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Section: 1

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EE313- Electronic Circuit Design

Lab1 Preliminary

Diode Characterization and Differential Temperature Sensor

Part A

For the very initial part of the preliminary I designed a basic diode circuit with only 3 components to calculate Is (saturation current) of a p-n diode (Figure 1). I observed 798.49mV through the diode which is the forward voltage (Vf) at the room temperature 25◦C. (Figure 2). I also find the current through the diode Id (Figure 3). From the equations below and "n" value given I derive Is with the help of Id and Vd:

$$Id = Is(e^{\frac{V_d}{n \times Vt}} - 1) \quad (\text{eq. } 1)$$

$$V_T = \frac{KT}{q} = 1.752 \qquad (\text{eq. } 2)$$

$$111.362 \times 10^{-3} = Is(e^{\frac{798.71 \times 10^{-3}}{0.0259 \times 1.752}} - 1) \quad (\text{eq. } 1.1)$$

$$Is = 2.5258\text{nA}$$

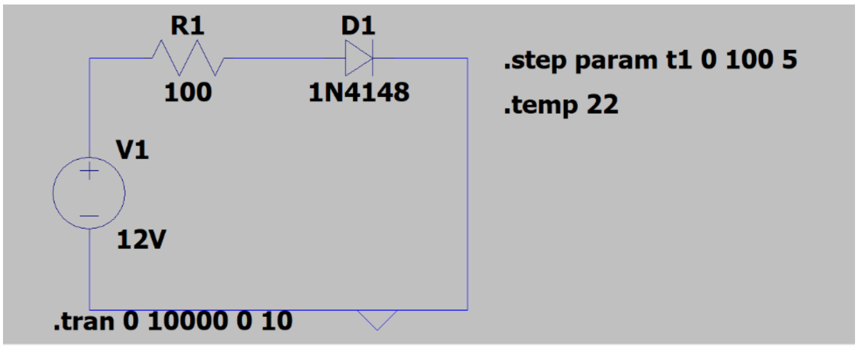

Figure 1: Diode Circuit

