Emre Şaş
EEE-313-001
22102764

EEE313 LAB 2 Low-Dropout Voltage Regulator

1) Measurement β of the BD-136 pnp transistor.

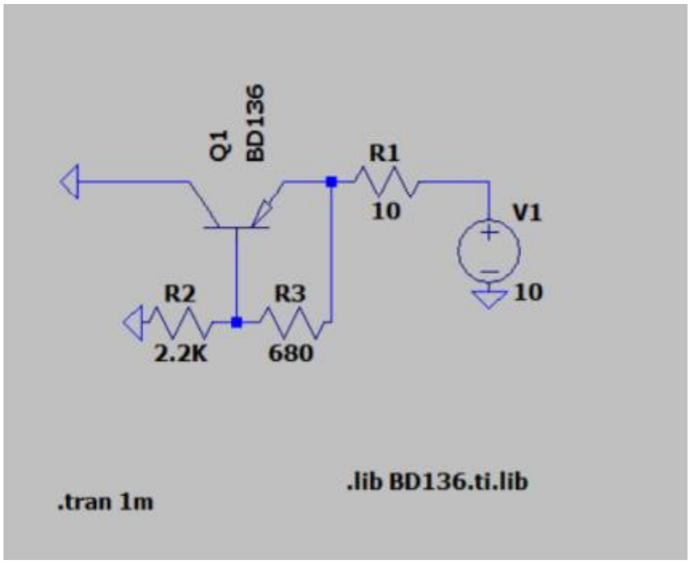

Figure 1: Circuit Design used for β calculation

Although the circuit in Figure 1 was designed at first, resistors were keep burning so, I increased the value of resistors. Constructed circuit can be observed from Figure 2.

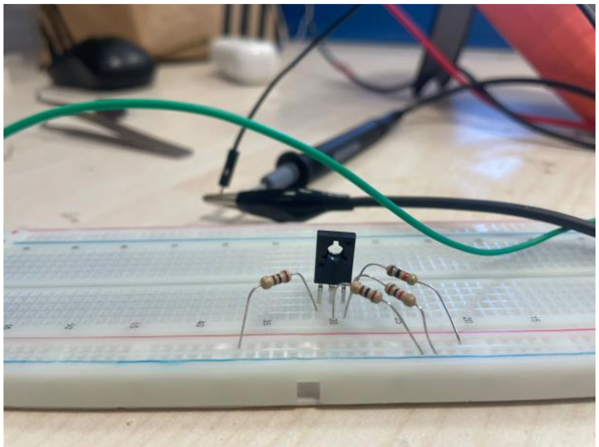

Figure 2 : Constructed Circuit

We should first measure the voltages V_E, V_B, V_C to find the result of following equations.

