

# Experiment 5 Preliminary Work

## Operational Amplifiers

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### 1 Introduction

In preliminary work of the Experiment 5 , the steps for the pre-experiment are conducted and presented.

### 2 Step 1

Videos in ODTUCLASS related to this experiment is watched and observations are noted.

### 3 Step 2

"Notes on Op-Amps" document is studied.

### 4 Step 3

In this step following 4 op-amp circuits are constructed in the LTSpice environment and simulated.  $V_{in(t)}$  is taken as  $3\sin(1000\pi)$  Volts. Then data are fetched from LTSpice and plotted in MATLAB.

#### 4.1 a)

Basic comparator circuit is constructed in LTSpice environment. The schematic is given in the Figure 1.

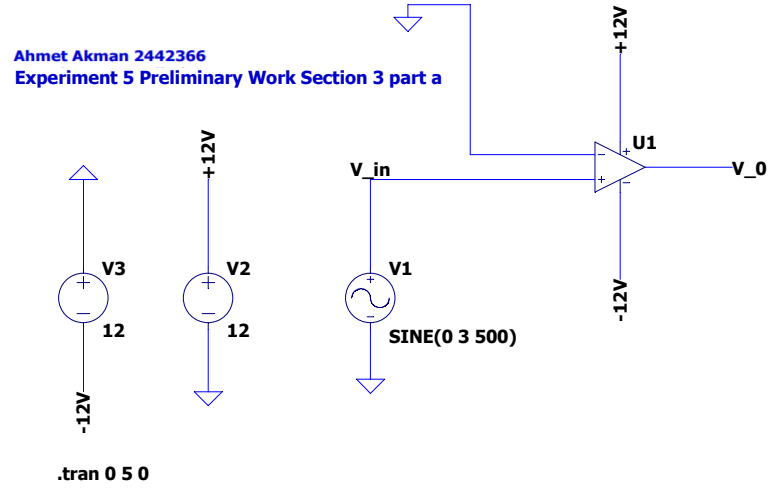


Figure 1: Circuit schematic for the basic comparator.

Then plots given in Figures 2,3 and 4 are obtained.

