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Course Code: EEE313

Section: 02

Experiment Number: 01

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Lab 1 Experimental Report

Introduction:

First part of the experiment is measuring (calculating) reverse saturation current I_S. The second part is creating the designed circuit in preliminary part on a breadboard with the given design specifications.

Methodology:

For Part A, designed circuit is created on a breadboard. From this circuit, diode current I_D and diode voltage V_D is measured and diode's reverse saturation current I_s is calculated from the diode current equation.

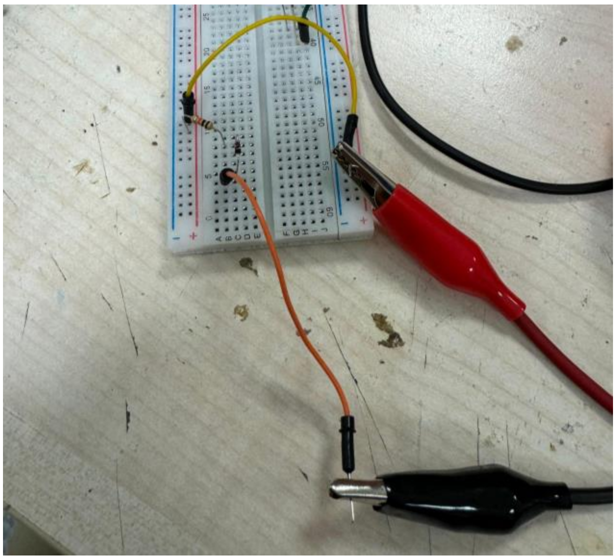

Figure 1: Created circuit for Part A

For Part B, designed circuit is created on breadboard. Temperature of the diode is measured by multimeter. Looking at the temperature difference, output voltage is observed. 0.1°C hysteresis is inspected by connecting the non-inverting input of the comparator OPAMP directly to DC voltage source. To inspect 0.1V hysteresis, the turn off voltage of LED is found by adjusting DC voltage value. After that, going up by 0.1V, LED is observed whether it turns on.

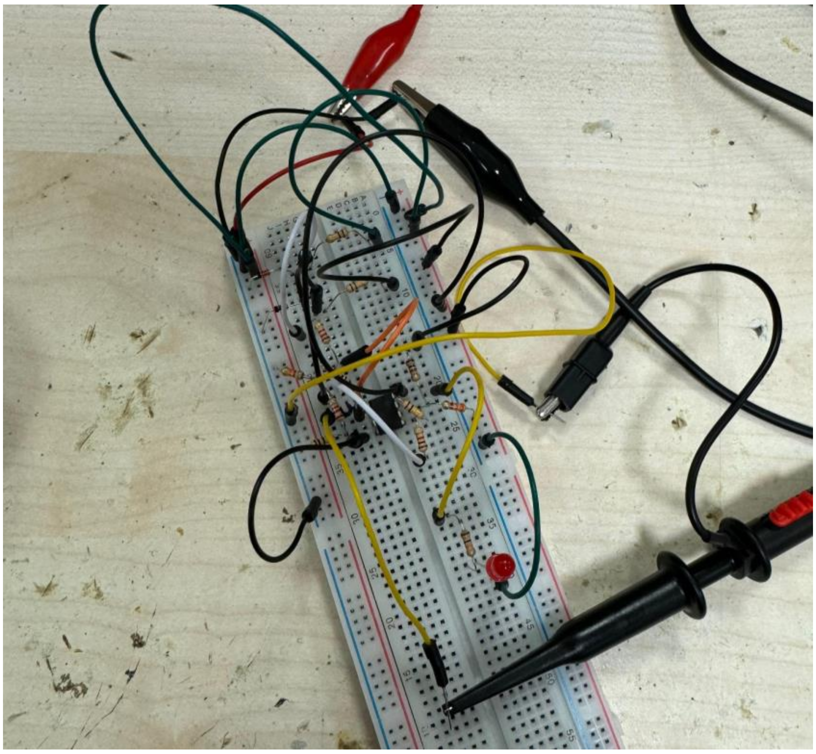

Figure 2: Created circuit for Part B

Analysis:

Part A

Below given the diode equation for 1N4148 diode (Eqn. 1).

$$I_D = I_S\left(e^{\frac{V_d}{(n*V_T)}} - 1\right);\ V_T = \frac{kT}{q} = 25.9mV, n = 1.752 \qquad \text{(Eqn. 1)}$$

I used a 10kΩ resistor series with 1N4148 diode. First I measured the voltage difference on 10kΩ resistor (Figure 3). $V_R = 11.39V$.

