Faculty Of Engineering and Technology

Electrical and Computer Engineering Department

CIRCUITS AND ELECTRONICS LABORATORY

ENEE 2103

Experiment #: 10

The Operational Amplifier

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1.Adding Application

The circuit was connected as shown in figures below.

1) When v1=0.5v and v2 = 2v -> vo = -6.991v

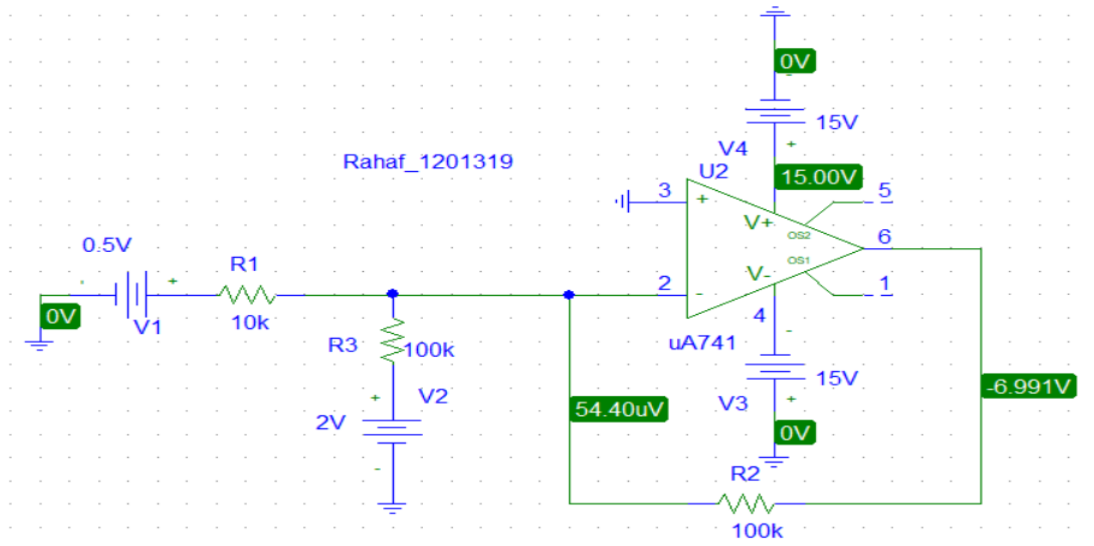

Figure 1.1: Adding application circuit1

2) When v1 = 0.3v and v2 = 4v -> vo=-6.99v

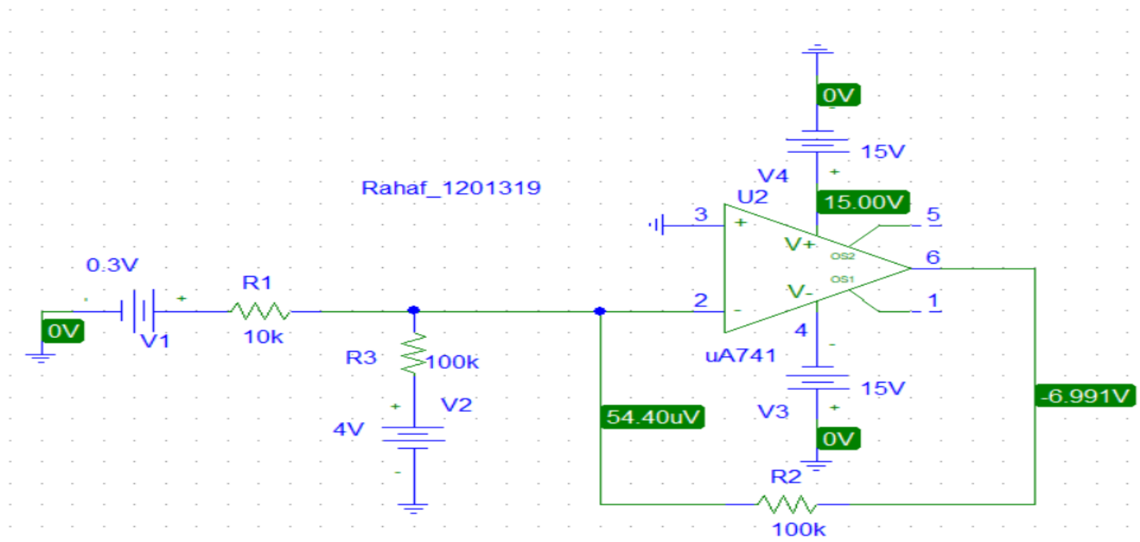

Figure 1.2: Adding application circuit2

3) When v1 = -1.5v and v2 = 6v -> vo=9.008v

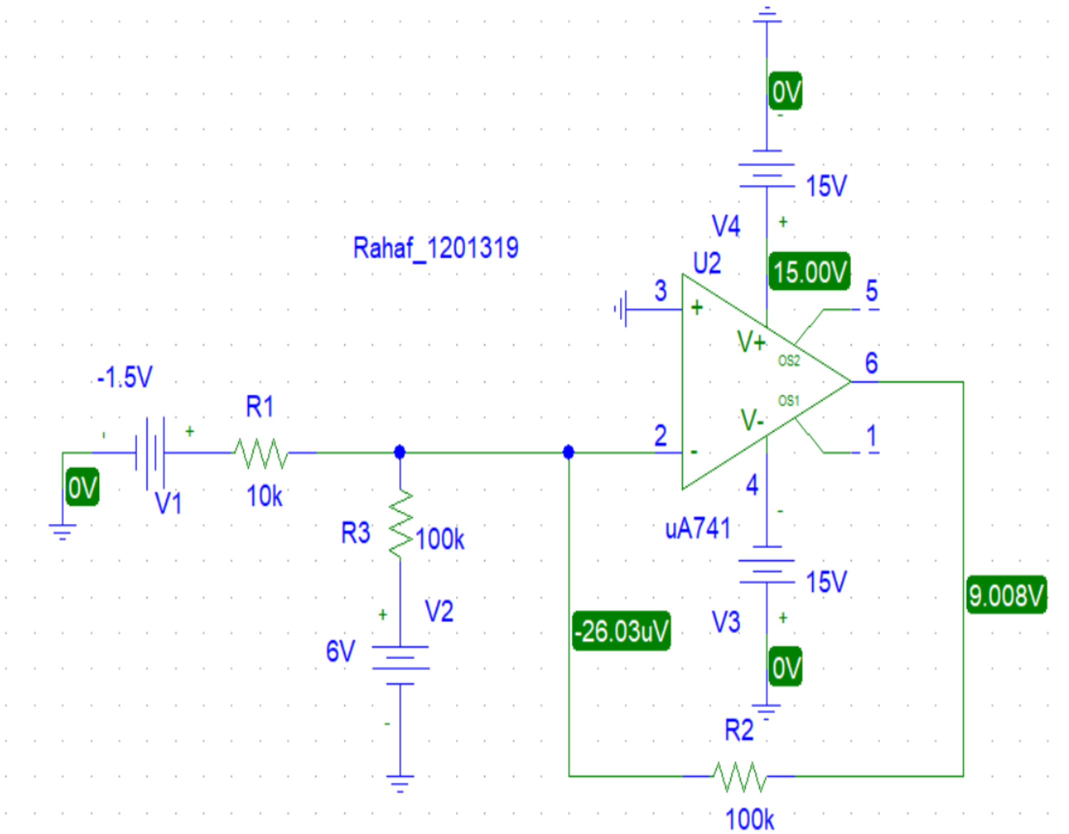

Figure 1.3: Adding application circuit3

Calculated voltage:

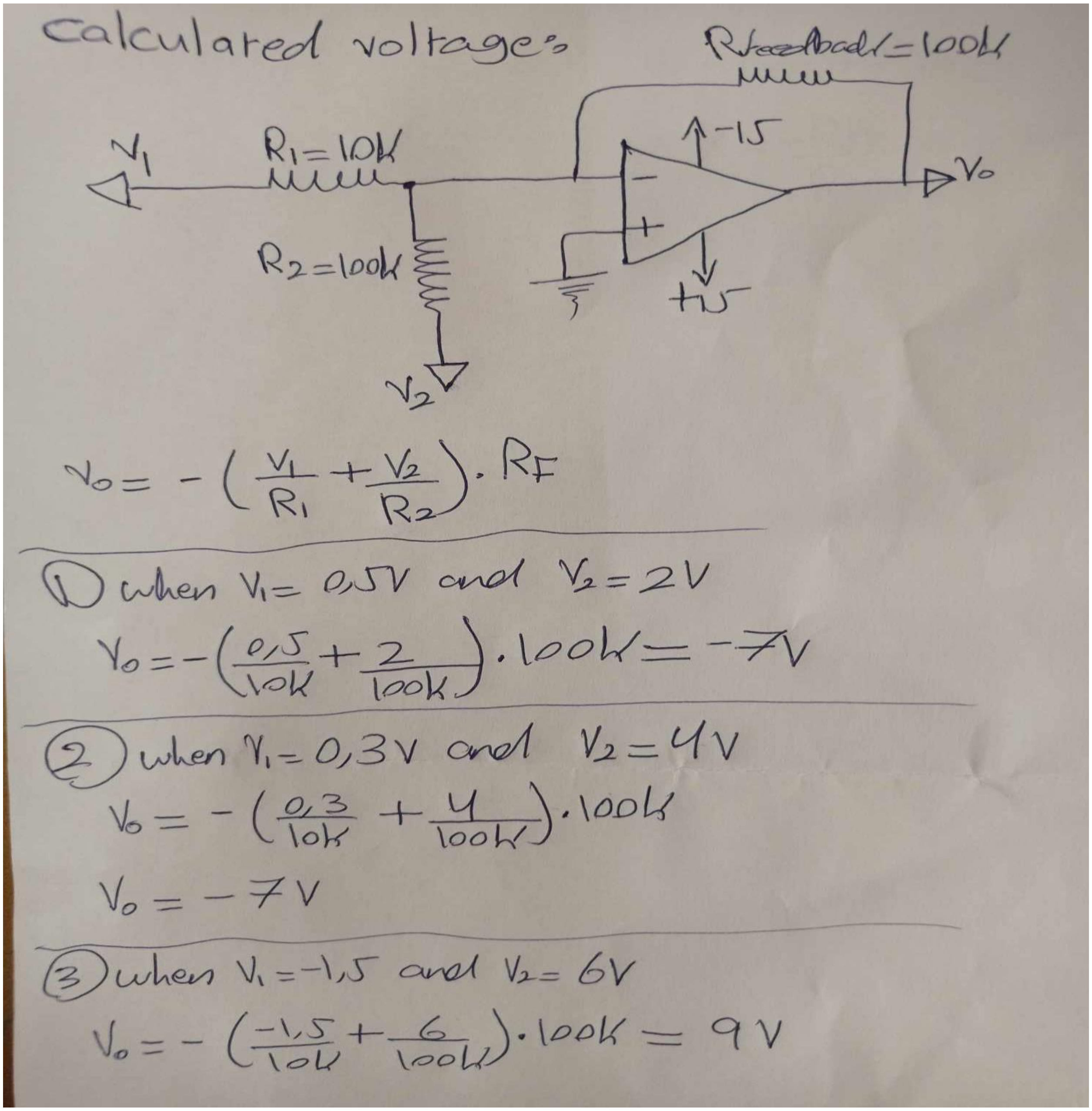

Figure 1.4: calculated voltage theoritical

Input voltage		Output voltage	
V1	V2	vo	Calculated voltage
0.5	2	-6.993	-7
0.3	4	-6.993	-7
-1.5	6	9.008	9

Table 1: output voltage for adding OpAmp

The expression relating vo to v1 and v2:

$$V_o = -\left(\frac{V_1}{R_1} + \frac{V_2}{R_2}\right) \cdot R_f$$

$$V_o = -\left[\frac{R_f}{R_1} \cdot V_1 + \frac{R_f}{R_2} \cdot V_2\right]$$

$$V_o = \frac{-R_f}{R_1} \cdot V_1 - \frac{R_f}{R_2} \cdot V_2$$

$$V_o = X V_1 + Y V_2$$

$$\Rightarrow X = \frac{-R_{fb}}{R_1} = \frac{-100k}{10k} = -10k$$

$$Y = \frac{-R_f}{R_2} = \frac{-100k}{100k} = -1k$$

$$\Rightarrow V_o = -10 V_1 - V_2$$

Figure 1.5: The expression of vo

2. Voltage Follower Application

The circuit was connected as shown in figure 2.2 below. By Performing DC sweep For DC voltage source Vi from 0V to +20V using increment of 0.1V