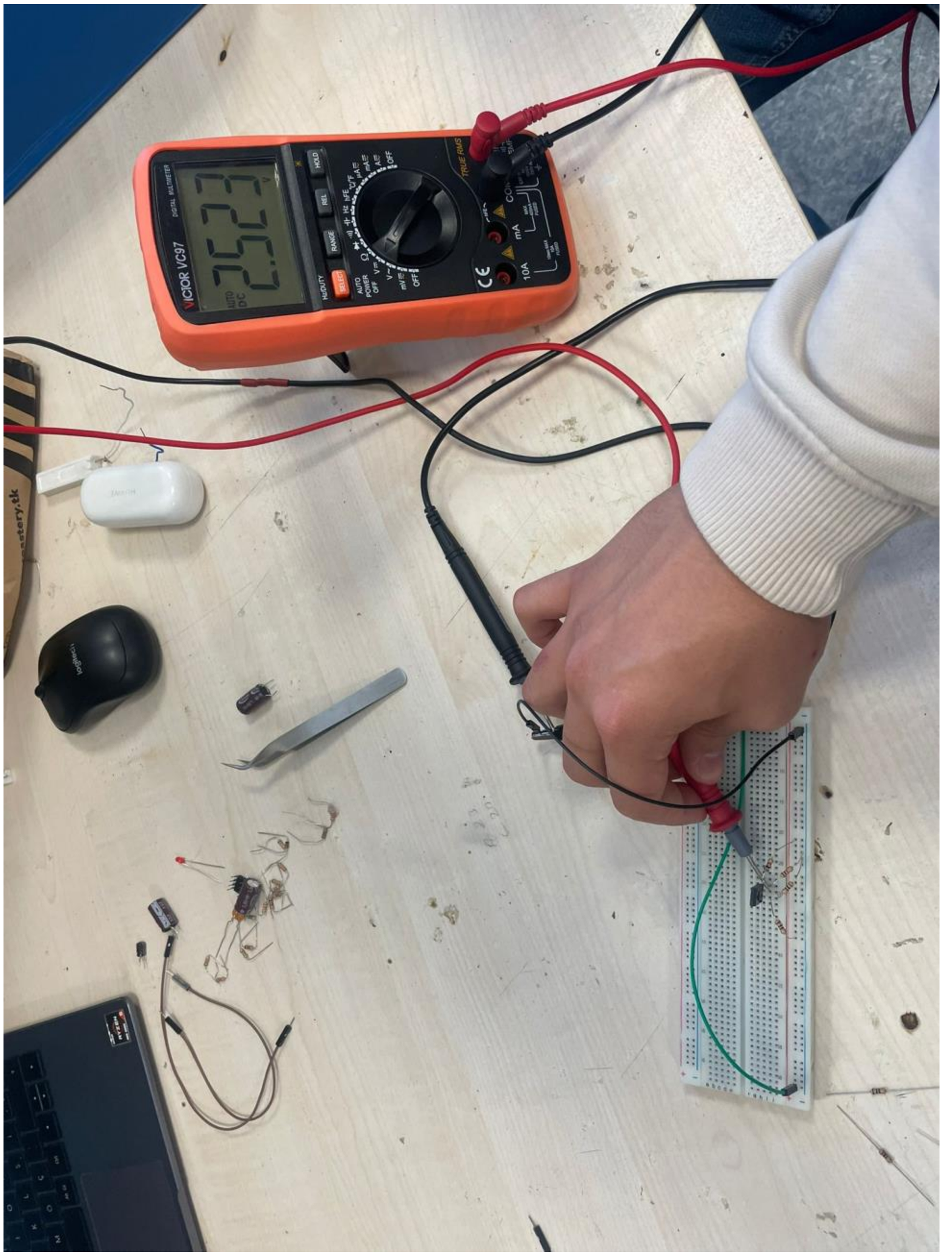

Figure 3: V_B (Base Voltage) Measurement

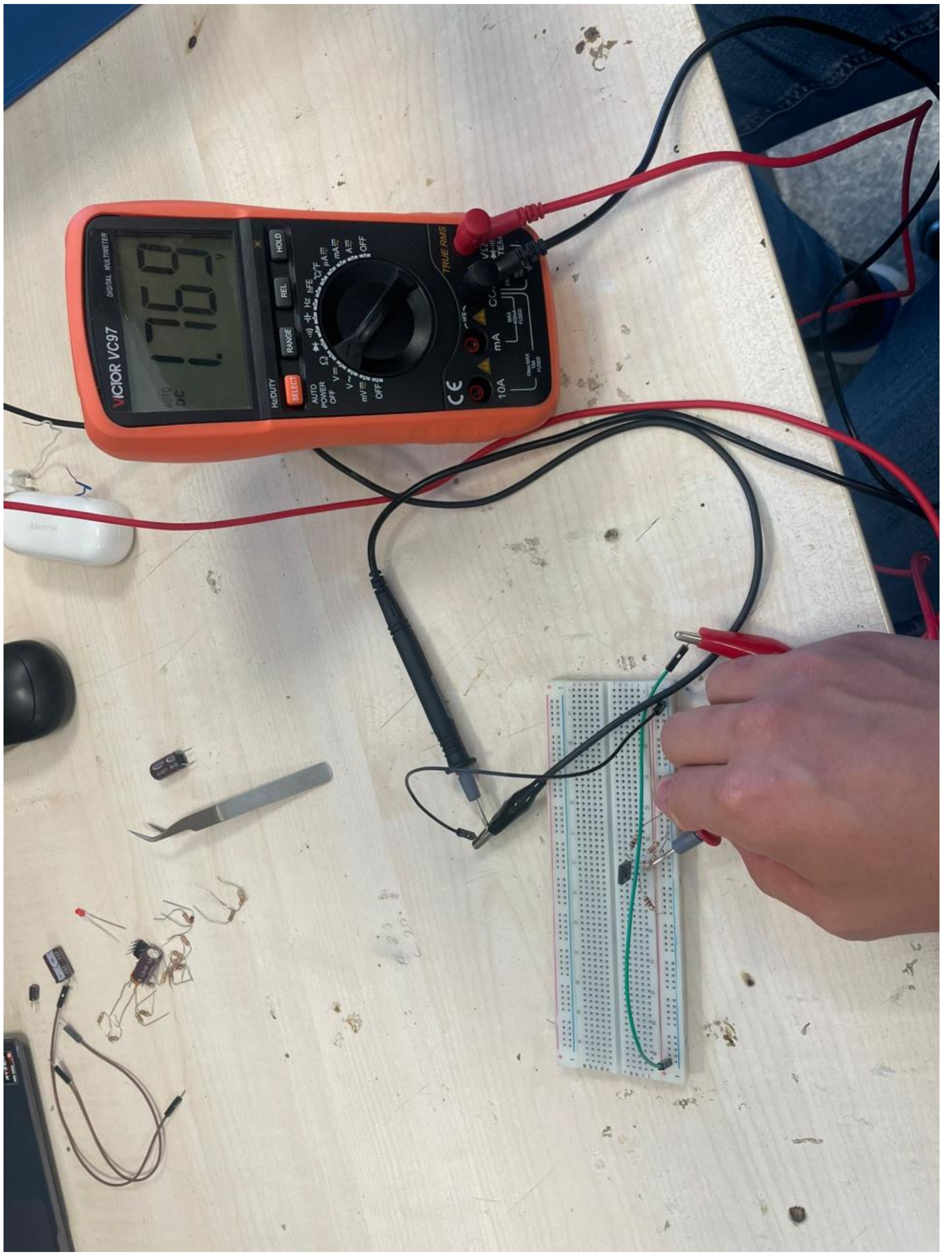

Figure 4:V_C (Collector voltage) Measurement

Now we will use the measured voltage values to find I_B and I_c.

$$I_B = \frac{(2\,V_B - V_{CC})}{R_1},\ I_c = \frac{V_c}{R_c} \rightarrow I_B = 70\mu A\,,\ I_c = 17.69\,mA$$

$$\beta = \frac{I_c}{I_B} \cong 259$$

β was found as 240 and now we see 259 which is close enough to say that the experiment was successful.