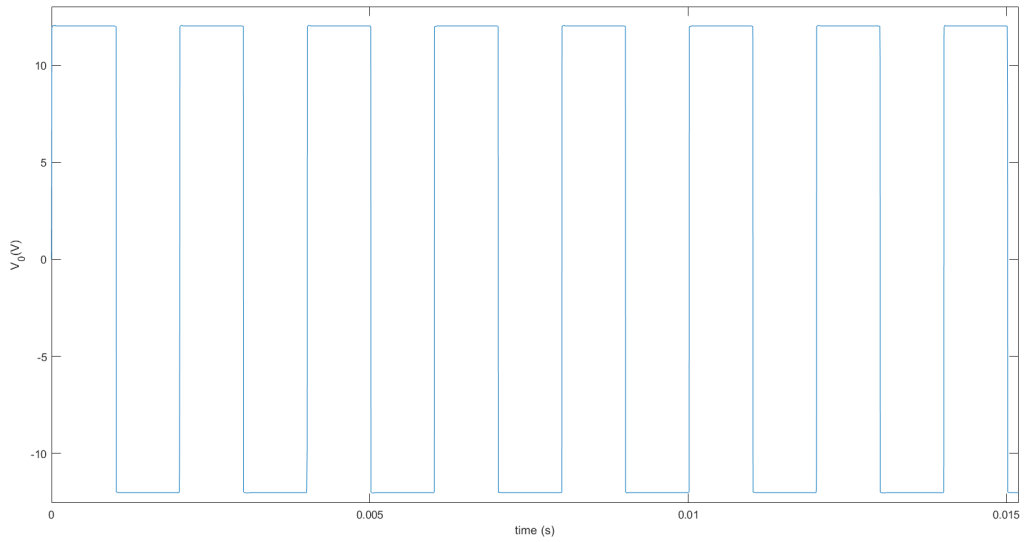


Figure 2:  $V_0$  vs  $t$

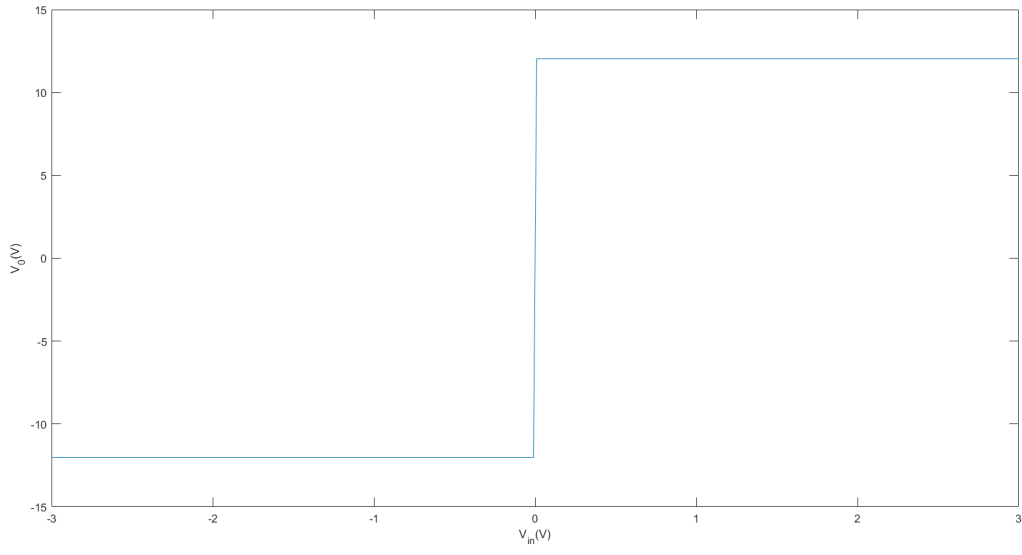


Figure 3:  $V_0$  vs  $V_{in}$

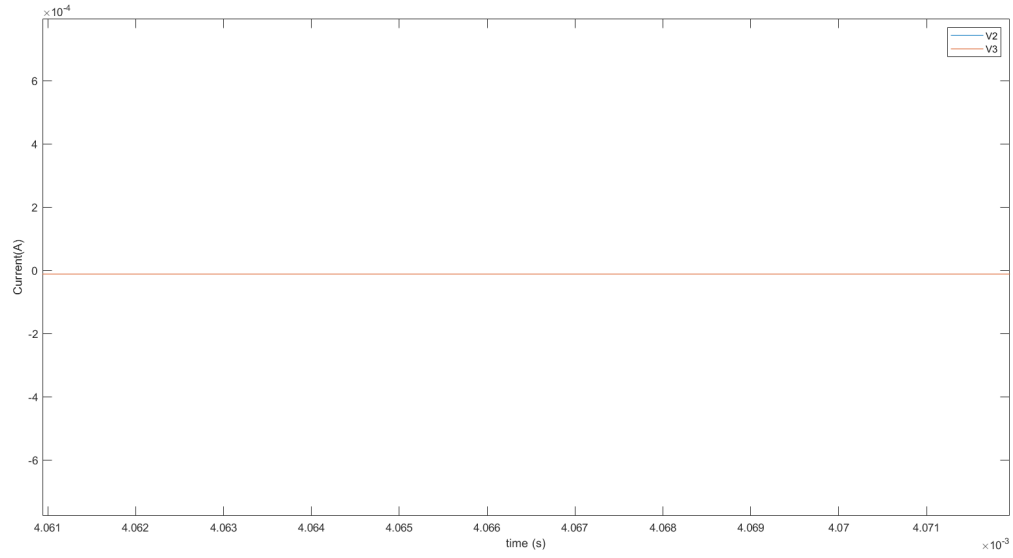


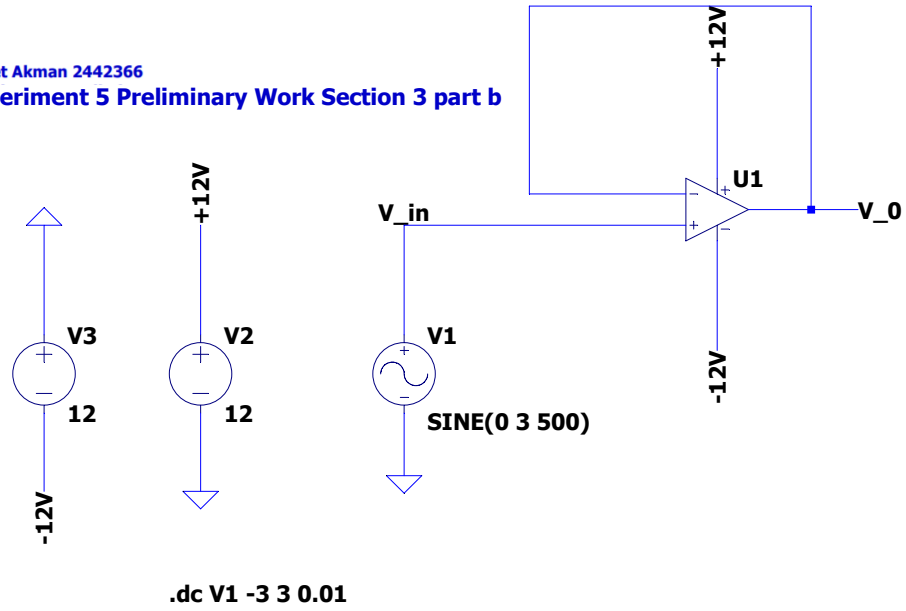
Figure 4:  $i$  vs  $t$

## 4.2 b)

Buffer circuit is constructed in LTSpice environment. The schematic is given in the Figure 5.

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Experiment 5 Preliminary Work Section 3 part b



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Figure 5: Circuit schematic for the buffer.

Then plots given in Figures 6 , 7 and 8 are obtained.

