Faculty of Engineering & Technology

Electrical & Computer Engineering Department

Analog Electronics ENEE2360

Project Report

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Section: 1

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Abstract

The purpose of this project is to design a circuit and find the required values . This circuit contains 4 resisters with different values, one BJT npn transistor, one Zener diode. We used these components to build the circuit. Then we will use PSPICE software to do this project.

Table of Contents

List of figures

Theory

Components

1- Resisters

The resistor is a passive electrical component that creates resistance in the flow of electric current. In almost all electrical networks and electronic circuits they can be found. The resistance is measured in ohms (Ω). An ohm is the resistance that occurs when a current of one ampere (A) passes through a resistor with a one volt (V) drop across its terminals. The current is proportional to the voltage across the terminal ends. This ratio is represented by Ohm's law:

$R=V/I$

Resistors are used for many purposes. A few examples include limiting electric current, voltage division, heat generation, matching and loading circuits, gain control, and setting time constants. They are commercially available with resistance values over a range of more than nine orders of magnitude. They can be used as electric brakes to dissipate kinetic energy from trains, or be smaller than a square millimeter for electronics.[1]

Figure 1: Resisters

2- Q2N2222 transistor

The 2N2222 is a type of bipolar junction transistor (BJT) that is commonly used as a small-signal NPN transistor. It was one of the first transistors that were widely used, and it is still used today in a wide range of applications. The 2N2222 is known for its reliability and ease of use.

The 2N2222 transistor has three regions: the emitter, base, and collector. The emitter is the negative terminal, the base is the control terminal, and the collector is the positive terminal. The transistor can be used as a switch or an amplifier depending on the bias applied to the base terminal. The 2N2222 transistor is also known for its switching capabilities, hence it's widely used in digital circuits.

The 2N2222 transistor can handle a maximum collector current of 800mA, and a maximum collector-emitter voltage of 40V. It can also handle a maximum power dissipation of 625mW. It's widely used in different application such as digital and analog circuits, switching circuit, oscillators, and amplifiers.[2]

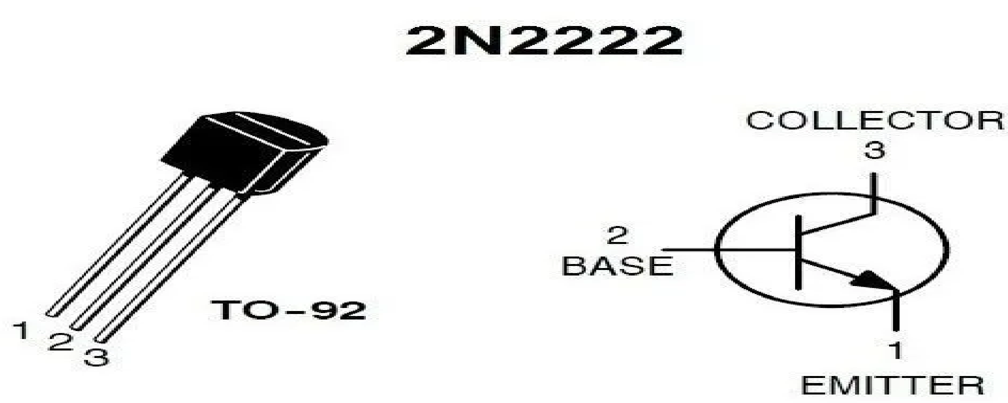

Figure 2: Q2N2222

3- D1N750 Zener diode

1N750 is a 4.7 Volt 400mW Zener diode that acts as a two-way switch means that it can conduct current in forward as well as reverse direction. It is a heavily doped diode and permits the reverse current when a specific voltage level is reached.[3]

Figure 3: D1N750 Zener diode

Procedure

Part A

Using PSPICE, find the current through each resistor and all nodal voltages.