2) Low-Dropout Voltage regulator

A low-dropout voltage regulator (LDO) is designed to efficiently regulate the output voltage while minimizing the difference between the input and output voltages. It achieves this by using components like a PNP transistor and an operational amplifier to provide stable voltage regulation, even with fluctuations in input voltage or load current. The aim of the LDO is to maintain a constant output voltage with minimal power loss, making it ideal for applications where energy efficiency is crucial, such as in battery-powered devices. LTSpice design can be seen in Figure 5.

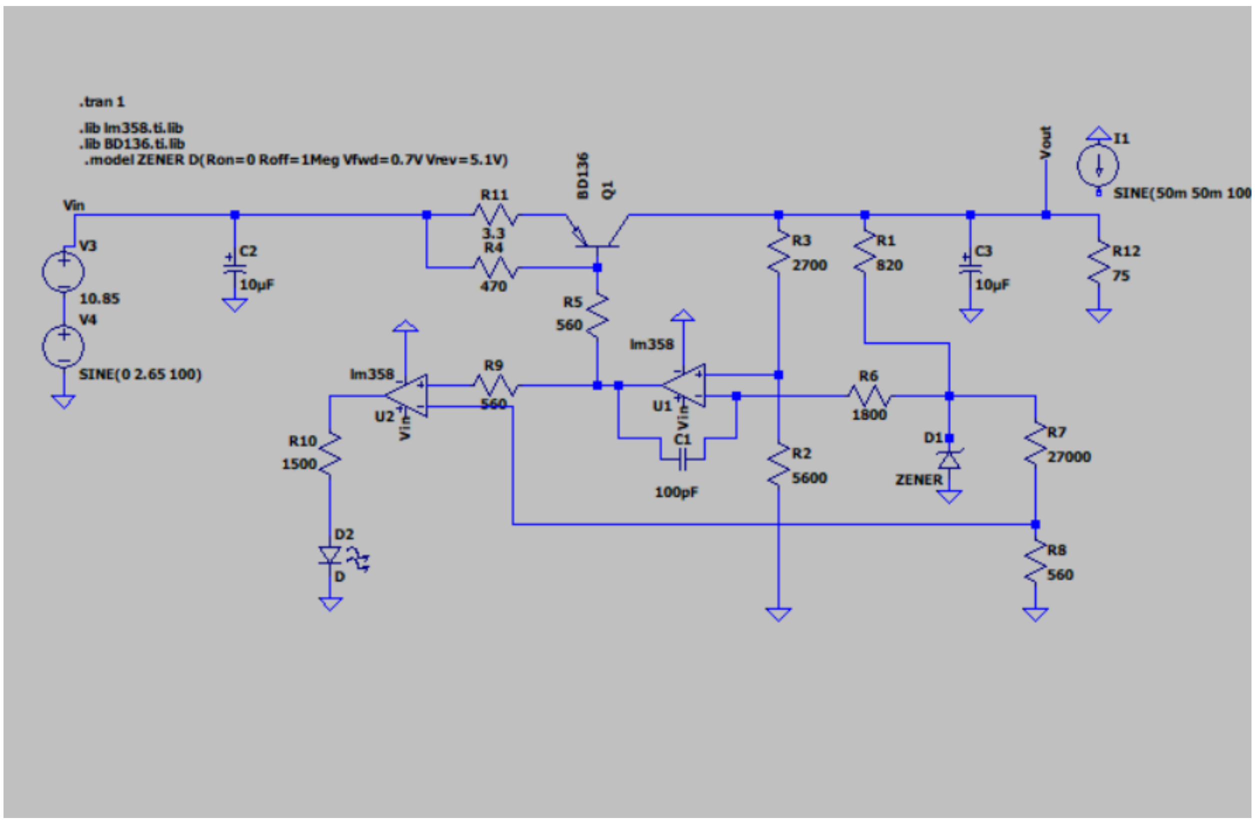

Figure 5: LTSpice Design

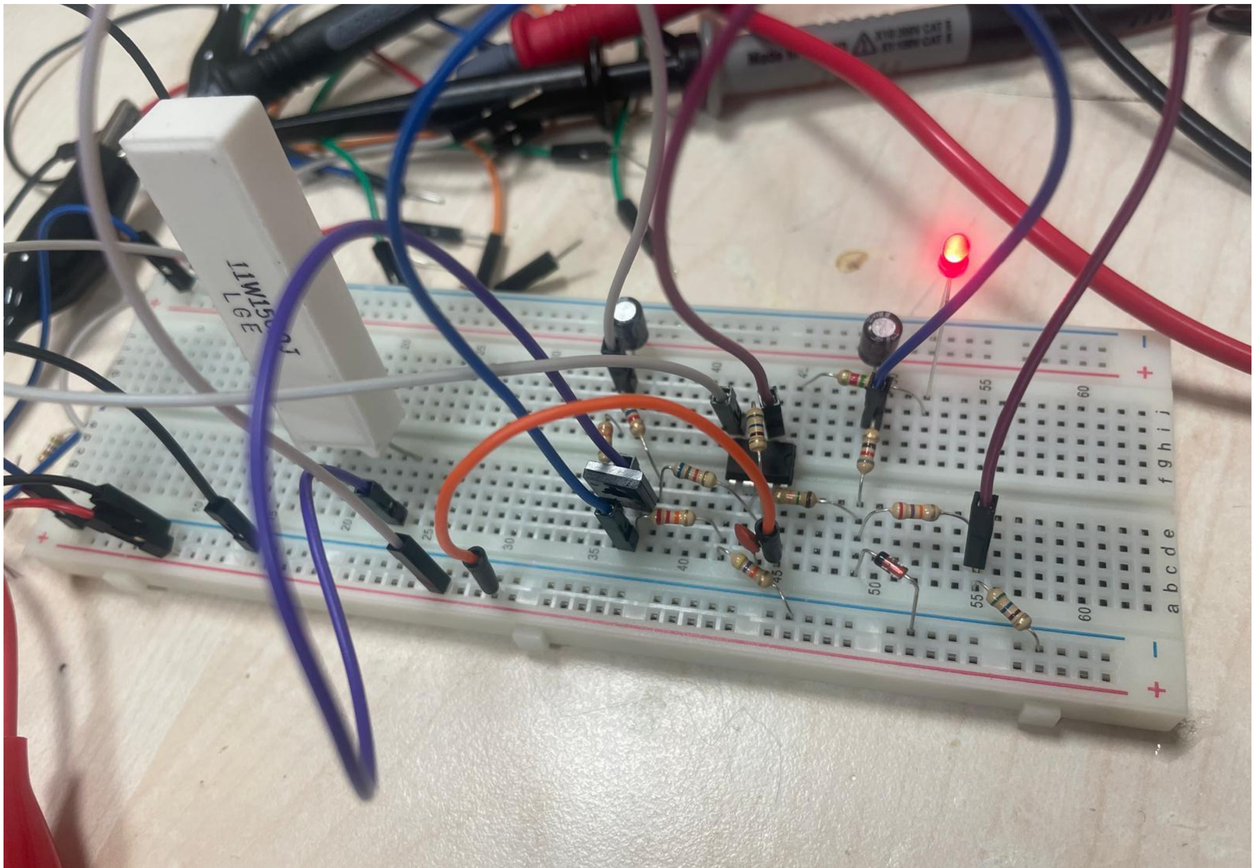

Figure 6: Constructed Circuit

First, we should met the first requirement:

- **Line Regulation**: The input voltage is varied between Vout+0.7V_{out} + 0.7Vout +0.7V and Vout+6V + 6Vout +6V at 100Hz while maintaining a 100mA load. The output voltage must remain stable, fluctuating by no more than 20mV, ensuring reliable performance under changing input conditions

Since we cannot give the wanted voltage from signal generator input voltage is changed by hand. Multiple voltage values were tested the ensure that the circuit is working as expected.