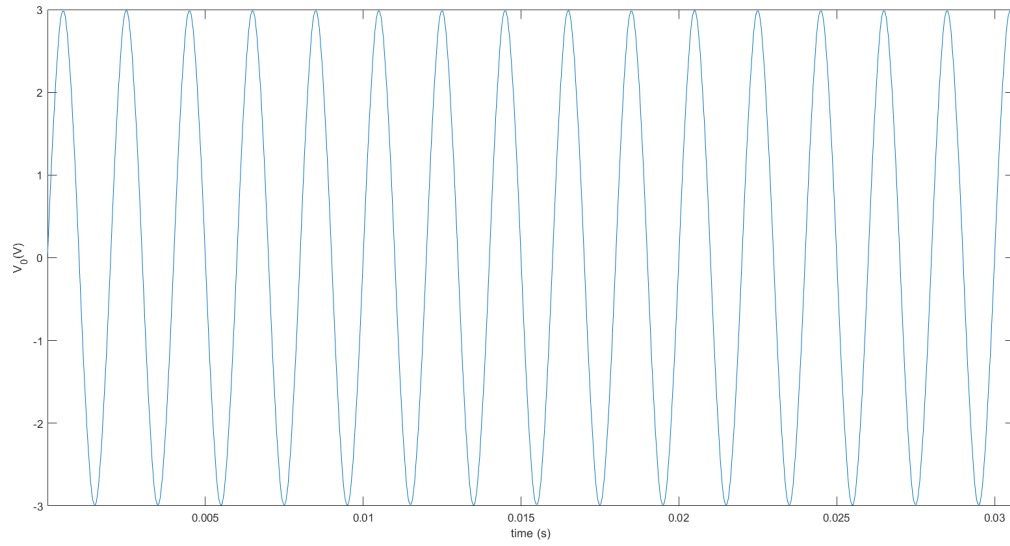


Figure 6:  $V_0$  vs  $t$

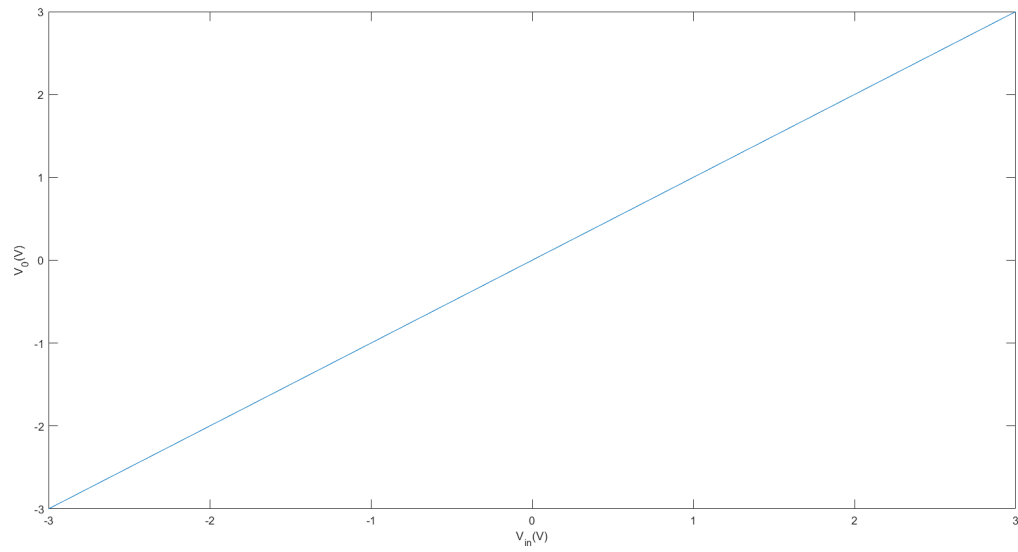


Figure 7:  $V_0$  vs  $V_{in}$

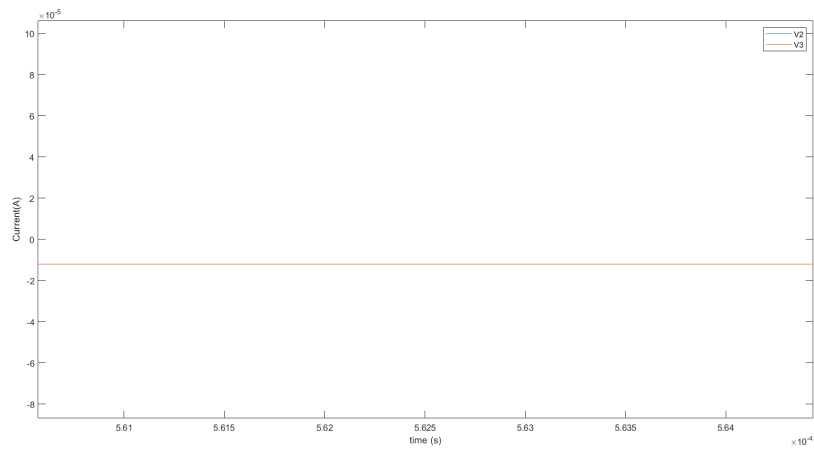


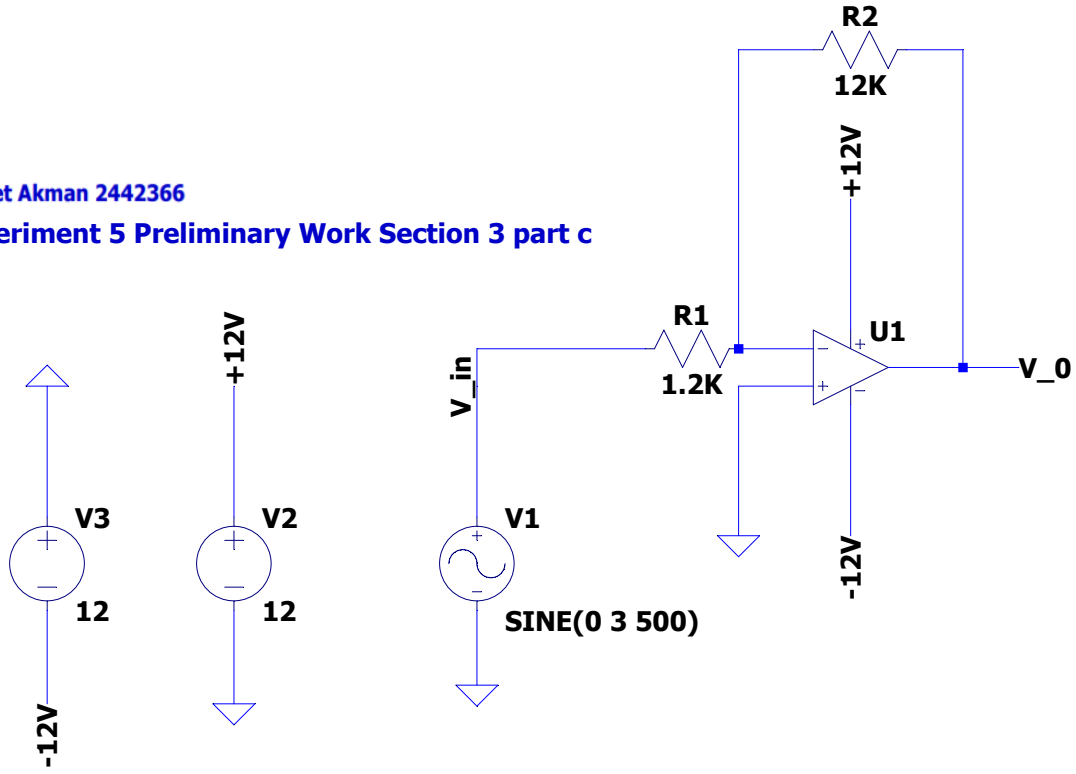
Figure 8:  $i$  vs  $t$

### 4.3 c)

Inverting amplifier circuit is constructed in LTSpice environment. The schematic is given in the Figure 9.

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Experiment 5 Preliminary Work Section 3 part c



.dc V1 2 0

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Figure 9: Circuit schematic for the inverting amplifier.

Then plots given in Figures 10,11 and 12 are obtained.