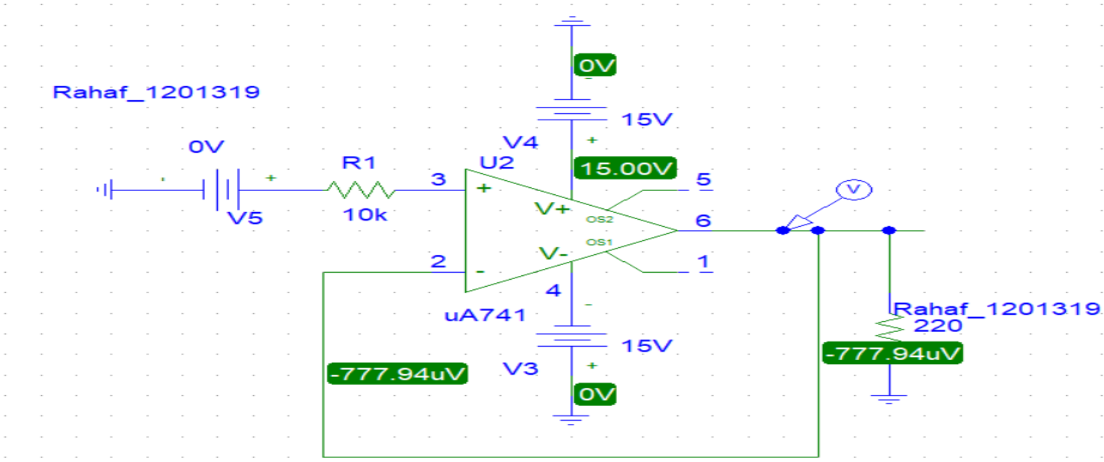

Figure 2.1: Voltage Follower Application circuit

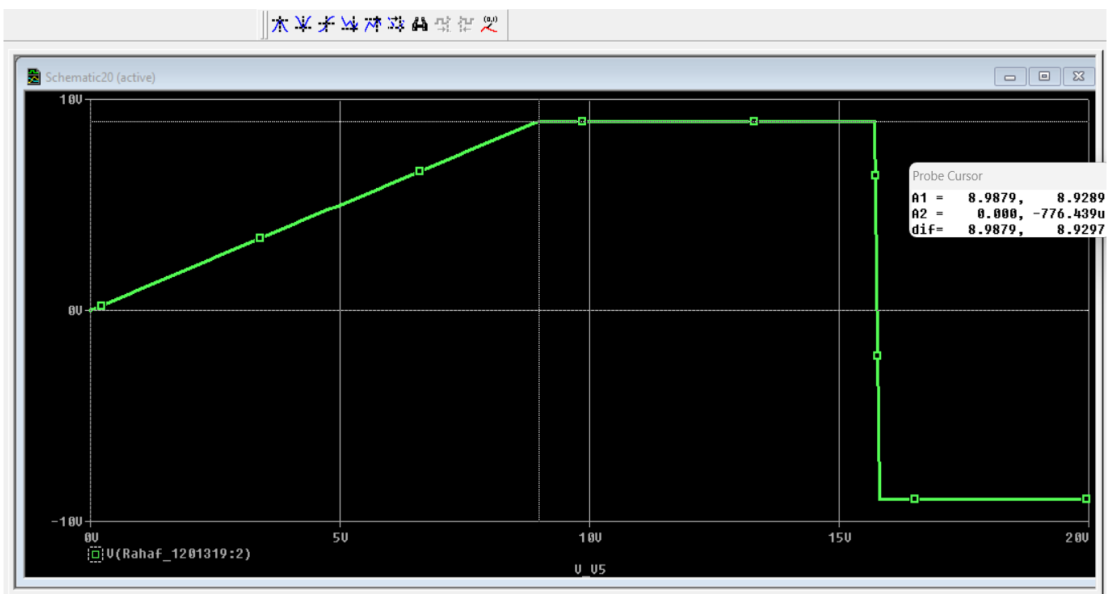

Figure 2.2: Output voltage

From the above figure, note that the output voltage (Vo) of the circuit closely follows the input voltage (Vi) without amplifying or attenuating it. The voltage follower, also known as a unity gain amplifier or buffer amplifier, has a voltage gain of approximately 1.

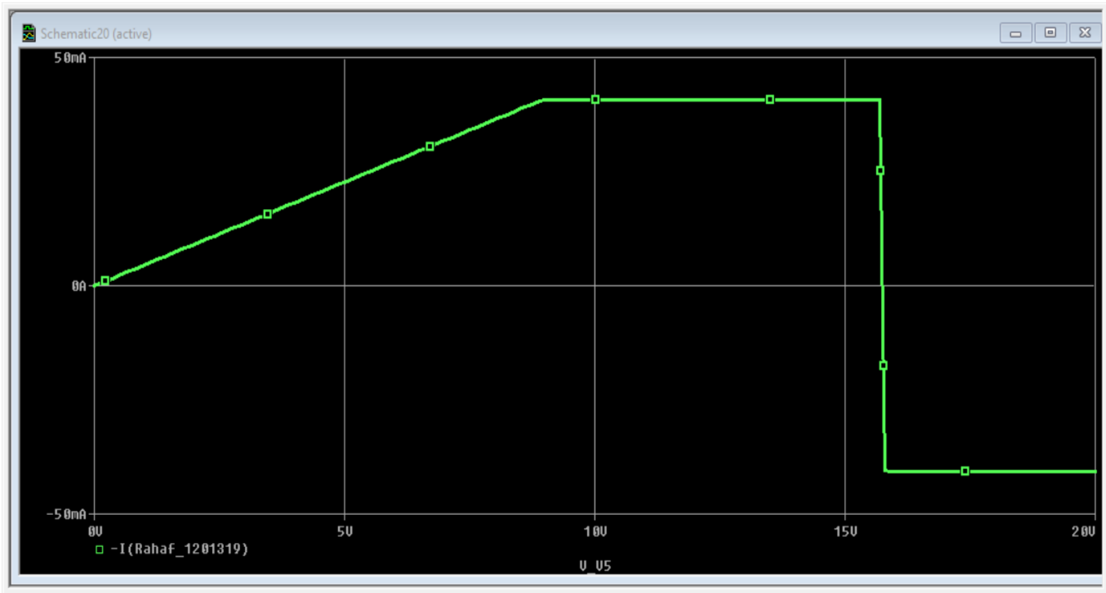

Figure 2.3: Output current

From the above figure, note that there is a current limit at the value 41mA, and this also leads to a voltage limit at the value 9 V.