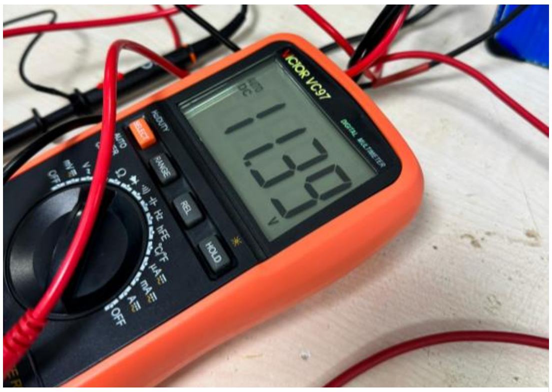

Figure 3: Voltage across 10kΩ resistor

Then, voltage of the diode is measured by multimeter (Figure 4). $V_D = 0.619V$.

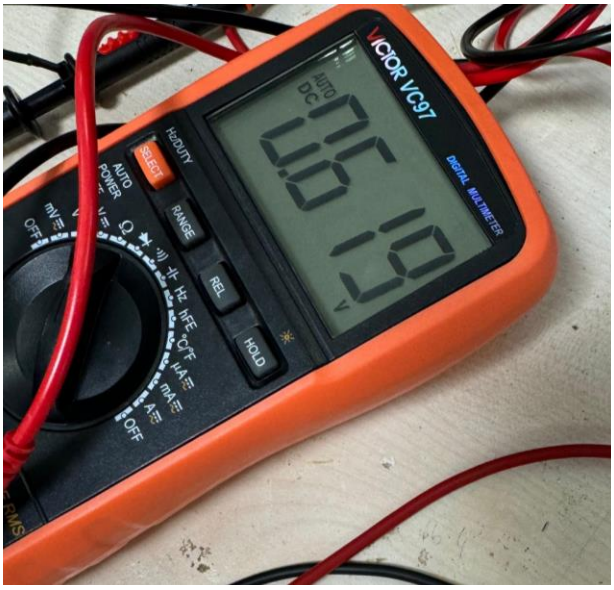

Figure 4: Voltage across diode

Using these values, First I calculated I_D by (Eqn. 2). Then I calculated the reverse saturation current I_S for 1N4148 diode from (Eqn. 1).

$$I = \frac{V}{R}$$

$$I_D = \frac{11.39V}{10k\Omega} = 1.139mA \qquad \text{(Eqn. 2)}$$

$$1.139\text{mA} = I_S\left(e^{\frac{0.619V}{(n*V_T)}} - 1\right);\ V_T = \frac{kT}{q} = 25.9mV, n = 1752$$

$$I_S = 1.36nA$$

In preliminary part, I_S values is found as 2.52nA, now, from the calculations made, I_S value is 1.36nA. The results are similar with a slight error included.

Part B

As designed in preliminary part, I installed the circuit on the breadboard. (Figure 5) shows the output voltage of difference OPAMP when both of the diodes are at the same temperature (23°C).