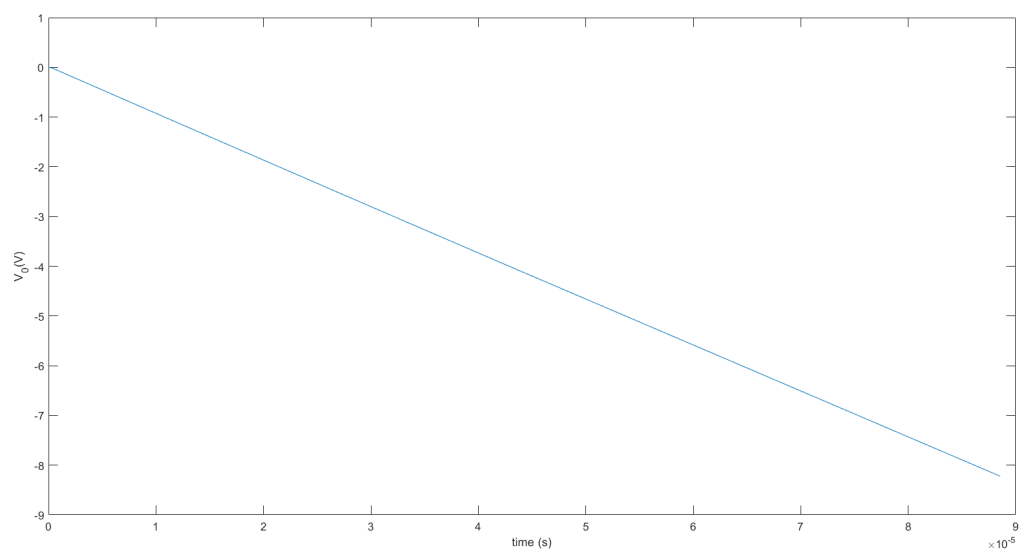


Figure 10:  $V_0$  vs  $t$

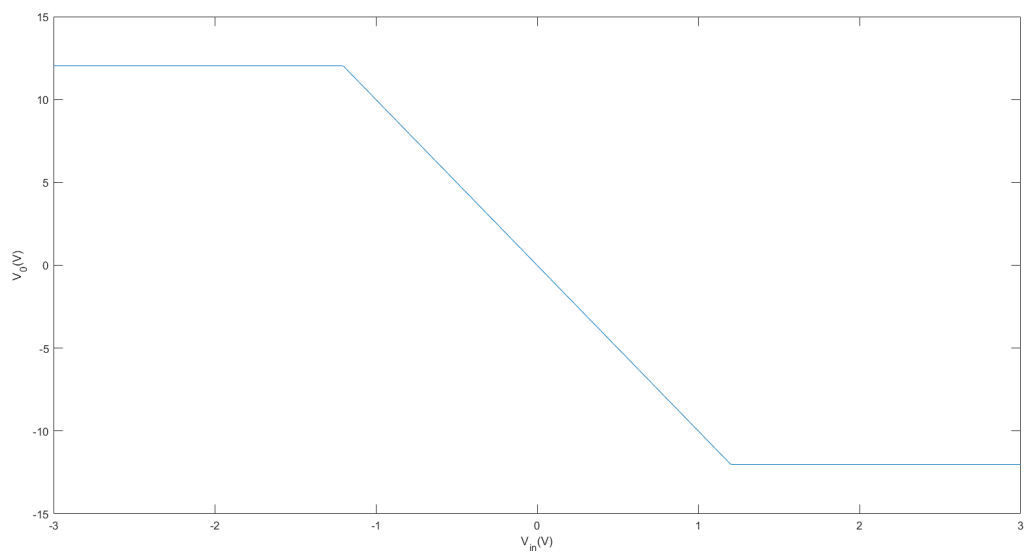


Figure 11:  $V_0$  vs  $V_{in}$

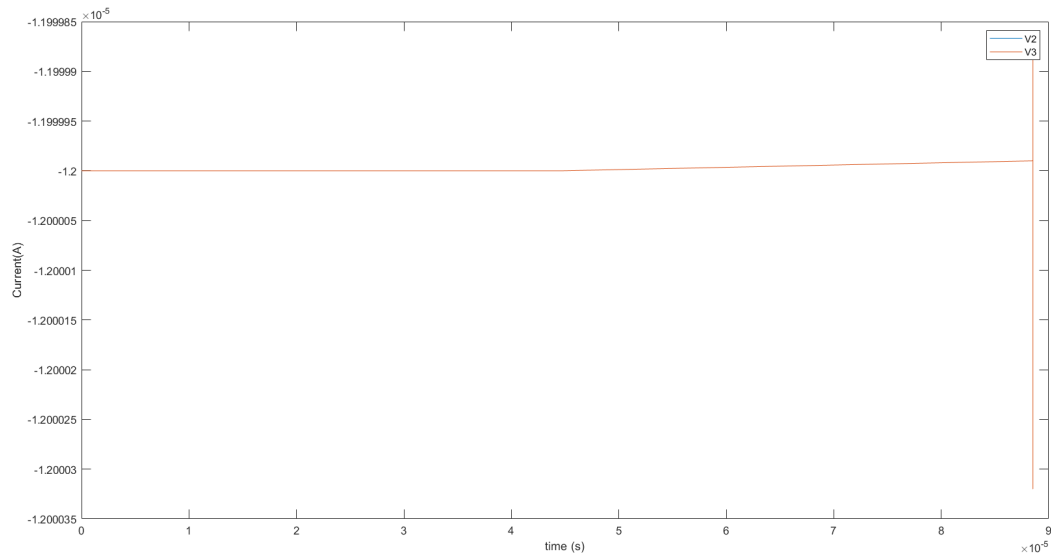


Figure 12:  $i$  vs  $t$

#### 4.4 d)

Non-inverting amplifier circuit is constructed in LTSpice environment. The schematic is given in the Figure 13.