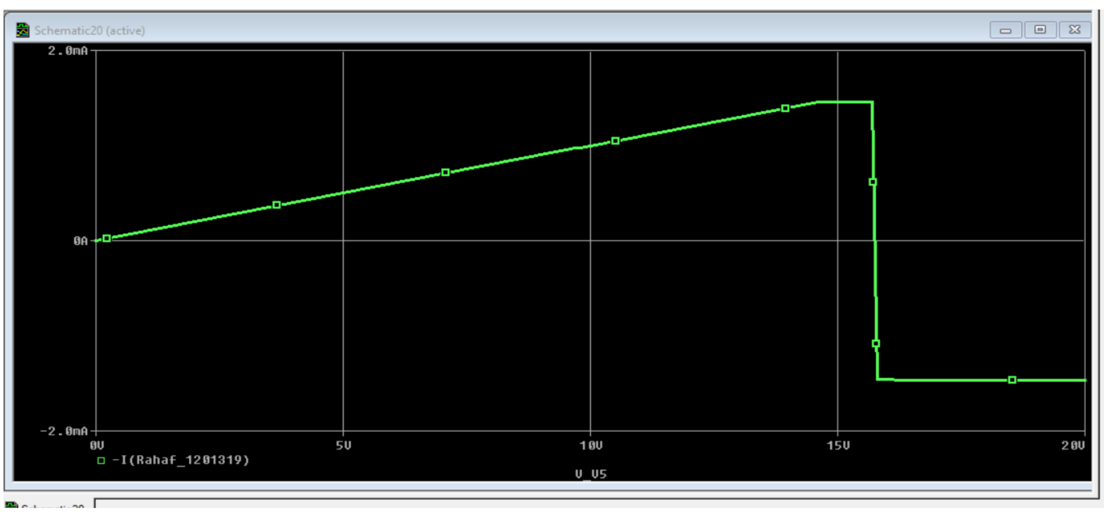

Figure 2.4: Output current with R=10k

From the above figure, note that there is a current limit at the value 1.46mA, and this also leads to a voltage limit at the value 14.5V

3. Comparator Application

The circuit was connected as shown in figures below. Uses 1 kHz triangular input signal to create a triangular wave form: V1=-1V, V2=1V, tr=0.5m, tf=0.5m, PW=10n,Period=1m.