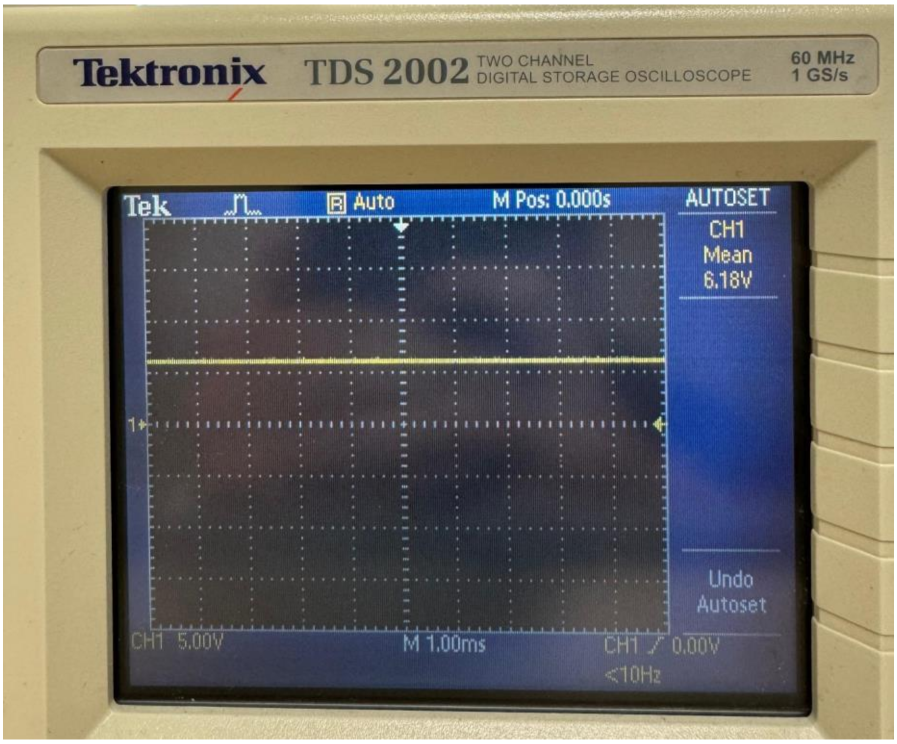

Figure 5: Output voltage of difference OPAMP

As expected, output voltage is around $\frac{V_{DD}}{2}$, where $V_{DD} = 12V$ in this case.

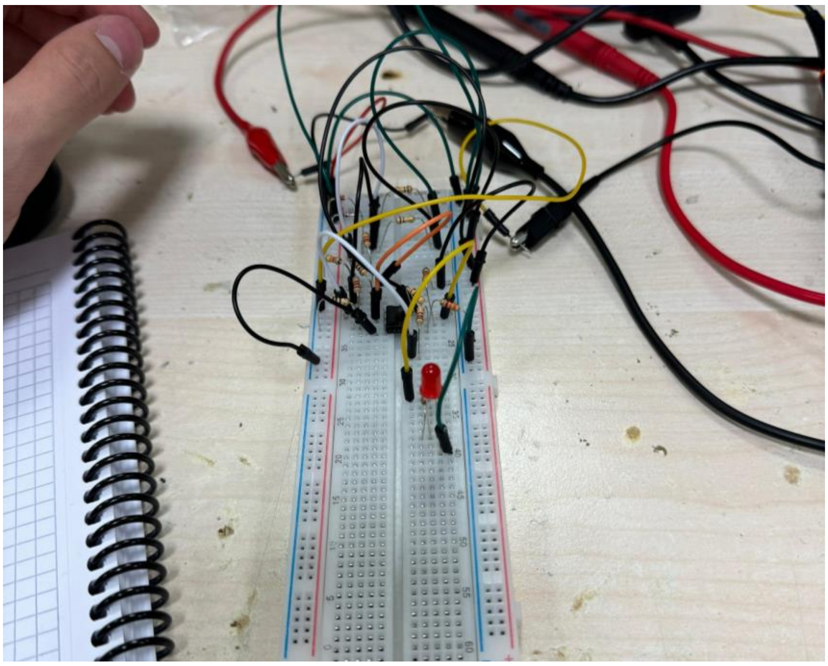
Figure 6: Circuit when temperature difference is less than 3°C