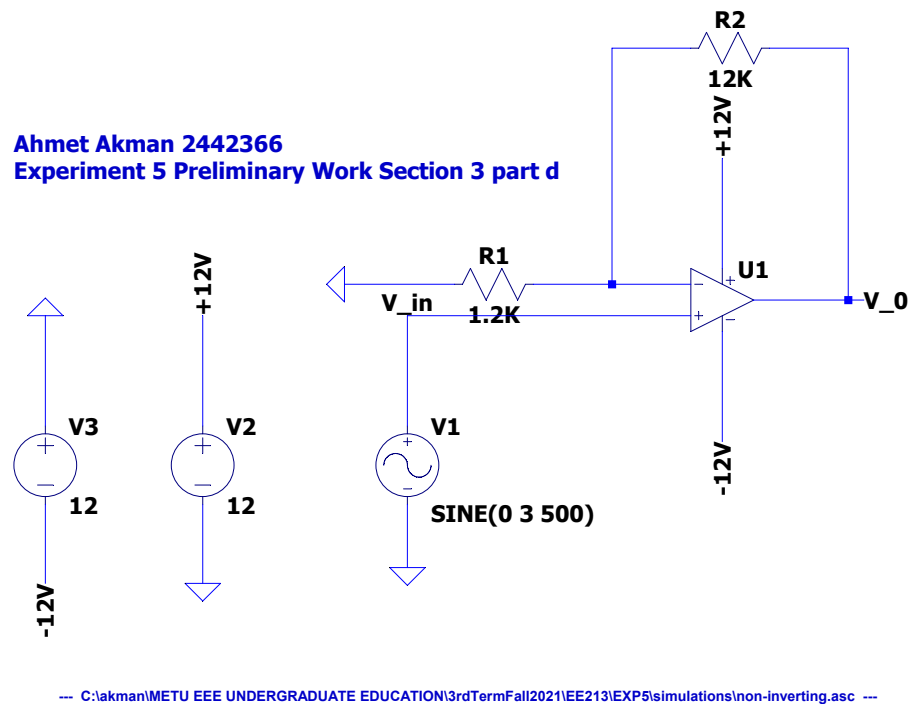


Figure 13: Circuit schematic for the basic comparator.



Then plots given in Figures 14,15 and 16 are obtained.