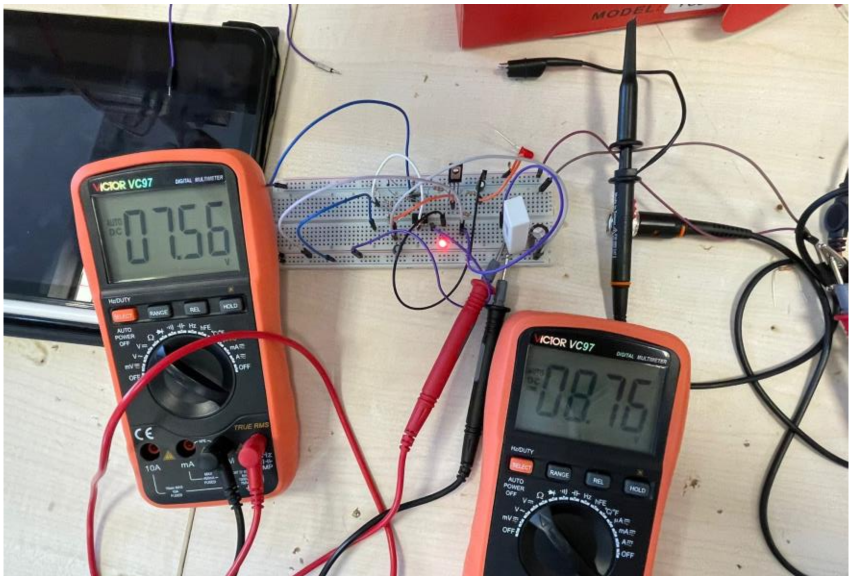

Figure 8: Output voltage when input voltage is 8.76V

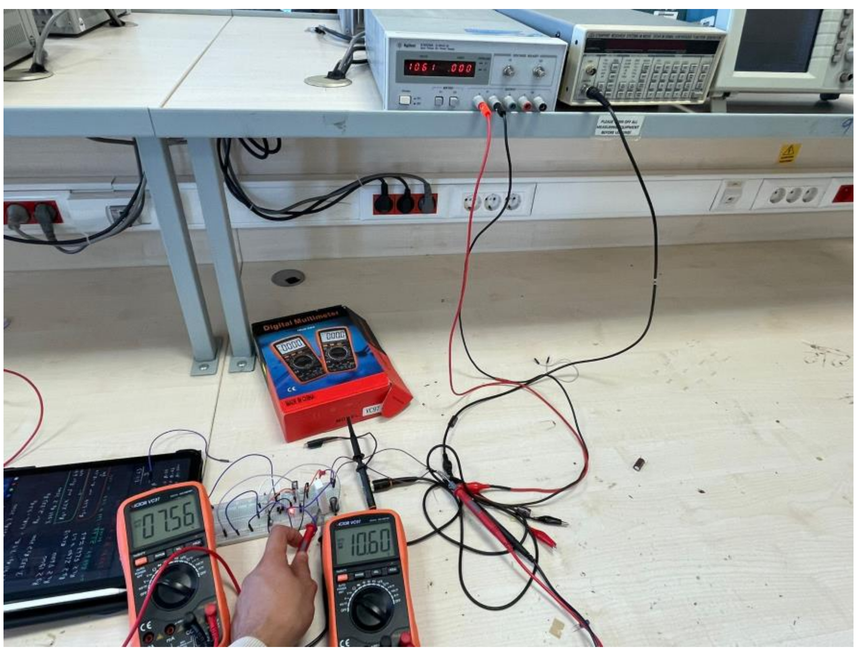

Figure 9 : Output voltage when input voltage is 10.6V

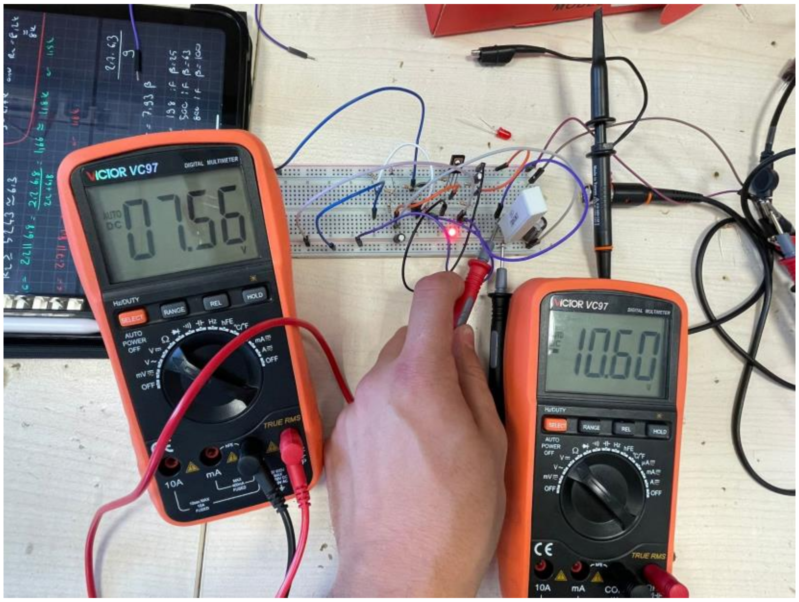

Figure 10: Output voltage when input voltage is 10.6V

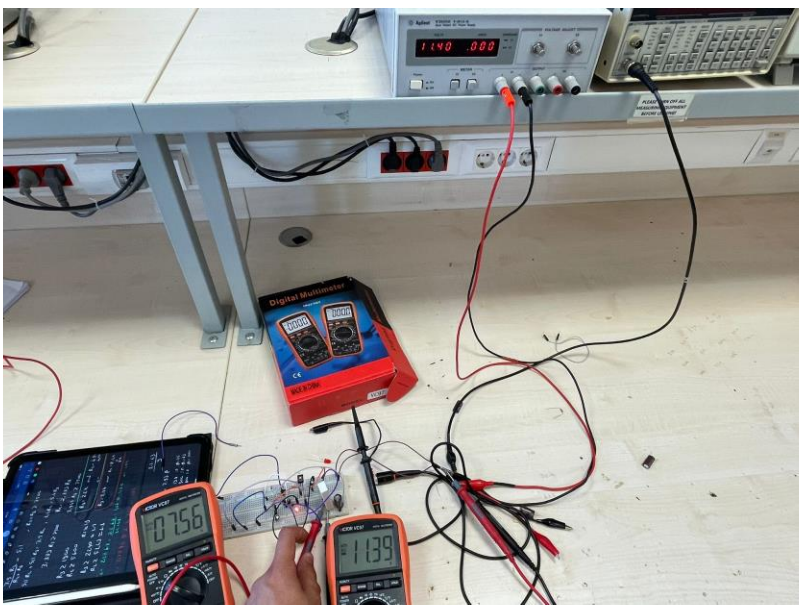

Figure 11: Output voltage when input voltage is 11.4V

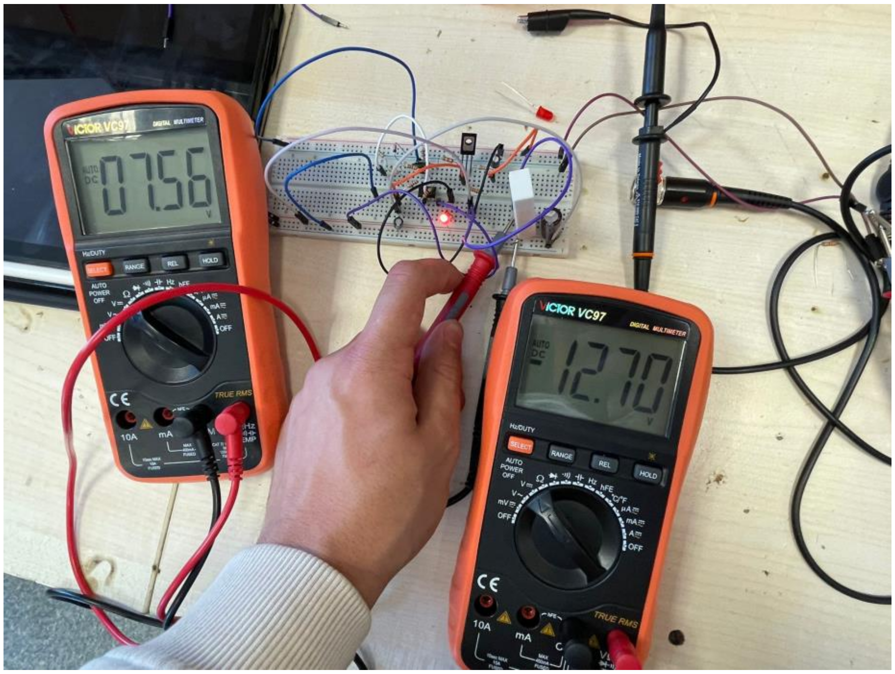

Figure 12: Output voltage when input voltage is 12.7V

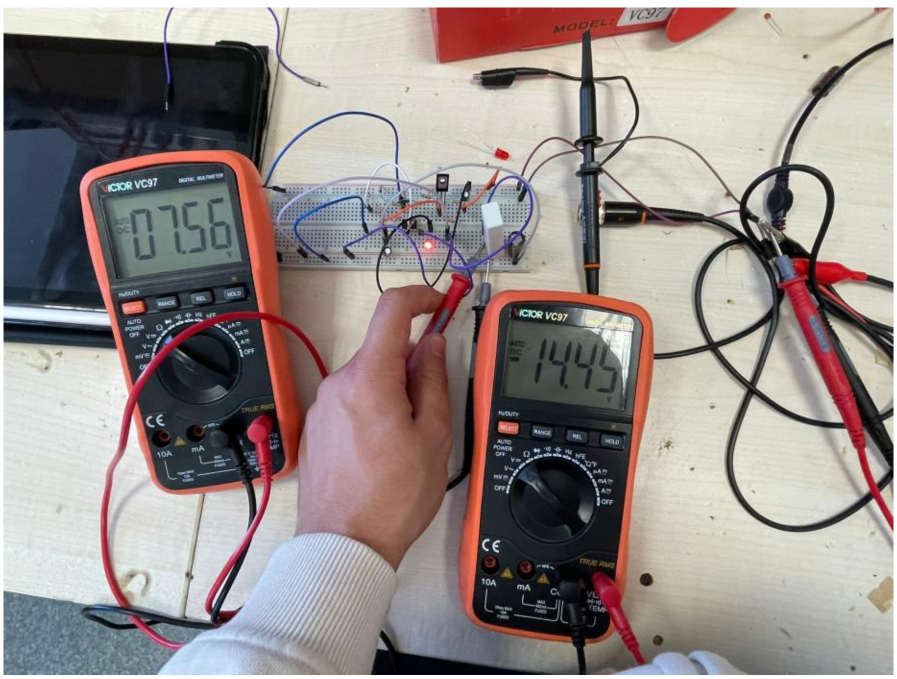

