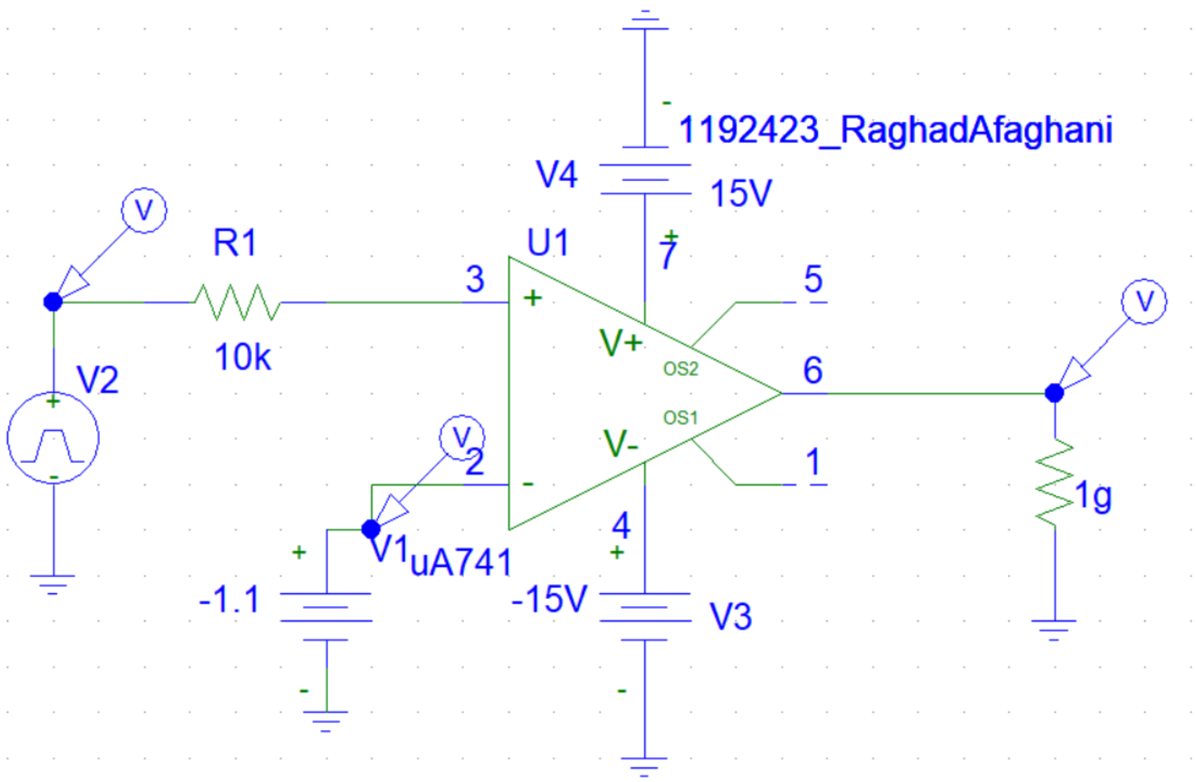
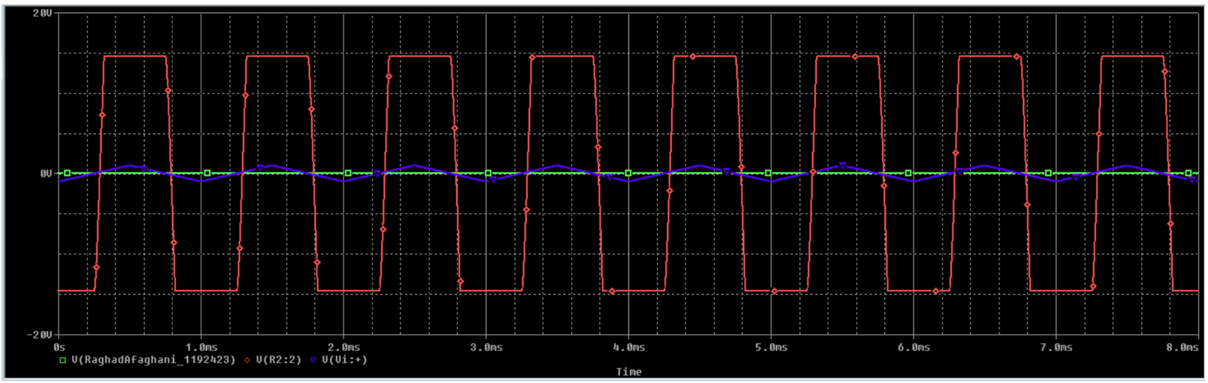
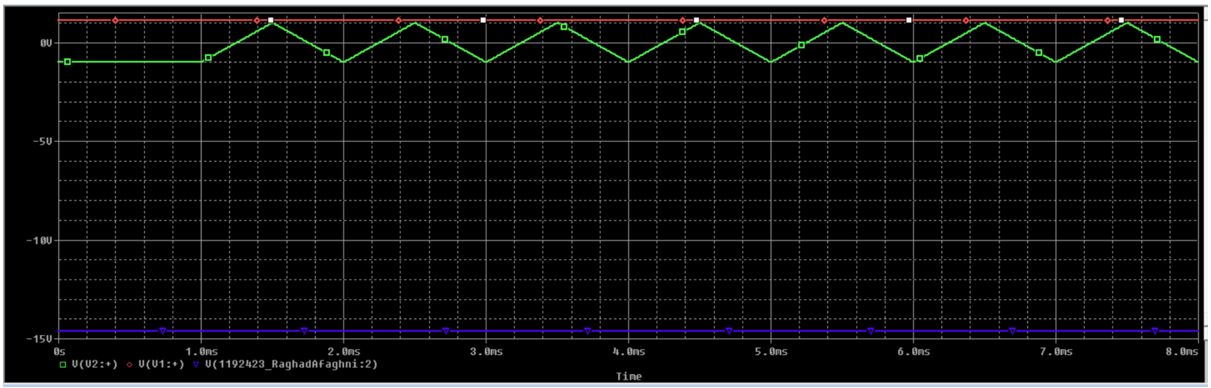