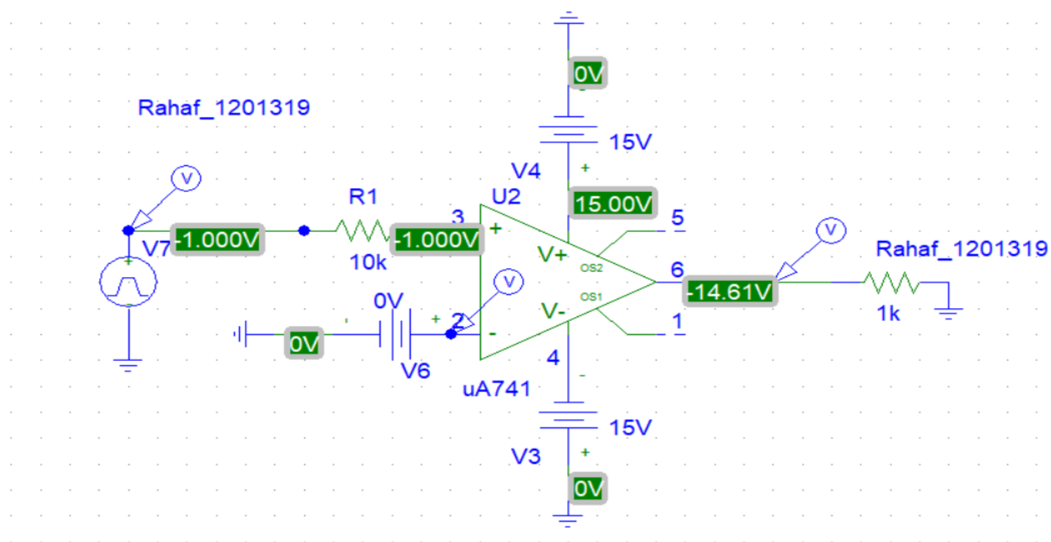

Figure 3.1: Comparator Application circuit when v6 =0

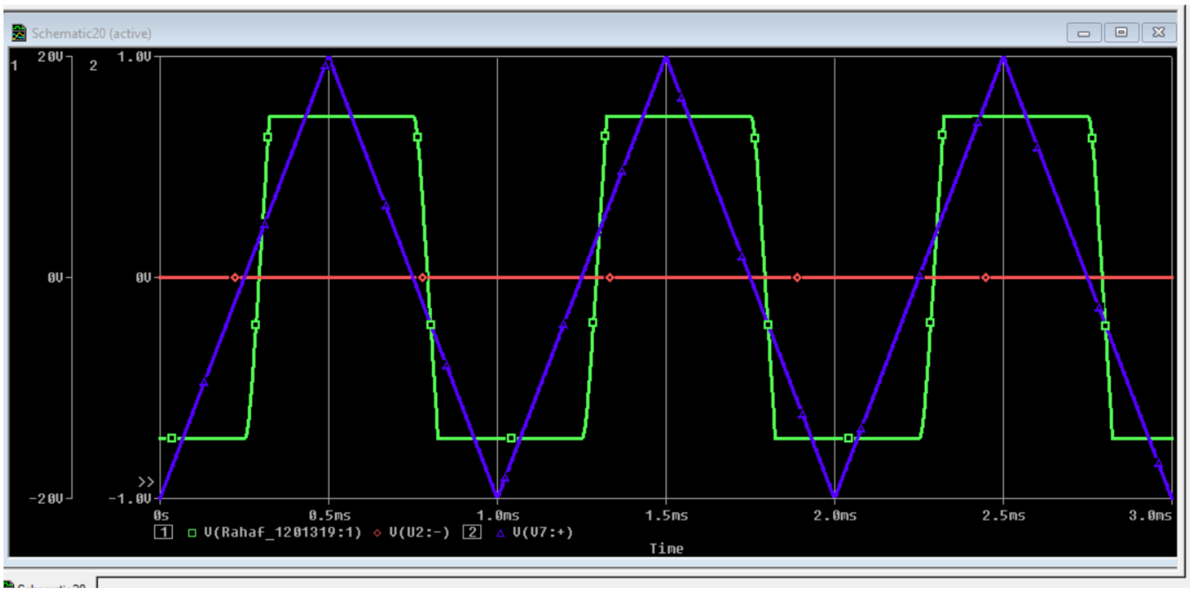

Figure 3.2: Input and Output voltage when V6=0v

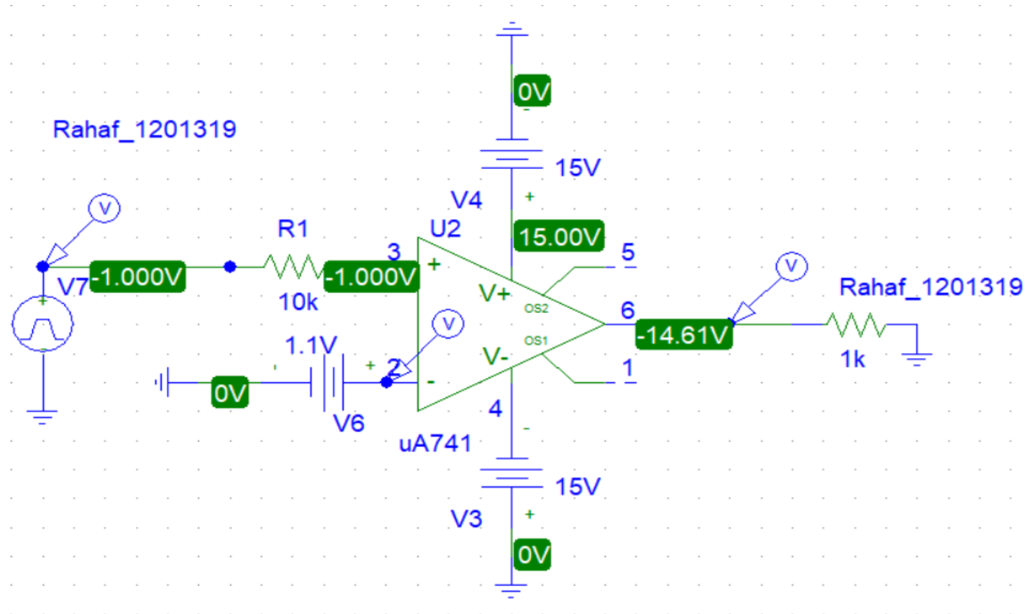