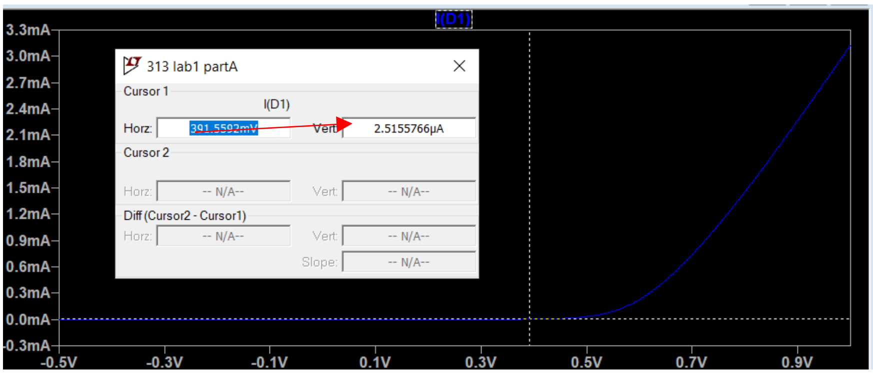

Figure 2: Plot of Is

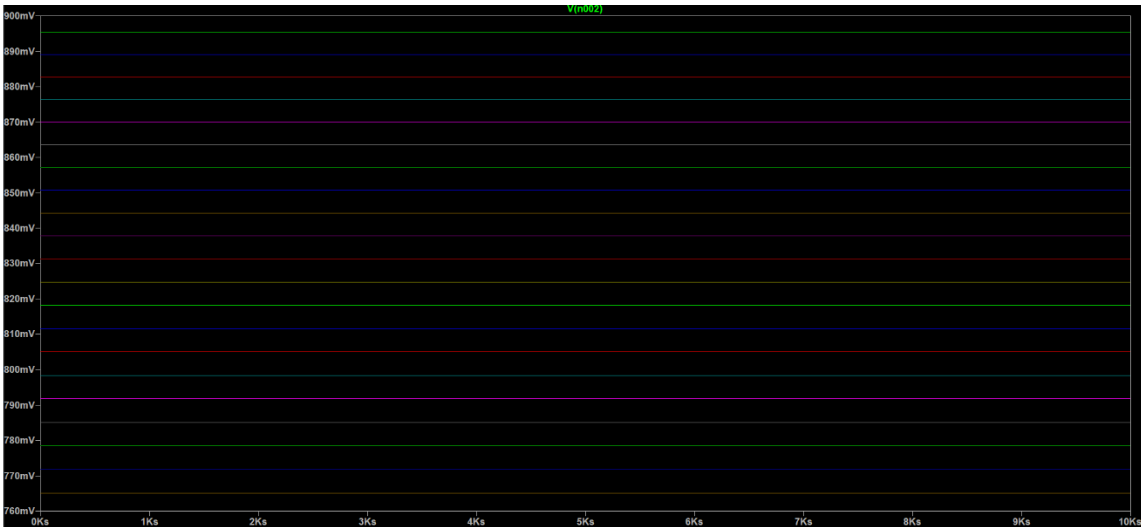

Figure 3: Temperature 0 to 100 with step of 5°C (turquoise after the pink below the plot shows 25°C response of voltage the diode)

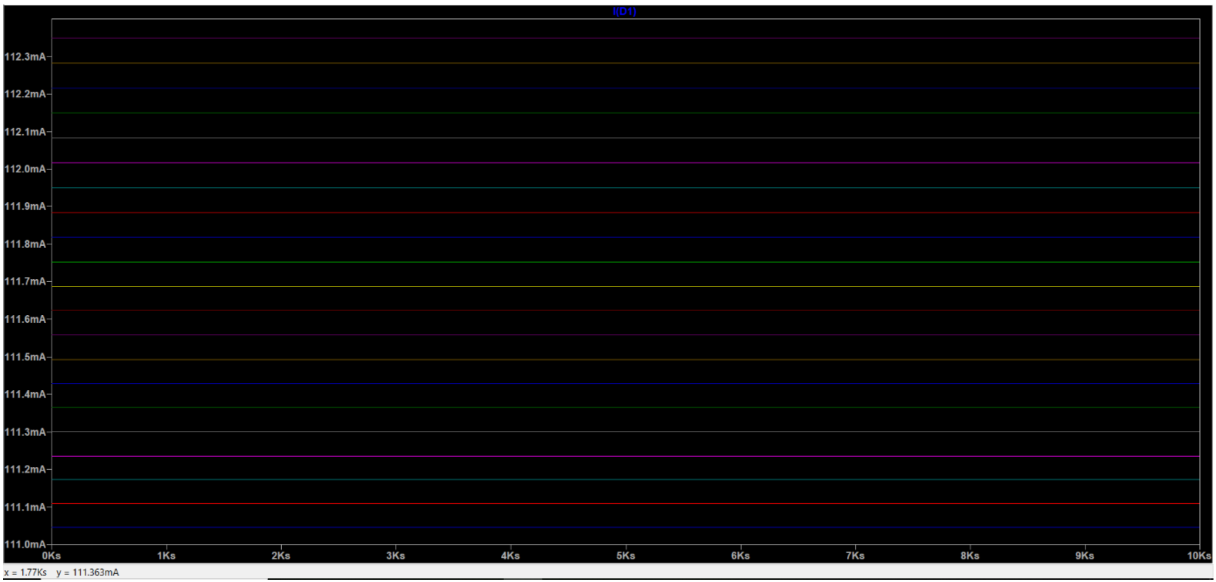

Figure 4: Temperature 0 to 100 with the step of 5°C (gray after the pink below the plot shows the response of the current at 25°C) (cursor shows the exact value left down below)

Part B

For part B, I initially designed the differential opamp (Figure 4) in order to raise the gain after the current goes through the diodes. However, when I grounded the R4 in the figure I got really low voltages like mV. After I connected my supply with my resistor there I observed higher voltages. After that I move on to design my comparator. My overall design shown below (Figure 5). In Figure 6 it is seen that Vout is really close to the value halvet the input voltage at 18℃, also, Vout is shown in Figure 7 at 28℃ still very close to the 6V.