Figure 3. Comparator Circuit

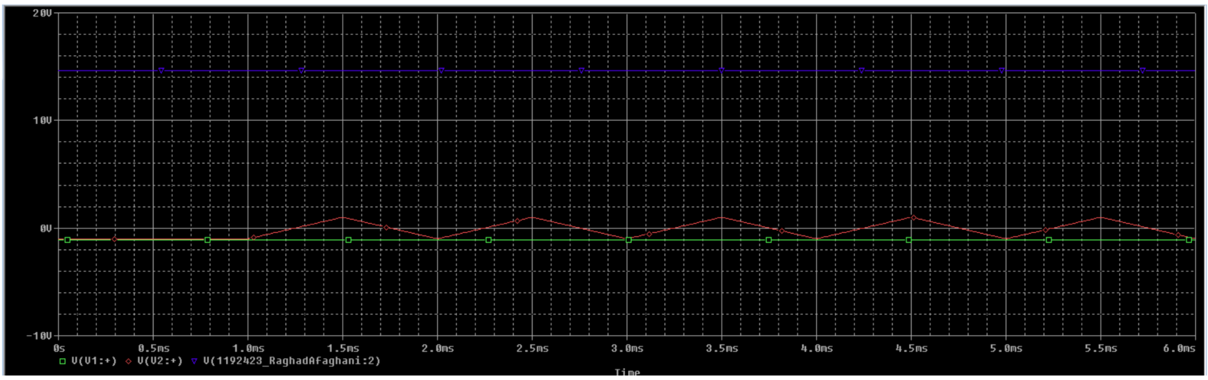
When V1 = 0V



When V1 = 1.1V



When V1 = -1.1V



Based on the preceding graphs, we can infer the following:

- If the input voltage surpasses the reference voltage, the output voltage will rise to a positive saturation level of 15 volts.
- If the input voltage falls below the reference voltage, the output voltage will decline to a negative saturation level of -15 volts.

Integrator and Differentiator:

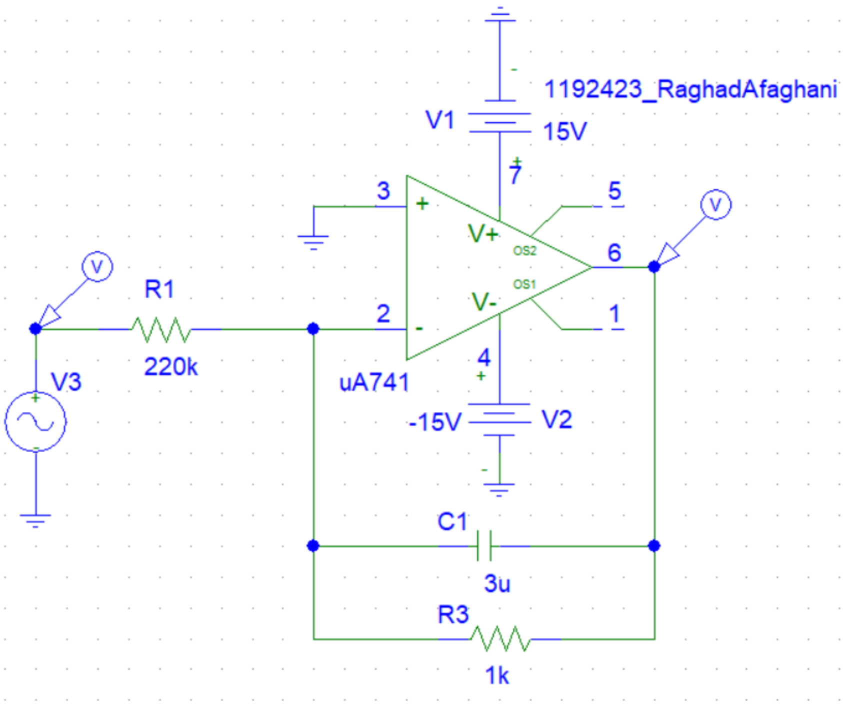
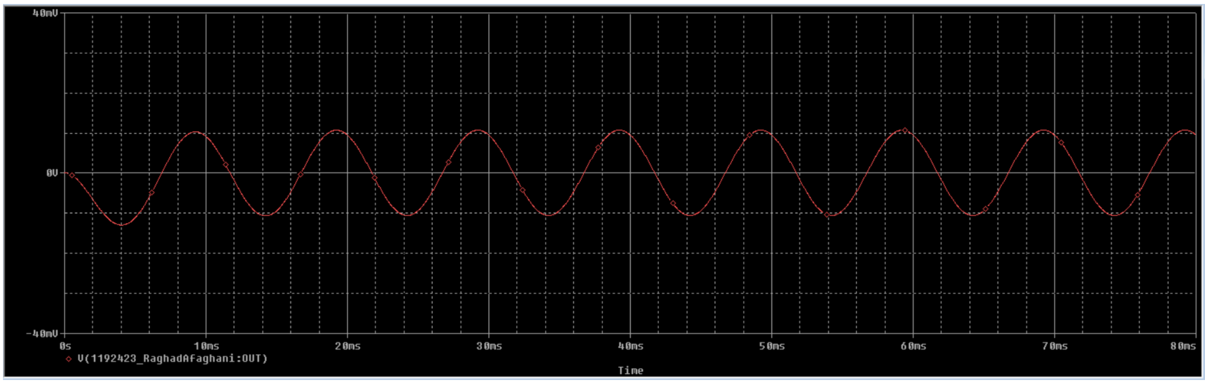
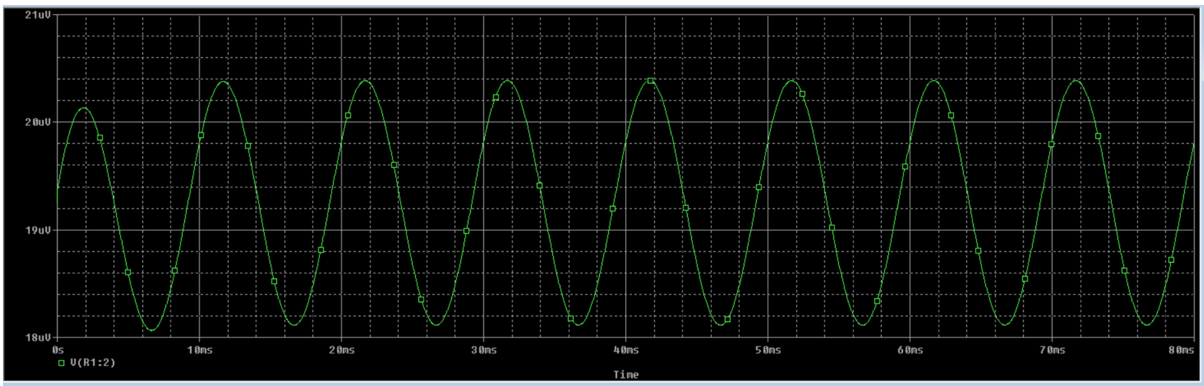