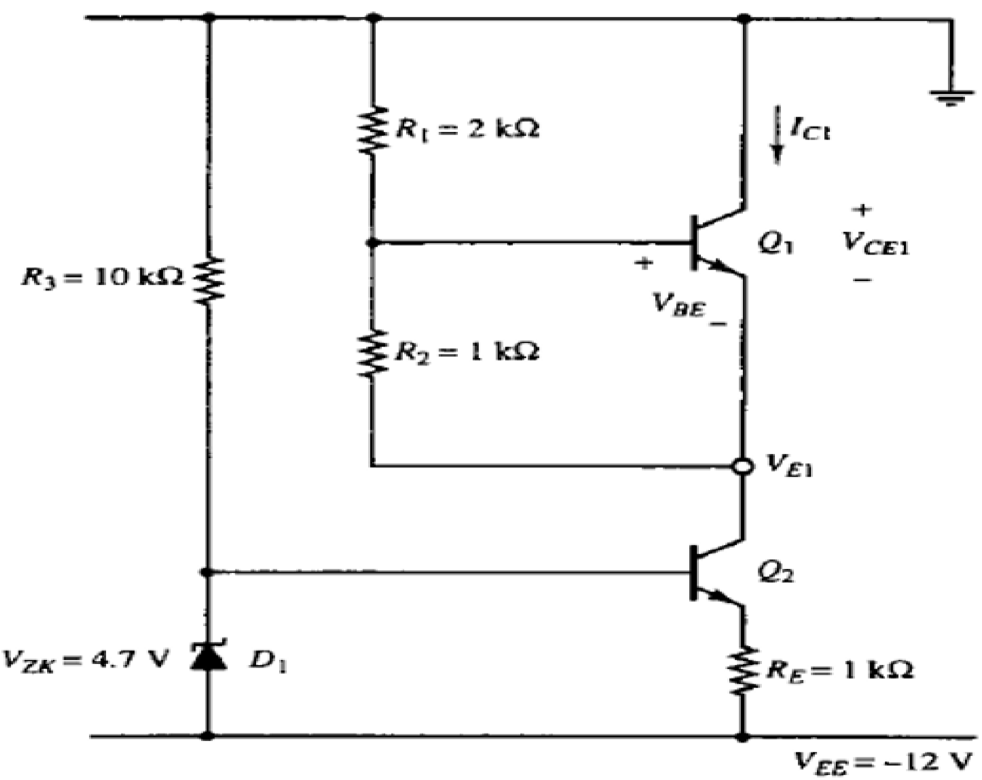

Figure 4: the circuit

I built the circuit in the PSPICE:

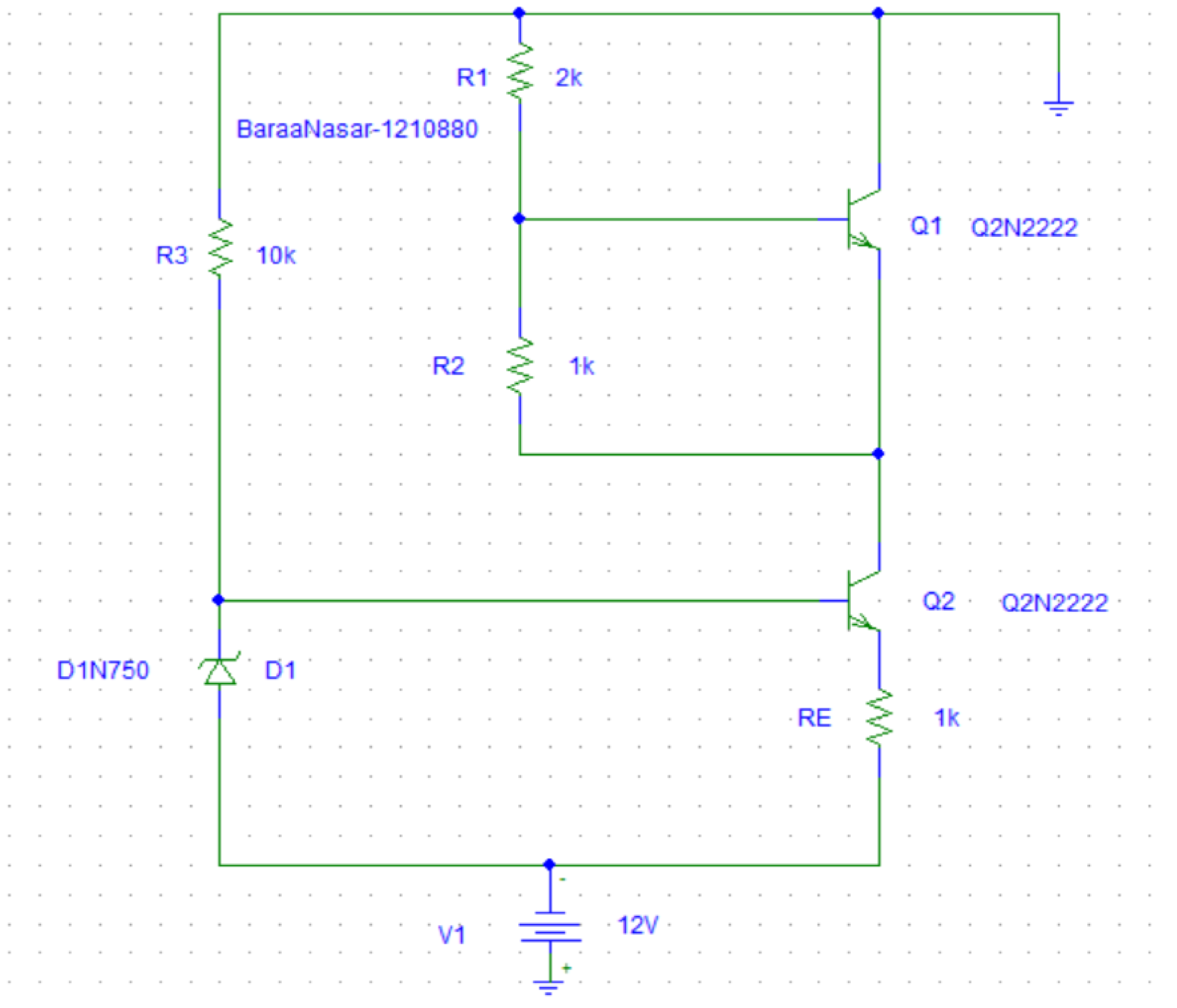

Figure 5: The circuit in the PSPICE.

The values for all currents and voltages are in Figure 6:

The Circuit Simulation:

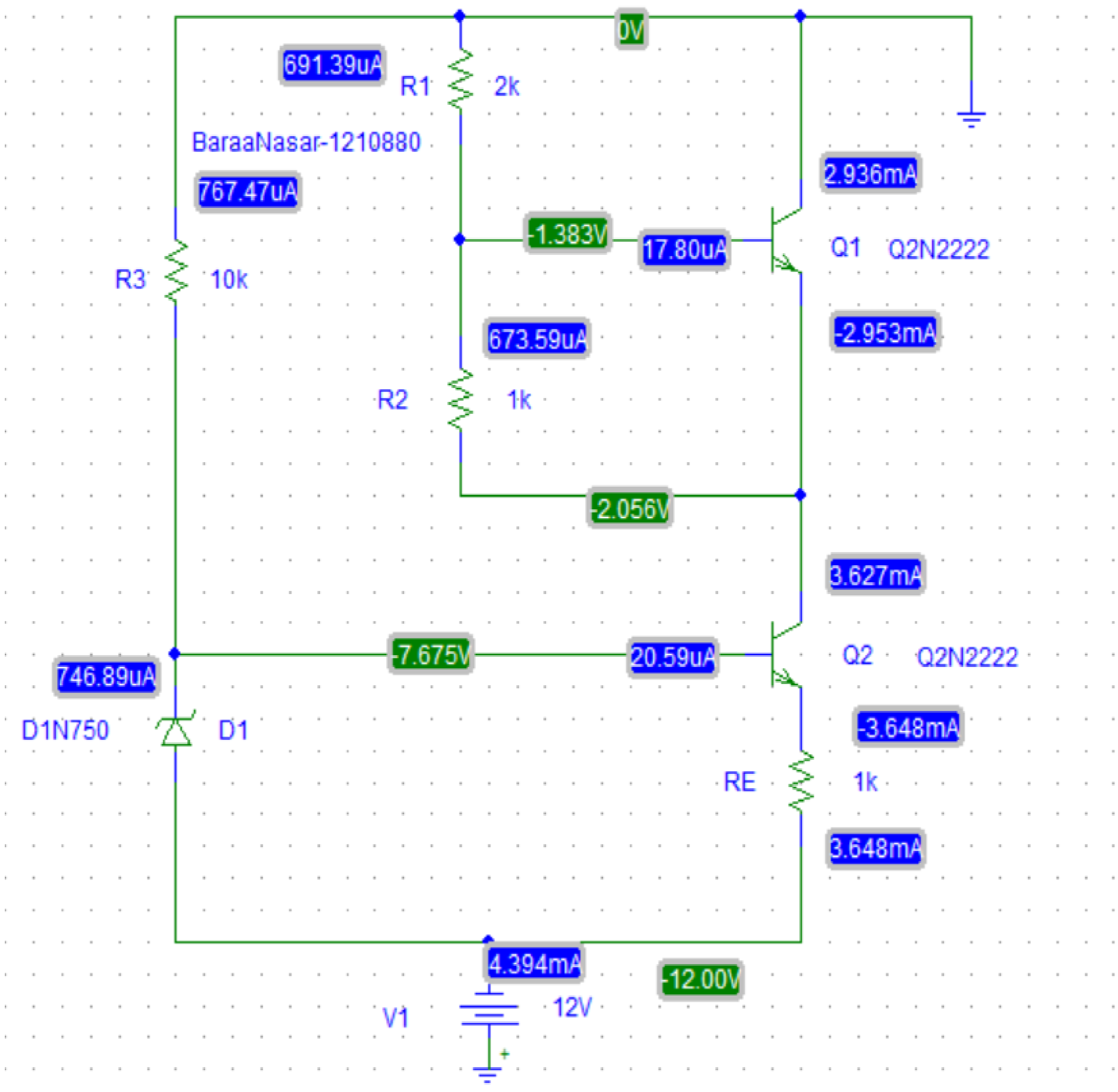

Figure 6: The Circuit Simulation of Part A.

Part B

Design a revised version of the circuit so that VE1 = -5.5V.

(i.e. change values of R1 and R2).

Using results of part a, calculate by hand the R2 and let R1=7K and VE1 = -5.5V.

Calculations and result:

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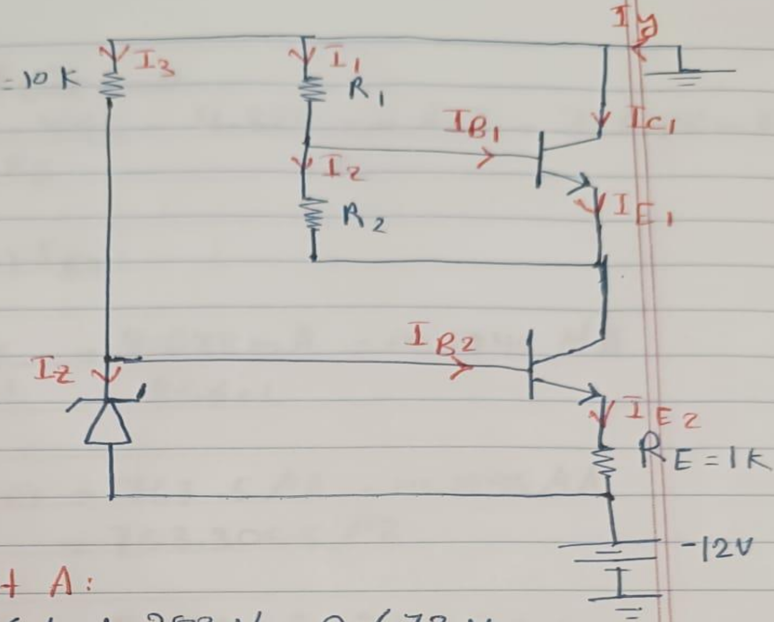