Differential Amplifier

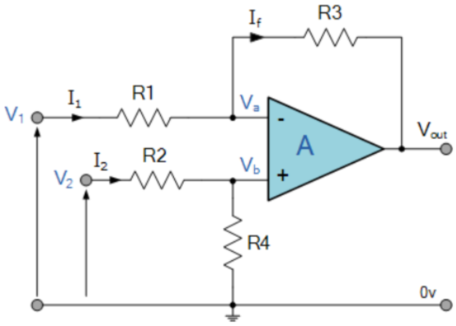

Figure 5: differential opamp design

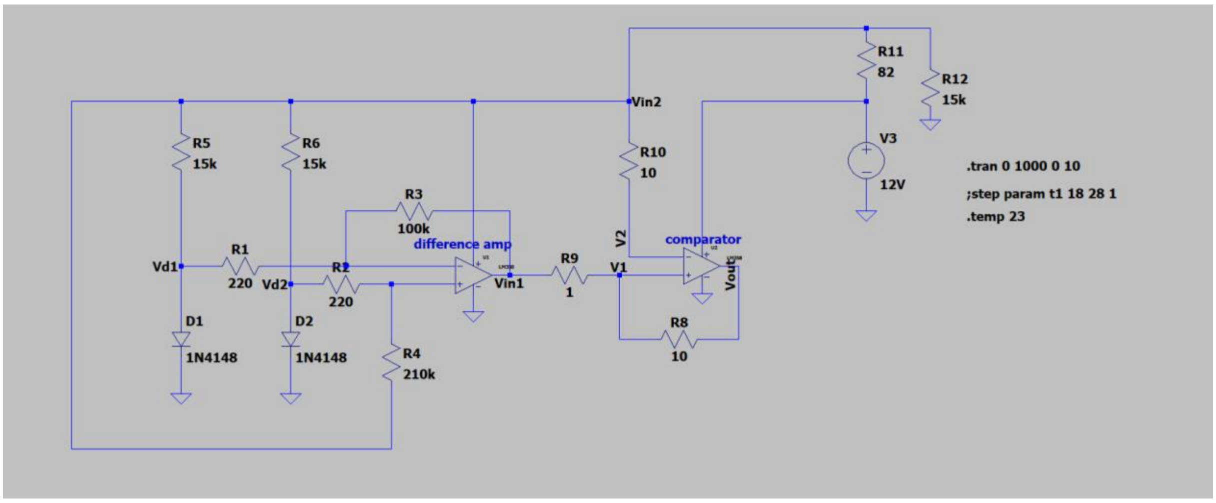

Figure 6: Overall Circuit for Differential Temperature Sensor

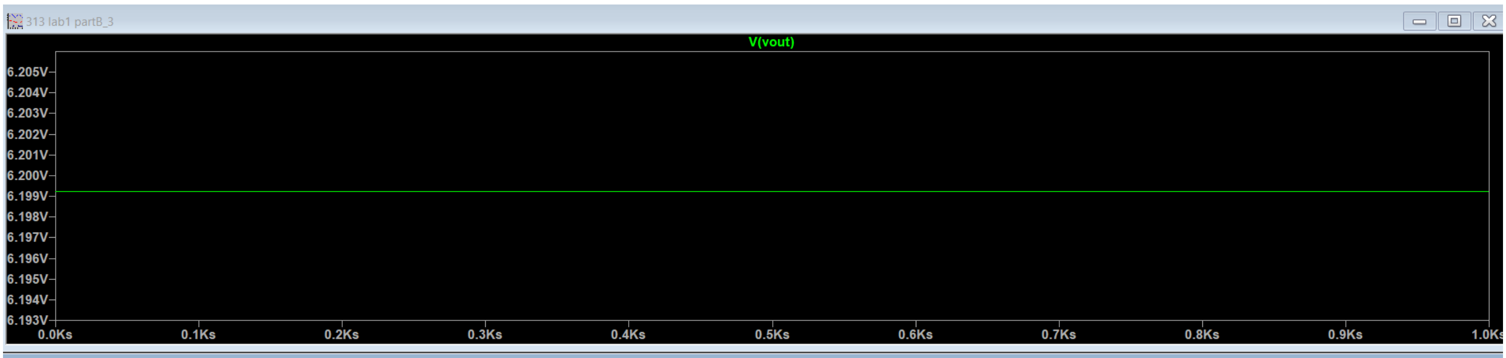

Figure 7: At temperature 18°C Vout is nearly Vdd/2

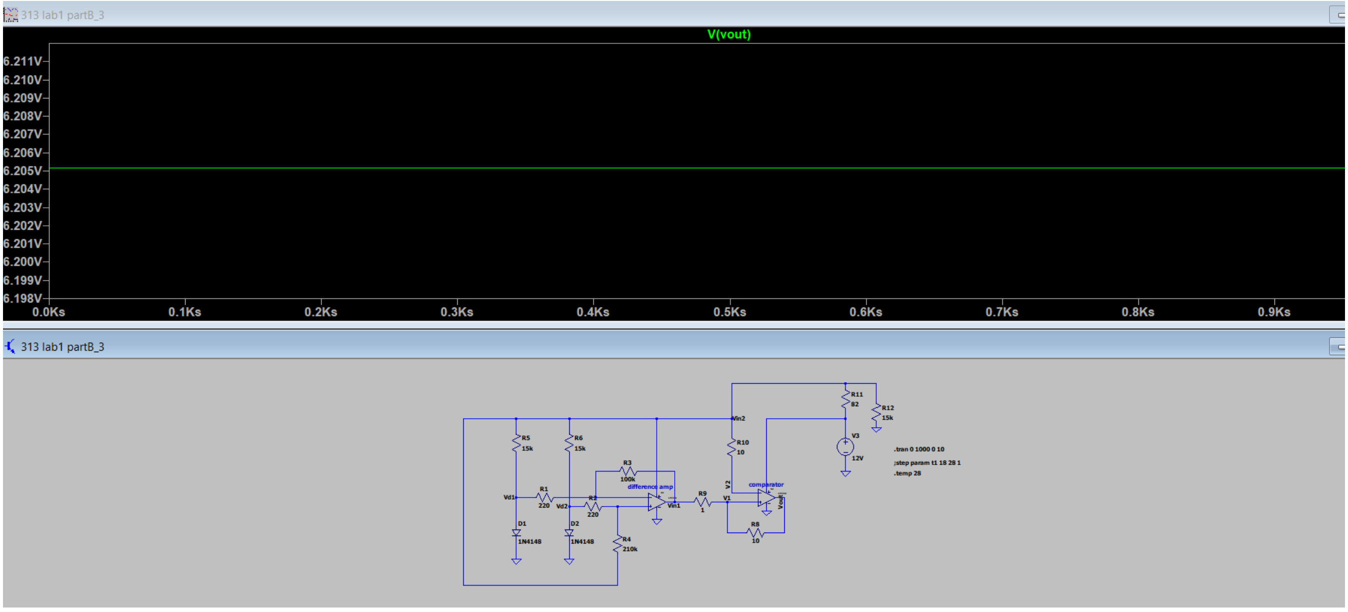

Figure 8: At temperature 28°C Vout is nearly Vdd/2

After checking the room temperature values, now I checked the response with the variety of degree values (18 to 28). Figure 8 shows, that in every 1 *°C* voltage values change with the steps 0.6 to 0.7 which does not satisfy the expectations, however close to 1V.