Figure 13: Output voltage when input voltage is 14.45V

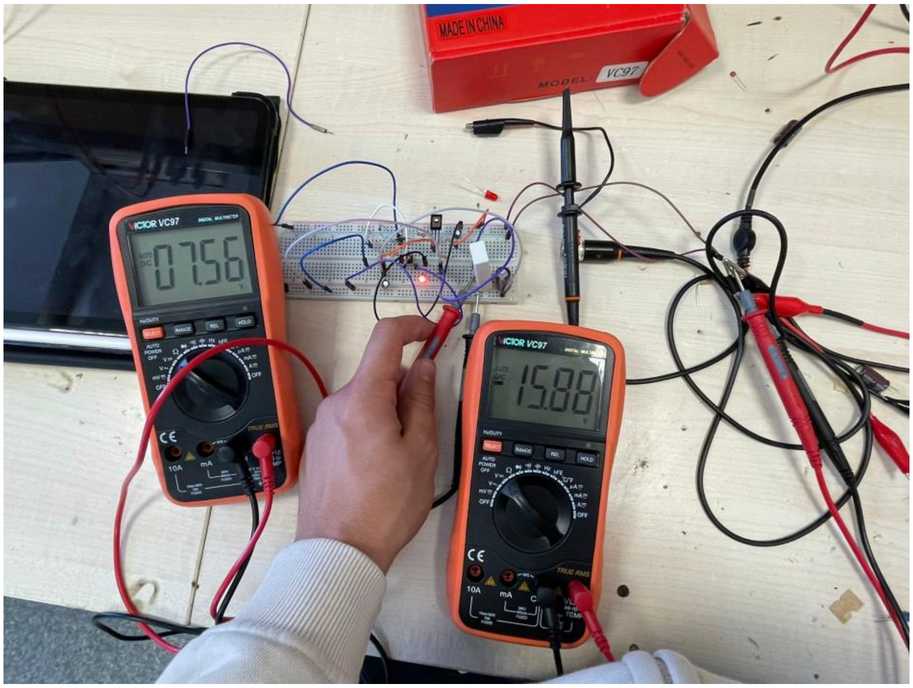

Figure 14: Output voltage when input voltage is 15.88V

As we can see in various scenarios input voltage is stable on 7.56 V which is close enough to intended value which is 7.5V. There is a error rate of 0.8% so we can say that the experiment was successful.

The second task was to ensure load regulation which is :