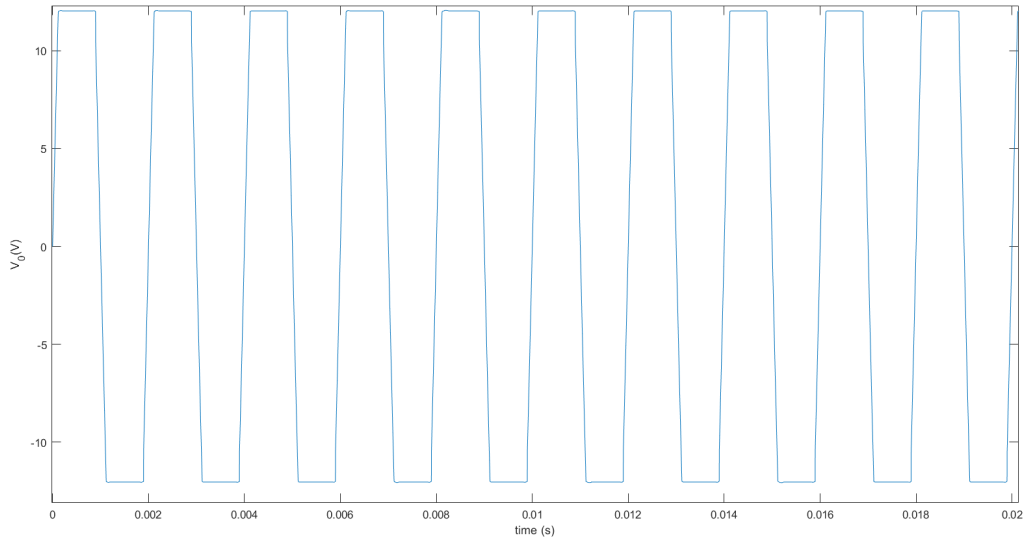


Figure 14:  $V_0$  vs  $t$

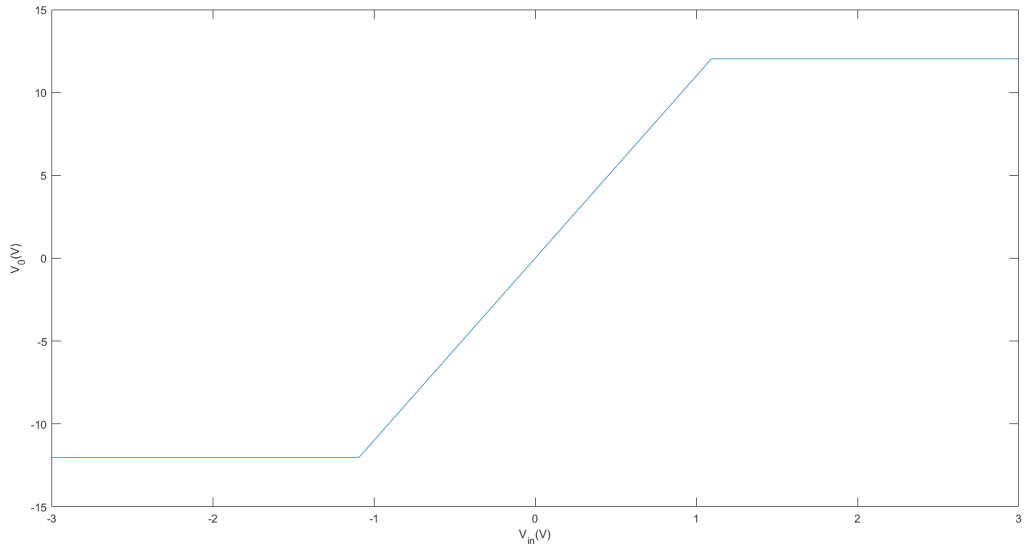


Figure 15:  $V_0$  vs  $V_{in}$

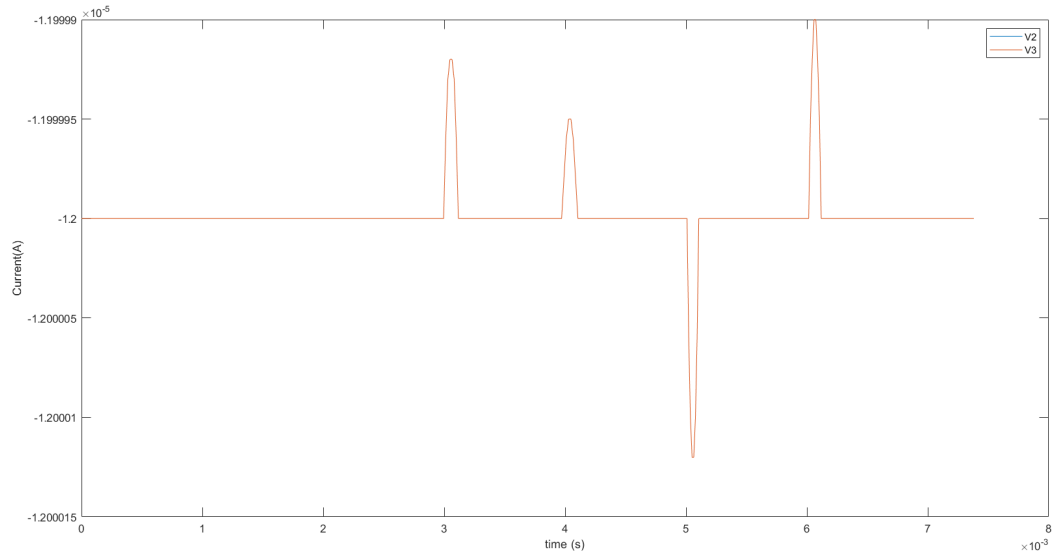


Figure 16:  $i$  vs  $t$

## 5 Step 4

In this step following 2 op-amp circuits are constructed in the LTSpice environment and simulated.  $V_a$  is taken as  $4\sin(1000\pi)$  Volts.  $V_b$  is taken as  $2\sin(1000\pi)$  Volts. Then data are fetched from LTSpice and plotted in MATLAB.

### 5.1 a)

Summing amplifier circuit is constructed in LTSpice environment. The schematic is given in the Figure 17.

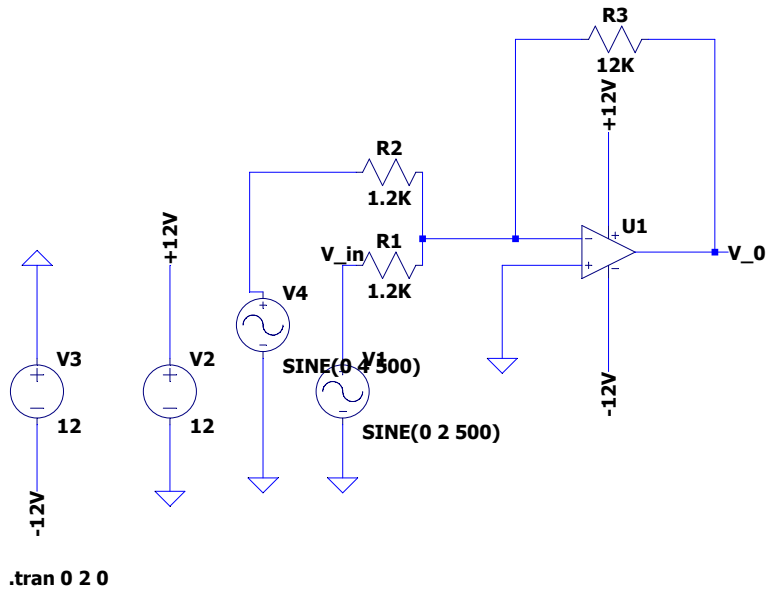


Figure 17: Circuit schematic for the summing amplifier.

Then plot given in Figure 18 is obtained.