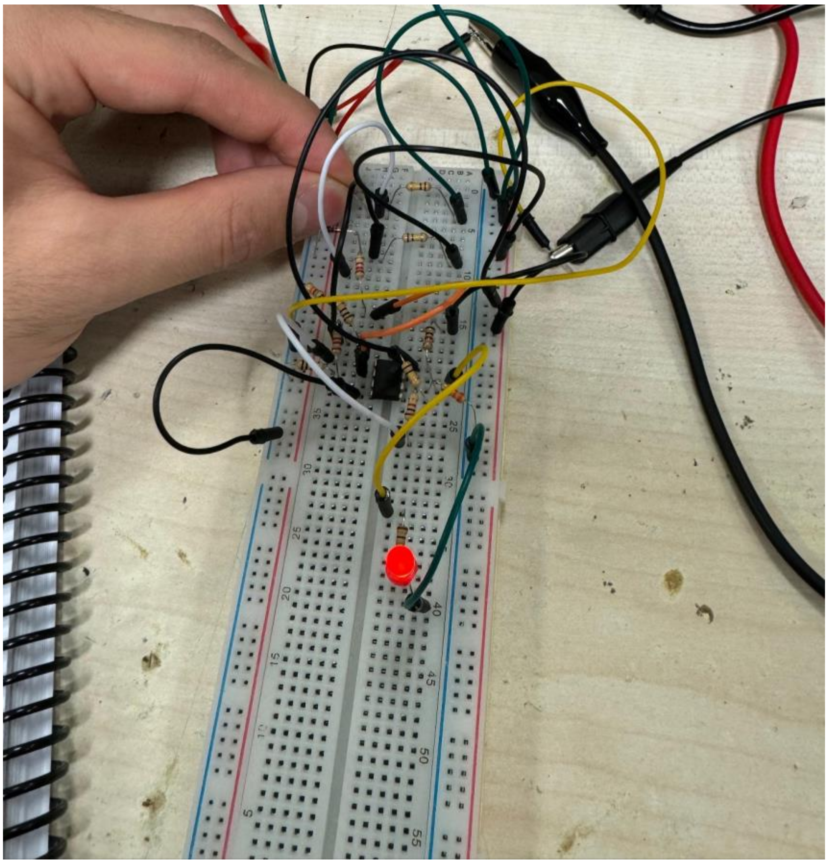

Figure 7: Circuit when temperature difference is more than 3°C

Figure 6 and Figure 7 shows when the LED turns on. As I touched my hand to sensor diode, temperature difference exceeds 3°C because lab temperature is around 24°C and my body temperature is around 35°C.

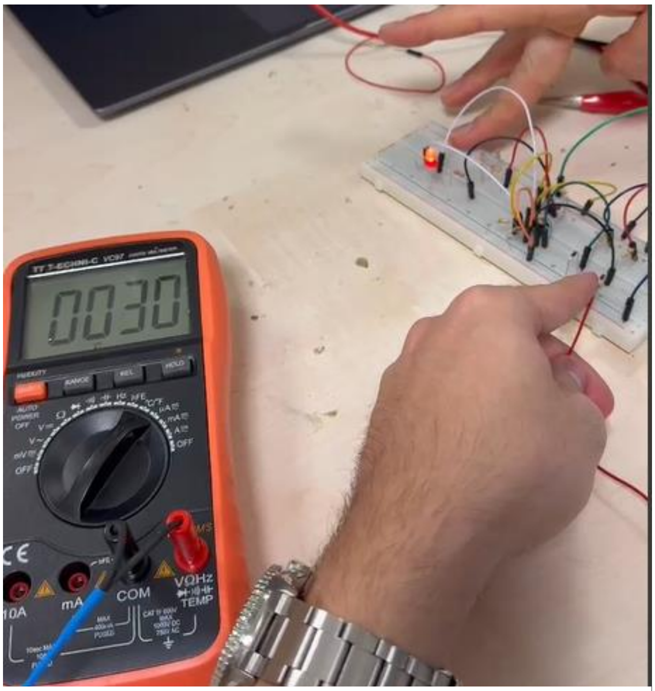

Figure 8: LED turn on at 30°C

Figure above shows that when temperature difference exceeds 3°C, LED turns on. The reference diode's temperature is 26°C in the figure above (Figure). Because the temperature difference is around 4°C, corresponding output voltage should be around $\frac{V_{DD}}{2} + 4$. Corresponding output voltage value can be seen in the figure below (Figure 9).