- Load Regulation: The input voltage is set at Vout+2V, and the load current is varied from 0 to 100mA. The output voltage should not change by more than 20mV, demonstrating the regulator's ability to handle dynamic loads.

As it is shown in Figure 11 output Voltage was 7.56 V when 150Ω stone resistor was placed. After changing the resistor from 150 Ω to 100 Ω and the voltage stays constant at 7.56.

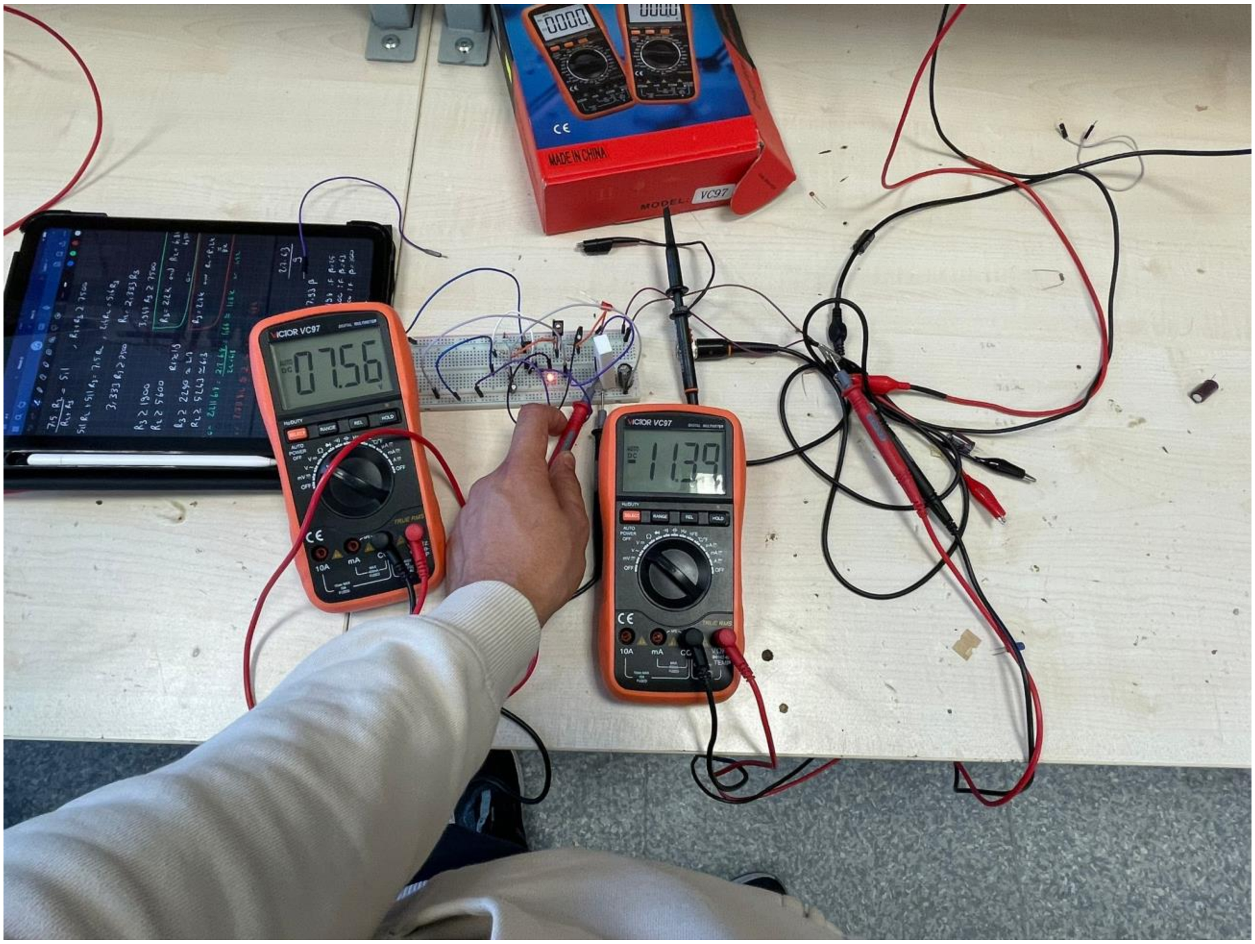

Figure 15: Circuit with changed resistance

As final task we should watch the LED to understand whether the circuit is regulating or not.