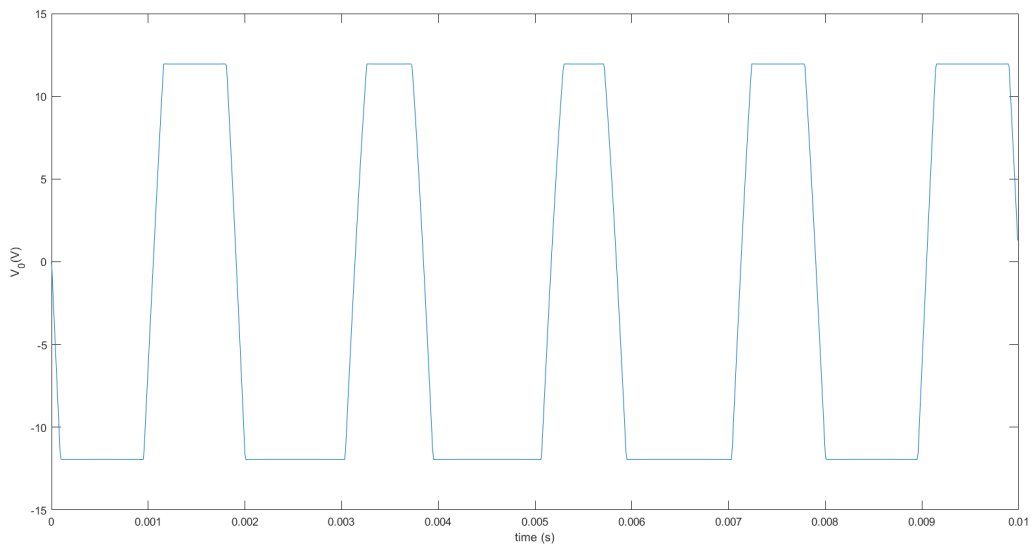


Figure 18:  $V_0$  vs  $t$

## 5.2 b)

Difference amplifier circuit is constructed in LTSpice environment. The schematic is given in the Figure 19.

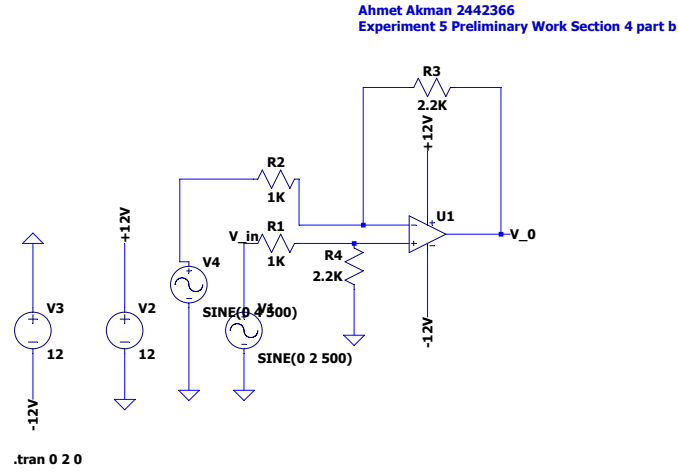


Figure 19: Circuit schematic for the difference amplifier.

Then plot given in Figure 20 is obtained.

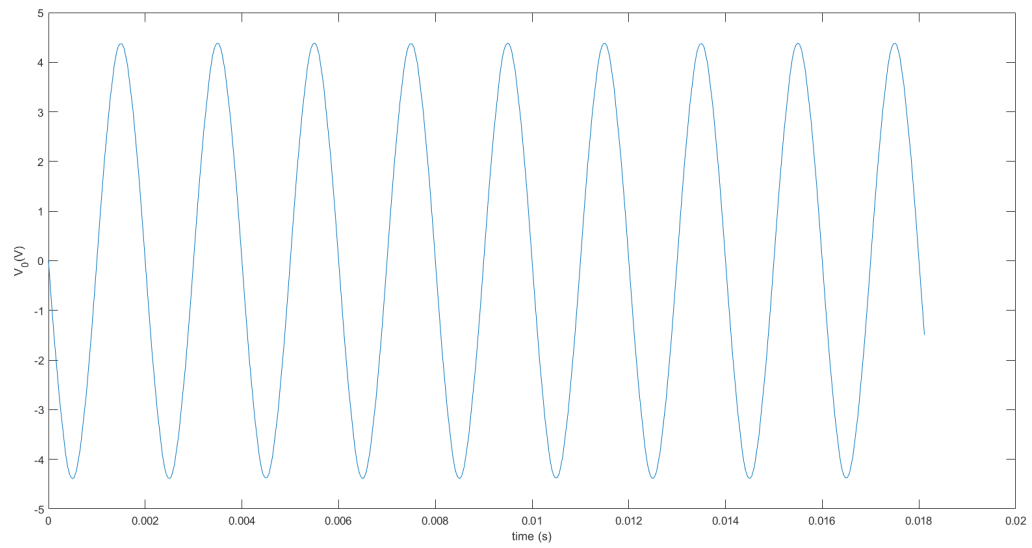


Figure 20:  $V_0$  vs  $t$

## 6 Step 5

To obtain the expression relating the output voltage  $V_o(t)$  to the input voltage  $V_{in}(t)$  of a inverting amplifier setup, the circuit in Figure 8 is taken as the reference. Then current through input terminals and the voltage of those terminals are taken as 0 since it is ideal amplifier. So the circuit simplifies to 2 terminals and 2 resistors. Then the following simplifications are followed.

$$\frac{V_{in} - 0}{R_1} = i$$
$$\frac{0 - V_o}{R_2} = i$$

So, the relation becomes as,

$$\frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1}$$

Therefore it seems linear region of the plot given in Figure 11 approximately corresponds our findings.

## 7 Conclusion

In conclusion, in preliminary work of experiment 5, "Operational Amplifiers" needed simulation are made and necessary data are plotted. Then the expression for the inverting amplifier obtained and compared.