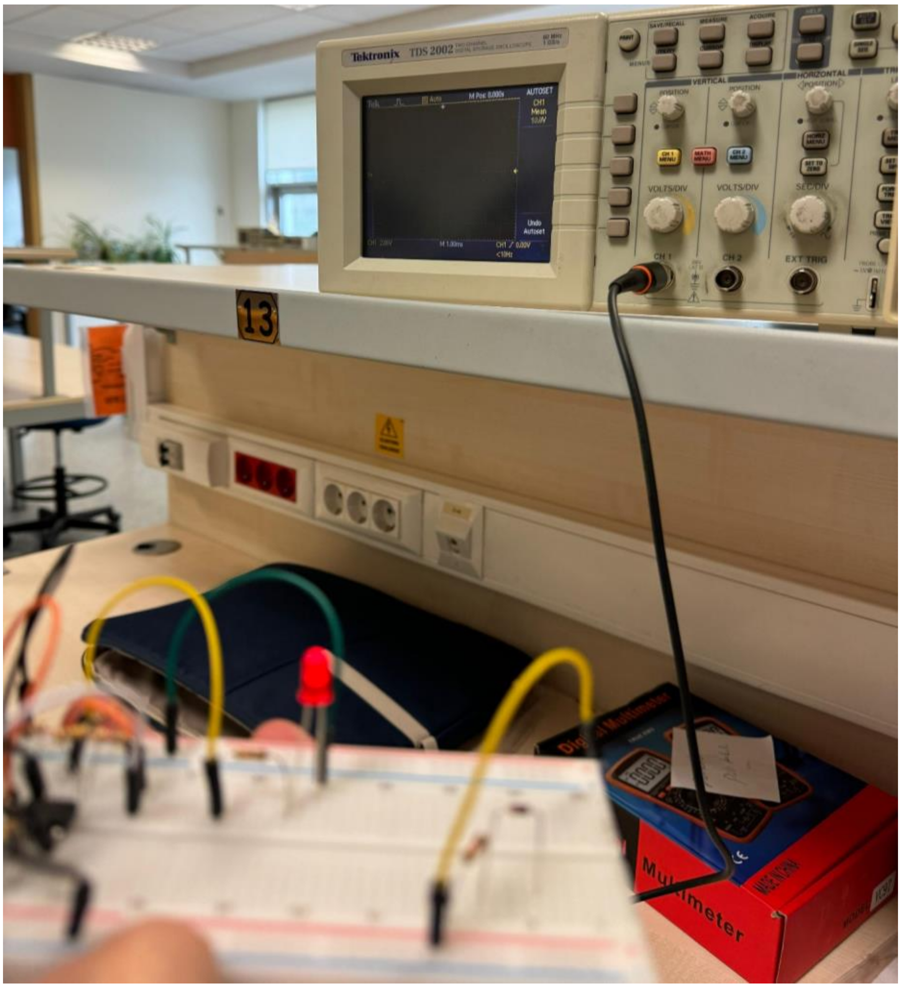

Figure 9: Output voltage is 10.0V volts

Oscilloscope that I used in the lab can show DC voltage up to 10.0V only. Because the temperature difference is around 4°C, Output voltage is seen as 10.0V, which is equal to $\frac{V_{DD}}{2} + 4 \cong 10$.

In order to inspect 0.1°C hysteresis, I connected non-inverting input of the comparator OPAMP to DC source. Figure 10 shows where the LED turns off.