Figure 3.3: Comparator Application circuit when v6 =1.1

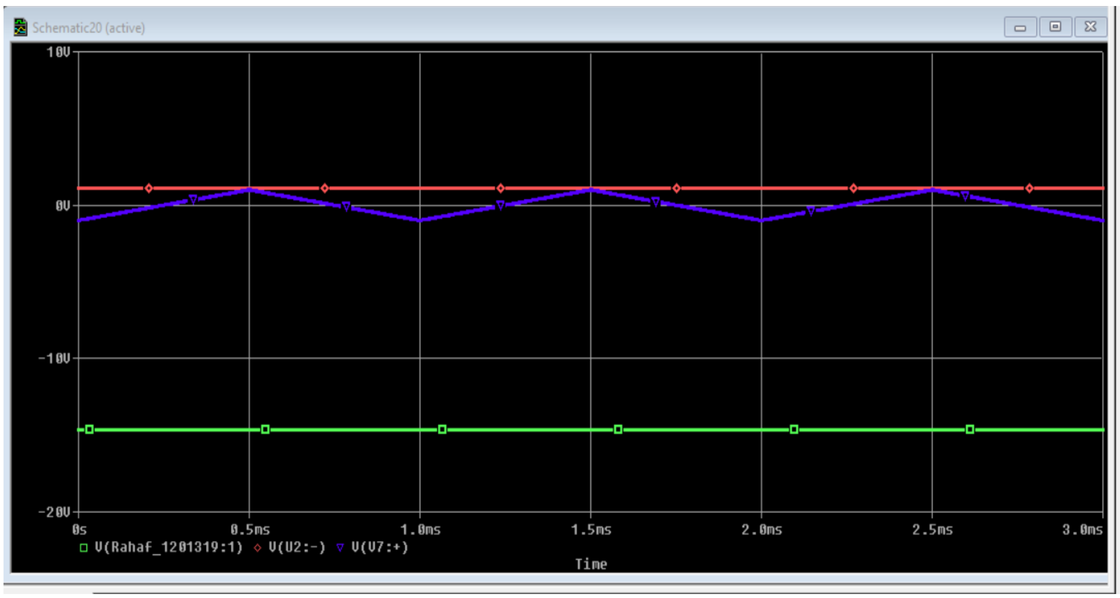

Figure 3.4: Input and Output voltage when V6=1.1v

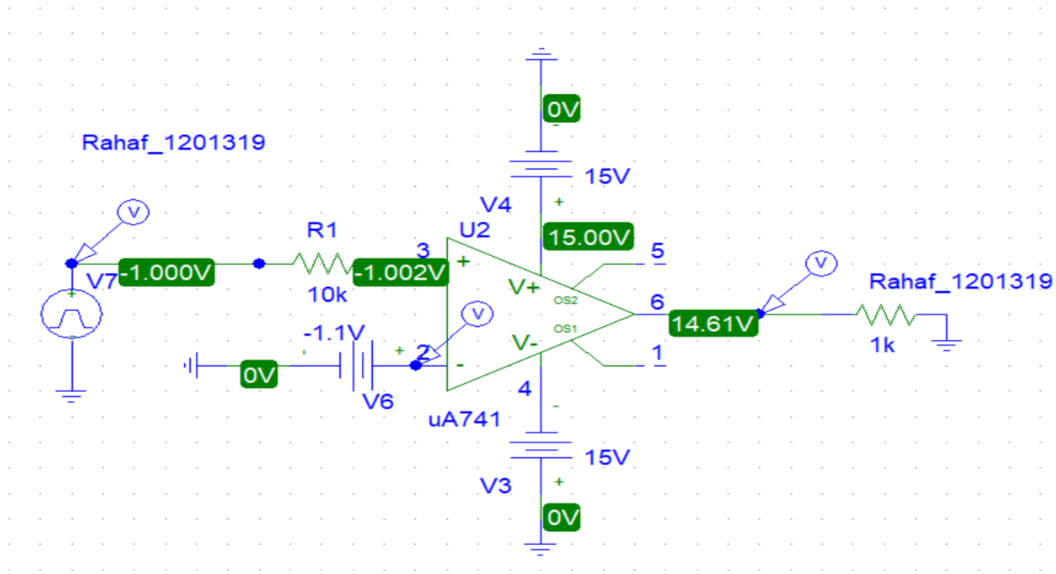

Figure 3.5: Comparator Application circuit when v6 = -1.1