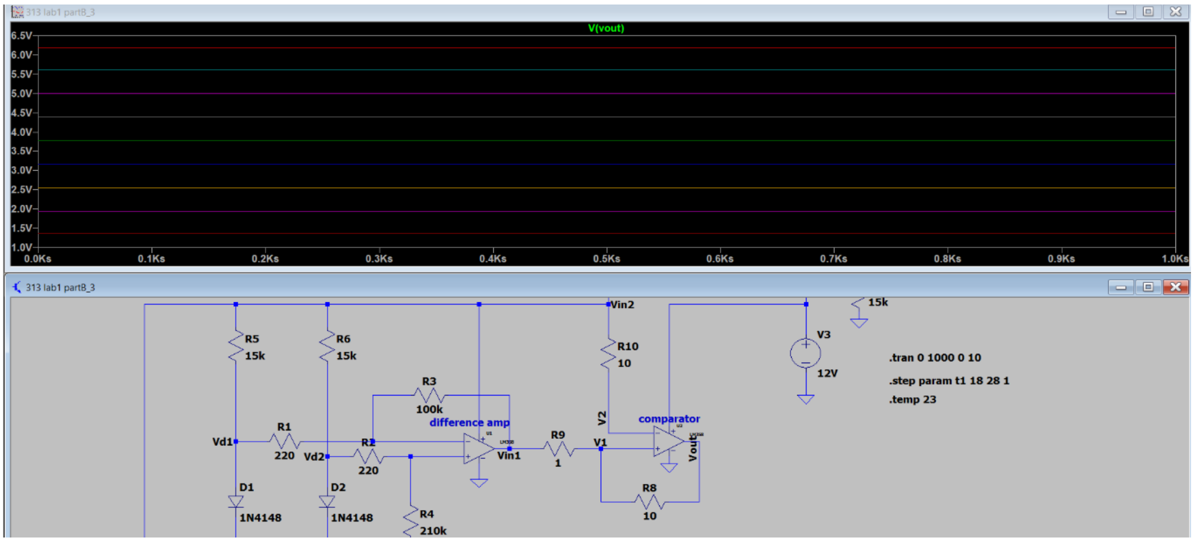

Figure 9: Voltage change based on temperature

In sections B.3 and B.4, the obstacle preventing further progress in my design was the significant alteration of output values upon the addition of an LED and resistor. This change had a ripple effect, impacting preceding steps and necessitating a backtrack to rectify the issue. This phenomenon likely stems from the reintroduction of output voltage feedback, thereby influencing the operational amplifier itself.