Figure 4. Integrator Circuit





Differentiator:

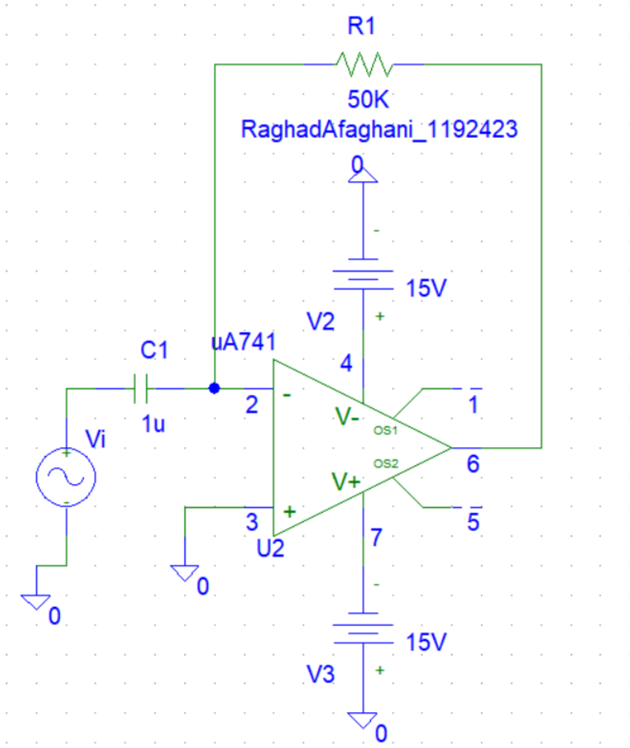
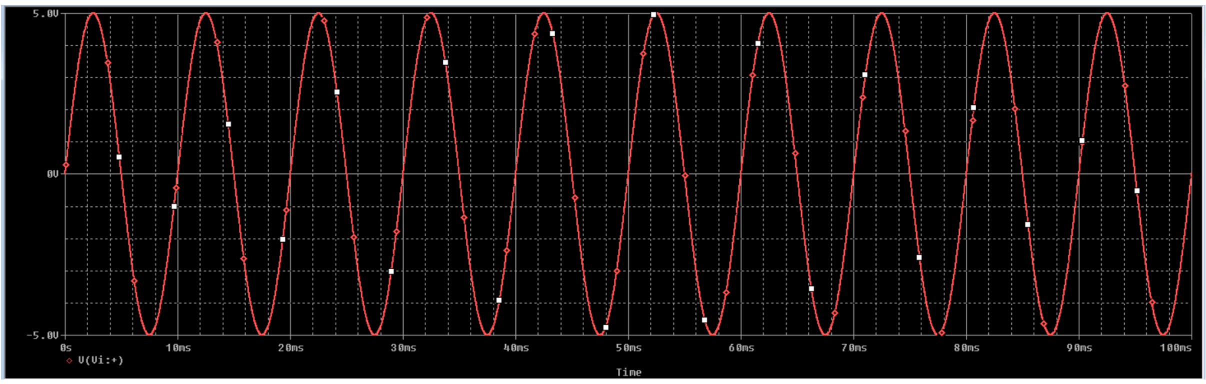
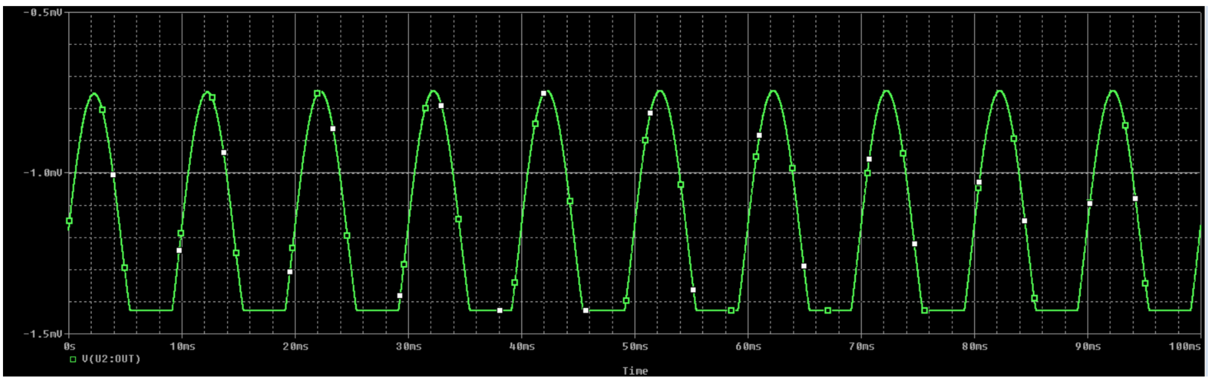