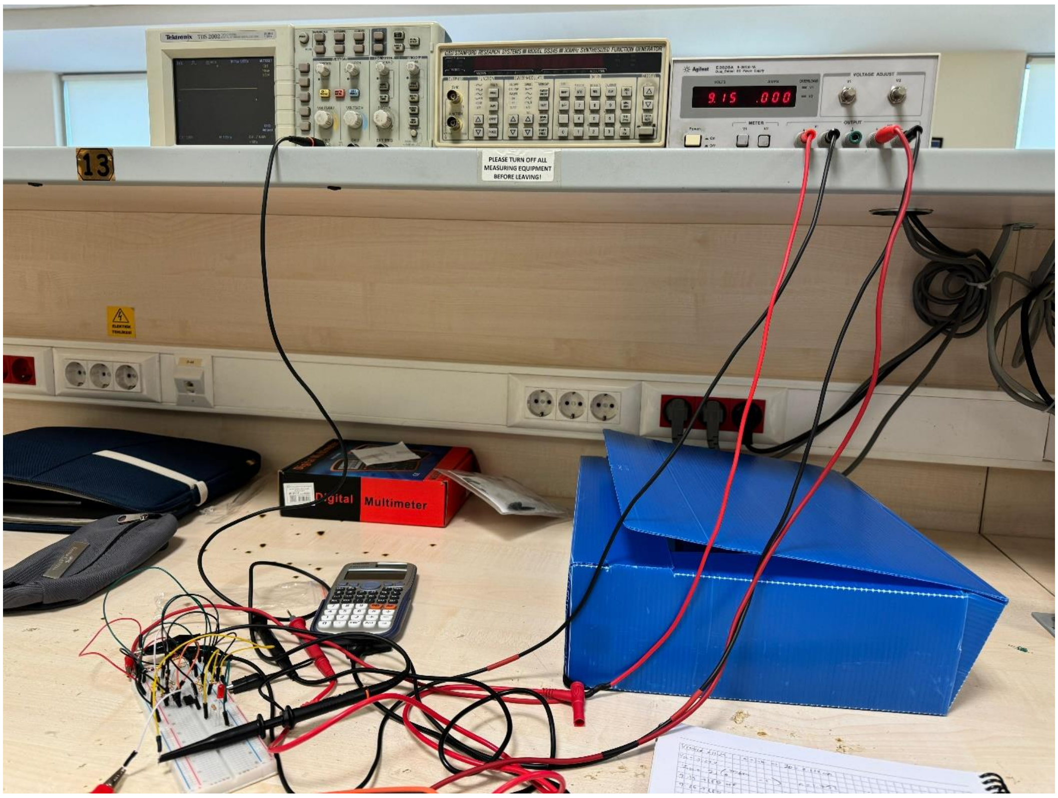

Figure 10: Voltage value when LED off

The voltage value is set to 9.15V. From preliminary part, as I increase the voltage by 0.1V, LED should turn on. Figure below shows the voltage value when the LED turns on.