Conclusion

Since there are multiple variables affecting the whole circuit and previous steps it was really hard to make some trial and error. However I achieved to reach substeps which are Vin2 and Vin1 shown below with the expected values Figure 9 and the plot I derive with my circuit in Figure 10. However, adding LED was challenging without losing the output voltage so I left at that step.

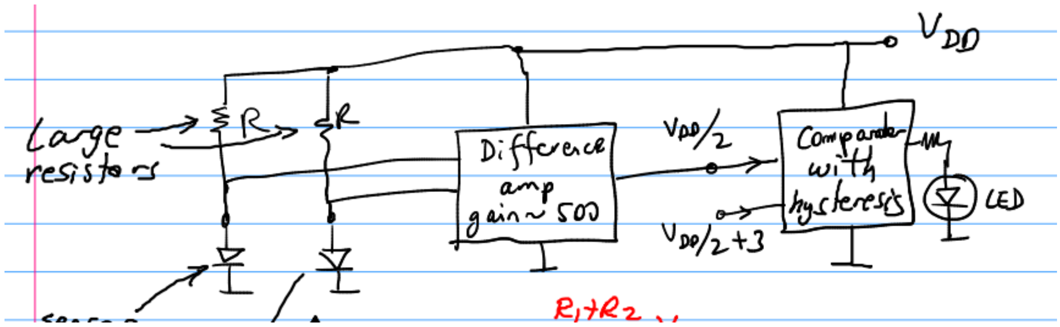

Figure 10: Vin1= Vdd/2 and Vin2=Vdd/2 +3

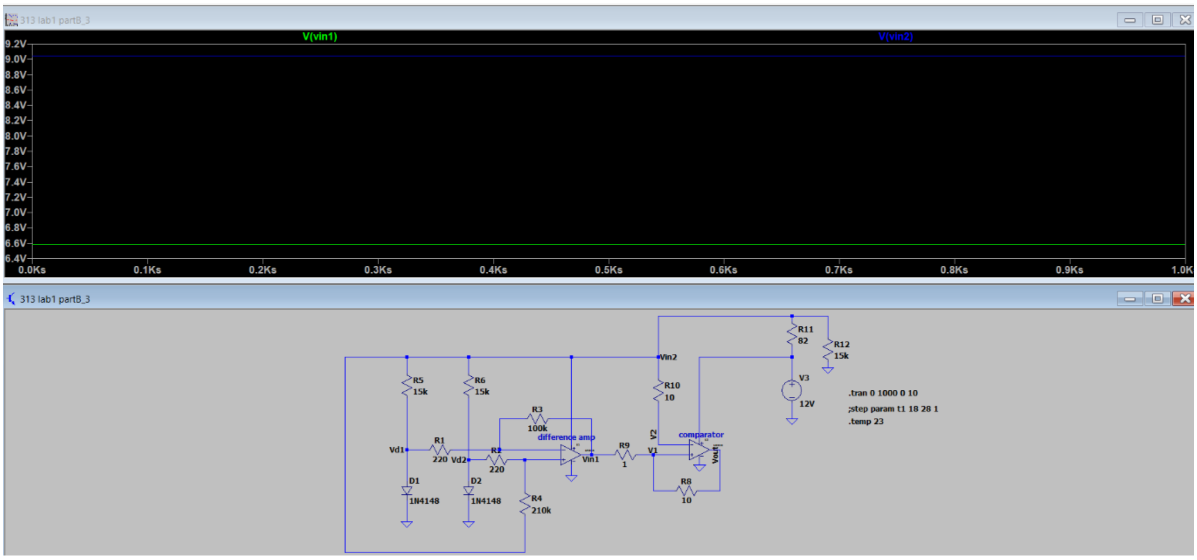

Figure 11: Vin= 6.58V and Vin2= 9.04V

REFERENCES:

https://www.electronics-tutorials.ws/opamp/opamp_5.html