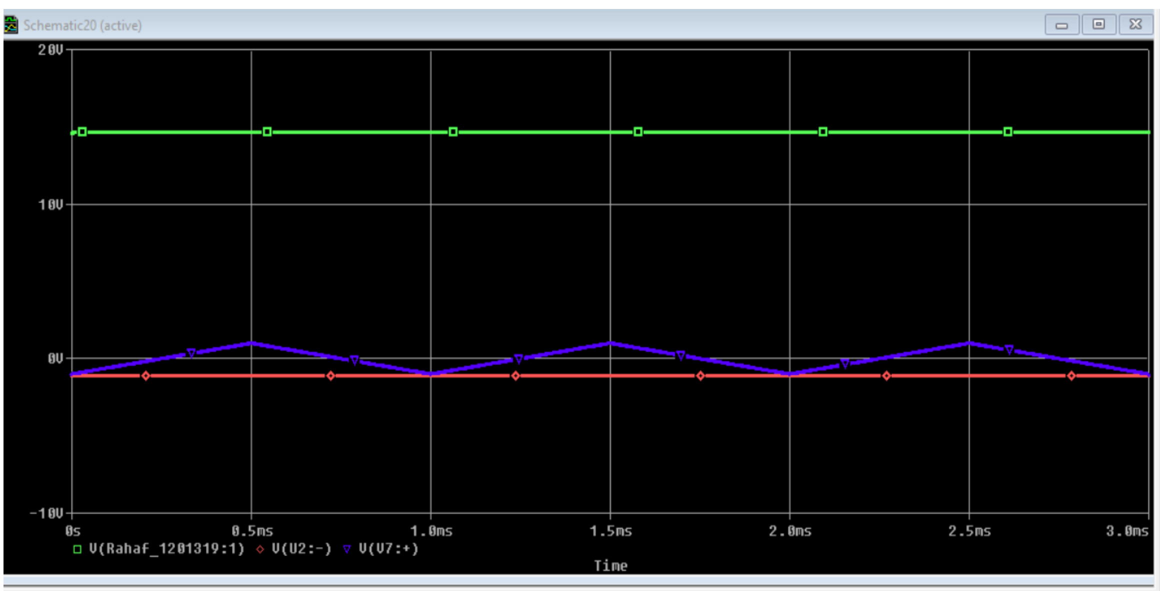

Figure 3.6: Input and Output voltage when V6= -1.1v

4. To investigate the effect of adding hysteresis

The circuit was connected as shown in figure 4.1 below, I Put Vi(t) = 15Vp-p sine wave of frequency 1 kHz.