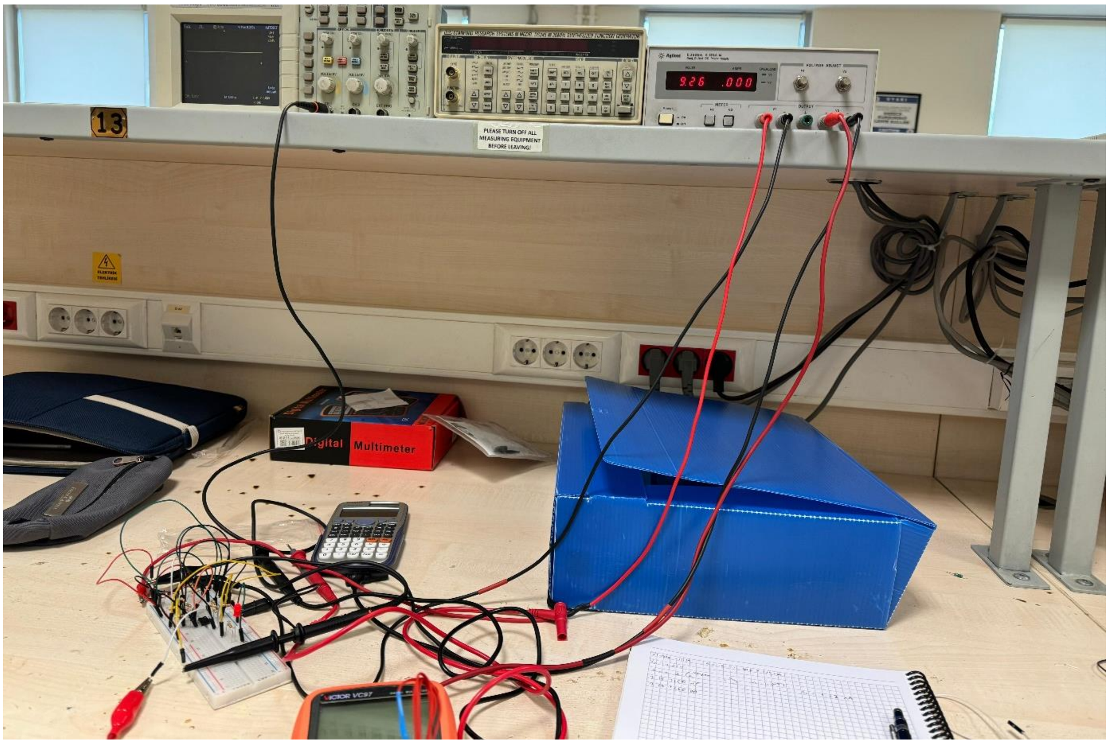

Figure 11: Voltage value when LED on

LED is off when voltage is 9.15V (Figure 10), and it turns on when voltage is equal to 9.26V (Figure 11). As expected, going up 0.1V from the voltage value when LED is off, LED turned on. As a result, I get a 0.11V hysteresis value.

Figure below shows the voltage across LED when the temperature difference is below 3°C.

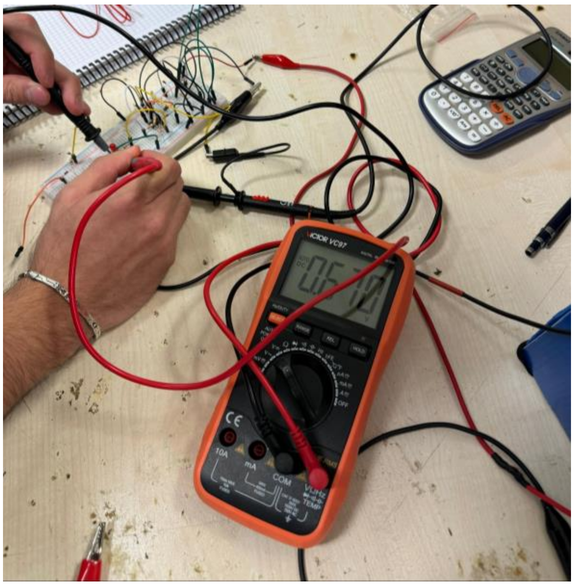

Figure 12: LED voltage when its off

When the LED is off, voltage across it is 0.67V.

Figure below shows the voltage across LED when it is on.

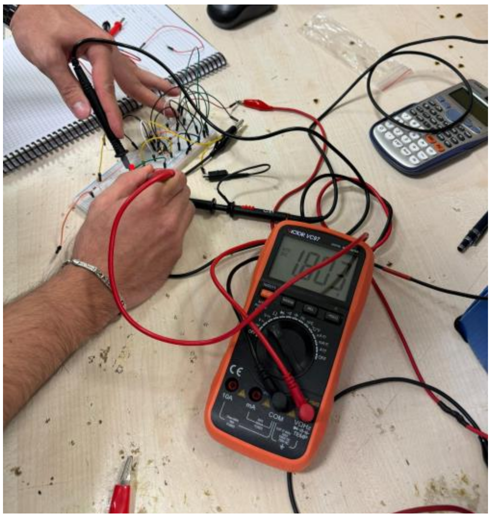

Figure 13: LED voltgae when its on

When LED is on, voltage across it is 1.803V, which is similar to 1.7V as given in the lab specifications.