⇒ From the Part A:

$V_{BE} = 2.056V - 1.383V = 0.673\ V$

$V_Z = 12.00V - 7.675\ V = 4.325\ V$

let $R_1 = 7K\Omega$

→ $V_{BE} - V_{E1} - I_1 R_1 = 0$ — ①

⇒ $I_1 = \dfrac{V_{BE} - V_{E1}}{R_1} = \dfrac{0.673 - 5.5}{7K} = 689.5\ \mu A$

→ $-V_{EE} - V_Z - I_3 R_3 = 0$ — ②

⇒ $I_3 = \dfrac{-V_{EE} - V_Z}{R_3} = \dfrac{12 - 4.325}{10K} = 767.5\ \mu A$

$$\Rightarrow V_Z - V_{BE} - R_E I_{E2} = 0$$

$$\rightarrow I_{E2} = \frac{V_Z - V_{BE}}{R_E} = \frac{4.325 - 0.673}{1K} = 3.648\,mA$$

$$\Rightarrow I_{E2} = (\beta + 1) I_{B2}$$

$$\rightarrow I_{B2} = \frac{I_{E2}}{\beta + 1} = \frac{3.648\,mA}{256 + 1} = 14.1945\,\mu A$$

$$\Rightarrow I_Z = I_3 - I_{B2} = 767.5\,\mu A - 14.1945\,\mu A$$
$$= 753.3055\,\mu A$$

$$\Rightarrow I_y = I_{E2} + I_Z = 3.648\,mA + 753.3055$$
$$= 4.4013\,mA$$

$$\Rightarrow I_{C1} = I_y - I_3 - I_1 = 4.4013\,mA - 767.5\,\mu A - 689.5\,\mu A$$
$$= 2.94\,mA$$

$$\Rightarrow I_{C1} = \beta I_{B1} \Rightarrow I_{B1} = \frac{I_{C1}}{\beta} = \frac{2.94\,mA}{256} = 11.4843\,\mu A$$

$$\Rightarrow I_2 = I_1 - I_{B1} = 689.5\,\mu A - 11.4843\,\mu A$$
$$= 678.0157\,\mu A$$

$$\Rightarrow R_2 = \frac{V_2}{I_2} = \frac{V_{BE}}{I_2} = \frac{0.673\,V}{678.0157\,\mu A} = 992.602$$

Then the value of R2 we got = 992.602

Part C

Verify the designed circuit in step b by simulation

When change values of R1 =7k

and by Calculations of part B we got R2= 992.602

Simulation and result:

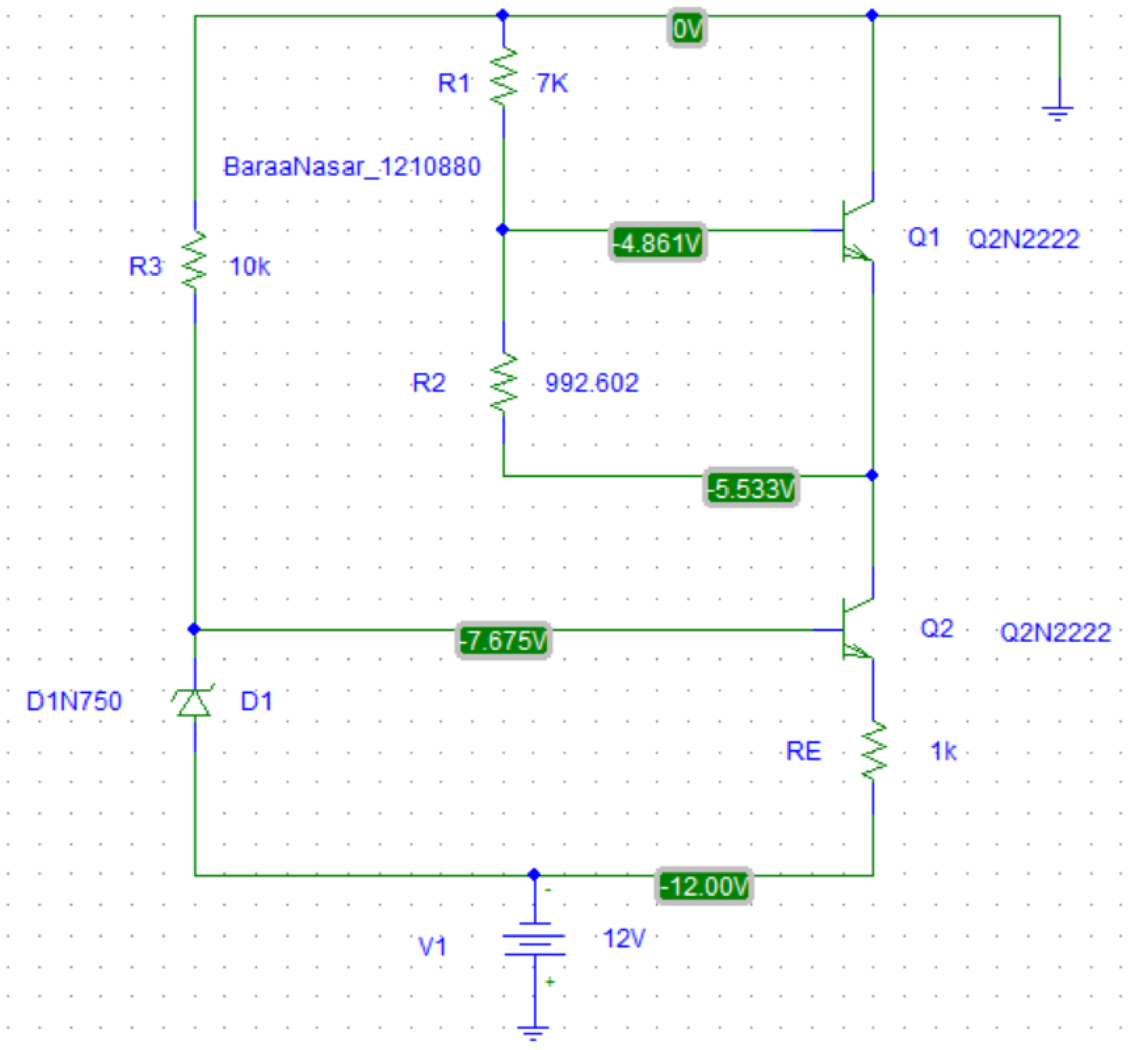

Figure 7: The Circuit Simulation of Part C.

In Part A, the value of R1=1k , and R2=2K , and through the result of the simulation, the value of VE1=-5.5V . But In Part B when change values of R1 =7k and by Calculations of part B we got R2= 992.602 so that VE1 = -5.5V ,and by the simulation In Part C the VE1 did not change, and its value remained almost equal

-5.5V So we conclude from that the result in PSPICE in Part C is closer to the

VE1=-5.5 in Part B, that's mean our results is true.

Conclusion

In conclusion, we learnt how to design and build the circuit , and we know about circuit's components, and how each components work, and we know the datasheet of them. We learnt how to simulate the circuit in PSPICE. We became able to find R2 In Part B and Verify the designed circuit in step B by simulation .And The result in PSPICE in Part C is closer to the VE1=-5.5 in Part B, that's mean our results is true.

Feedback

This project is a nice one, we learnt some new ideas in Analog electronics and we became more familiar with PSPICE.

References

[1] Resistor. (2023 , 9 3). Retrieved from https://eepower.com/resistor-guide/resistor-fundamentals/what-is-a-resistor/#

[2]Q2N2222 transistor. (2023, 9 3). Retrieved from https://www.datasheetcafe.com/q2n2222-pdf-19246/

[3] D1N750 Zener diode. (2023, 9 3). Retrieved from https://www.circuits-diy.com/1n750-4-7v-400mw-zener-diode-datasheet/