Figure 5. Differential Circuit

Plot of Vo and Vi





Investigate the effect of adding hysteresis:

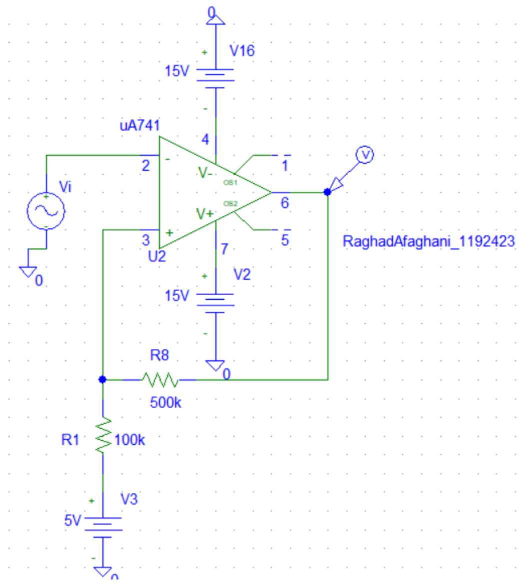
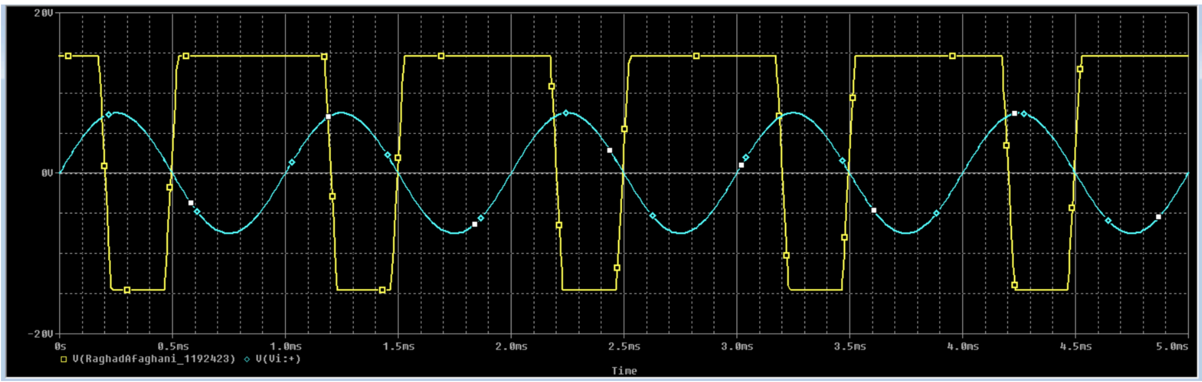


Figure 6. Effect of Adding Hysteresis

Plot the Vo and Vi



- To determine the levels of Vi(t) where Vo(t) transitions from low to high and high to low, we need to analyze the Schmitt trigger comparator circuit. The output voltage of the circuit is either +Vsat or -Vsat, depending on the voltages at V+ and V-.

- Assuming Vo = +Vsat = Vcc - 2 = 15 - 2 = 13 V, we can calculate V+ as follows:

V+ = R2/(R2+R1) * V(sat) + R1/(R2+R1) * V(2) = 100k/(100k+500k) * 13 + 500k/(100k+500k) * 5 = 6.3333 V.

- Therefore, when Vin is less than the upper threshold voltage of V+ = 6.3333 V, Vo will be +Vsat = 13 V.

- Assuming Vo = -Vsat = -Vcc + 2 = -15 + 2 = -13 V, we can calculate V+ as follows:

V+ = R2/(R2+R1) * (-V(sat)) + R1/(R2+R1) * V(2) = 100k/(100k+500k) * (-13) + 500k/(100k+500k) * 5 = 2 V.

- Therefore, when Vin is greater than the lower threshold voltage of V- = 2 V, Vo will be -Vsat = -13 V.

- Thus, the circuit has hysteresis, and the hysteresis voltage can be calculated as follows:

Hysteresis voltage = Upper threshold voltage - Lower threshold voltage = 6.3333 V - 2 V = 4.3333 V.