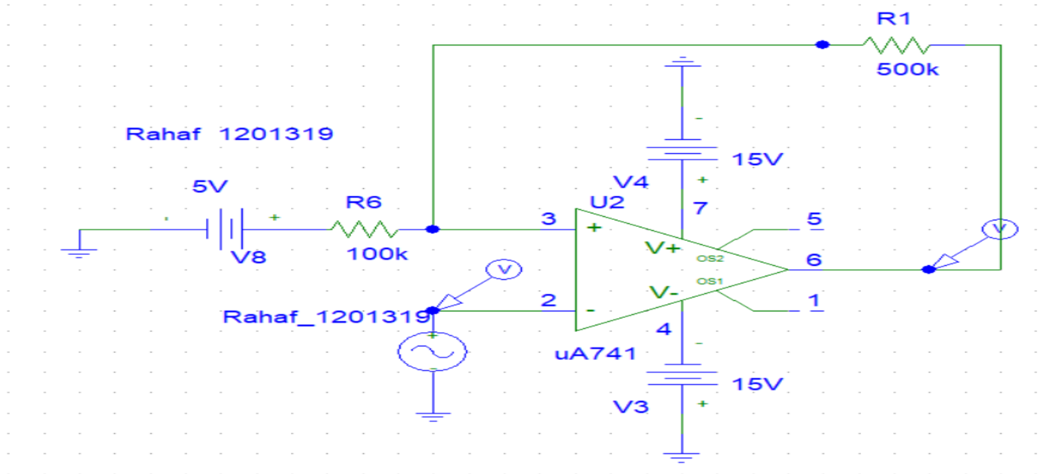

Figure 4.1: The effect of adding hysteresis circuit

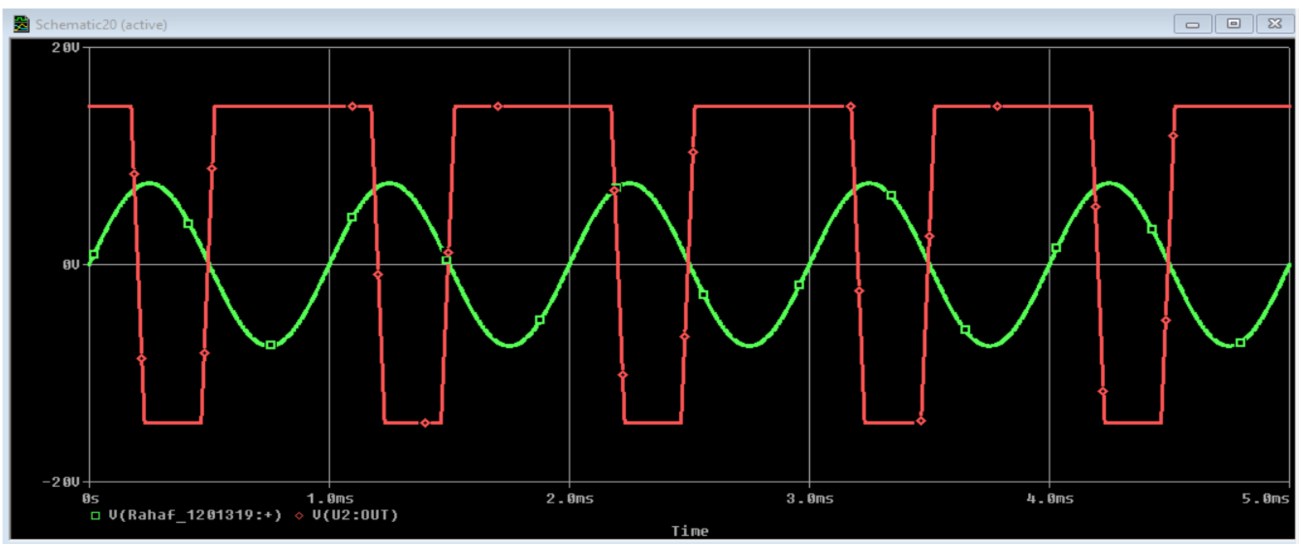

Figure 4.2: Input and Output circuit

The reference voltage at the non-inverting input changes creating two different references voltage values and two different switching points. One point being called the Upper Trip Point (UTP), while the other is called the Lower Trip Point (LTP). The difference between these two trip points is known as Hysteresis.