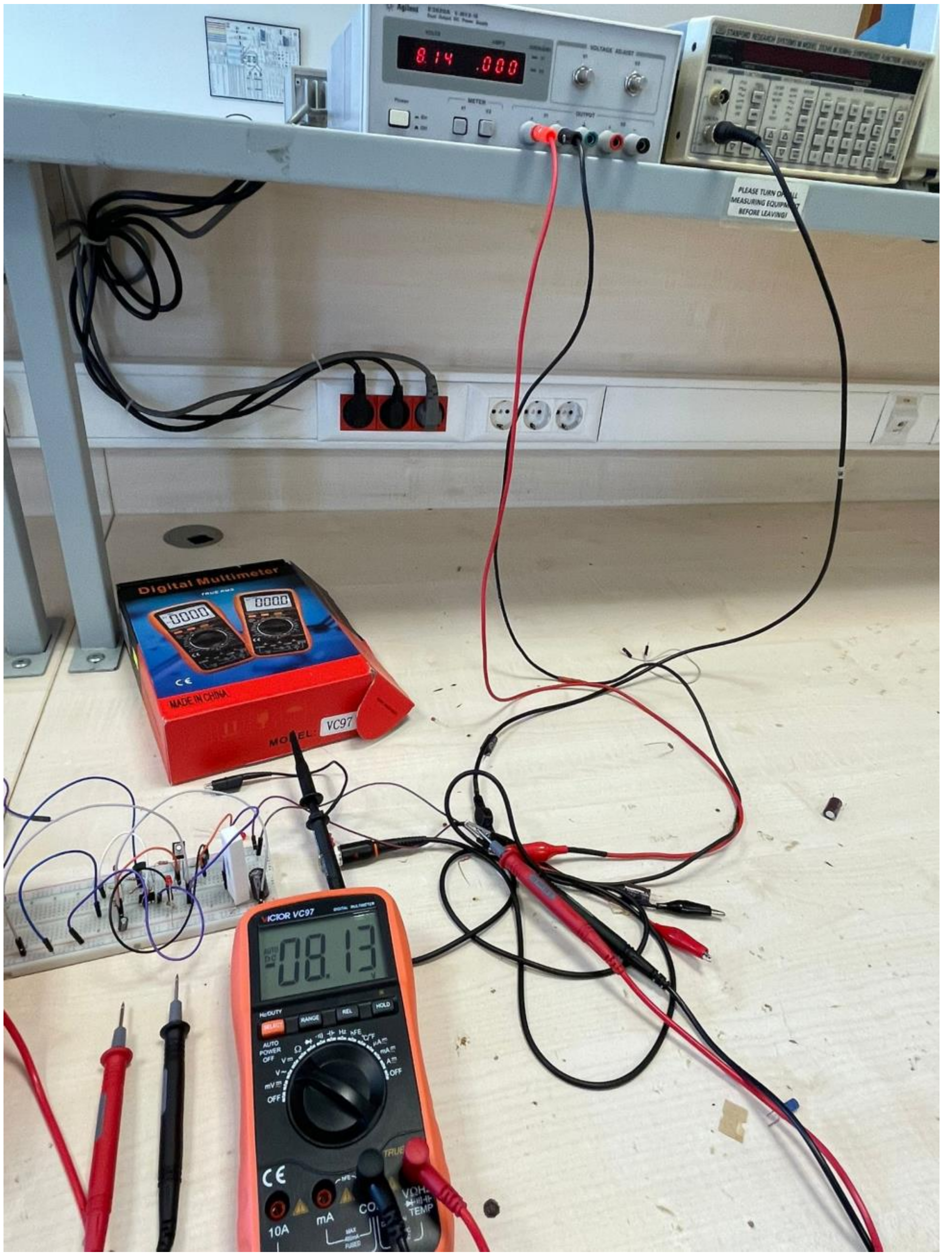

Figure 16: LED stops regulating.

Task accomplished.

Conclusion

The goal of this lab was to build a low-dropout (LDO) voltage regulator with an output current of 100mA and a dropout voltage of 0.7V or less. It also involved designing and implementing a method for measuring the β of the BD136 PNP transistor. Operational amplifiers for feedback control, a Zener diode for producing a steady reference voltage, and a BD136 transistor for voltage regulation were important parts of the design. As a status indicator, a green LED was used to confirm that the output regulation was correct. There were small discrepancies between the simulated and measured results throughout the experiment due to problems including component inaccuracy, variances in resistor values, and breadboard connectivity issues.

In spite of these difficulties, the LDO regulator demonstrated efficient line and load control by maintaining an output voltage of 7.56V with a low error rate of 0.8%. This experiment shed light on the usefulness of BJTs in power regulation circuits, the stability that Zener diodes offer, and the significance of accuracy in analog circuit design.