PART A

I measured I_S of a p-n being 1N4148 using the following formula (n=1.752 and V_T = kT/q):

$$I_D = I_S(e^{\frac{V_D}{nV_T}} - 1)$$

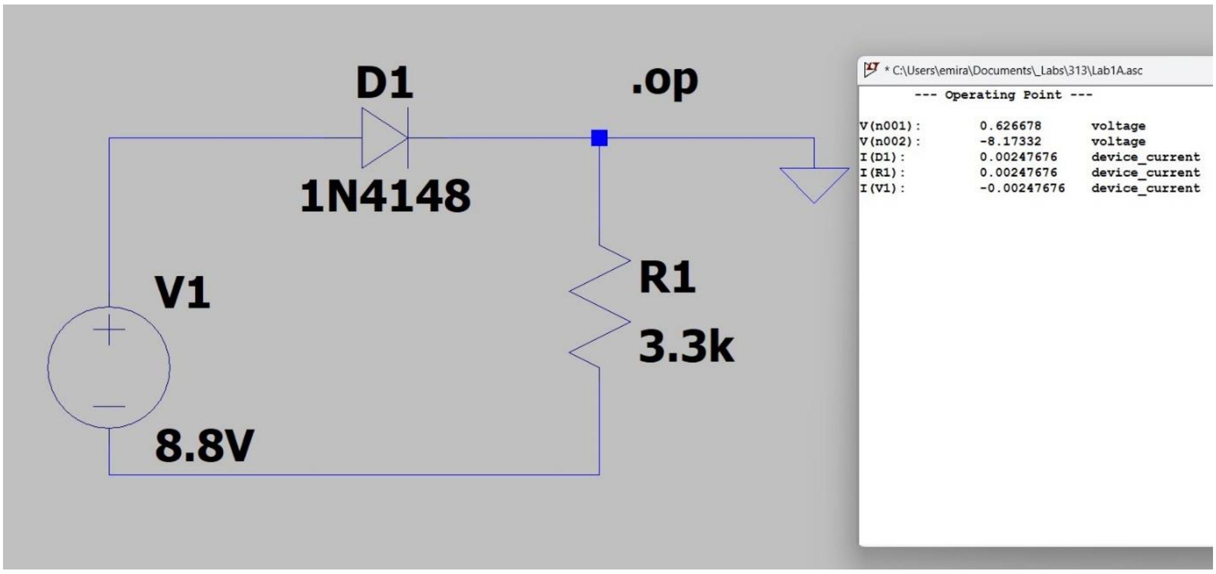


Figure 1: Circuit and Simulated Values

Here the formula gives I_S = 2.44 nA, implying a 3.17% error percentage from the desired 2.52 nA.

PART B

In Part B, a differential temperature sensor was designed as in Figure 2.

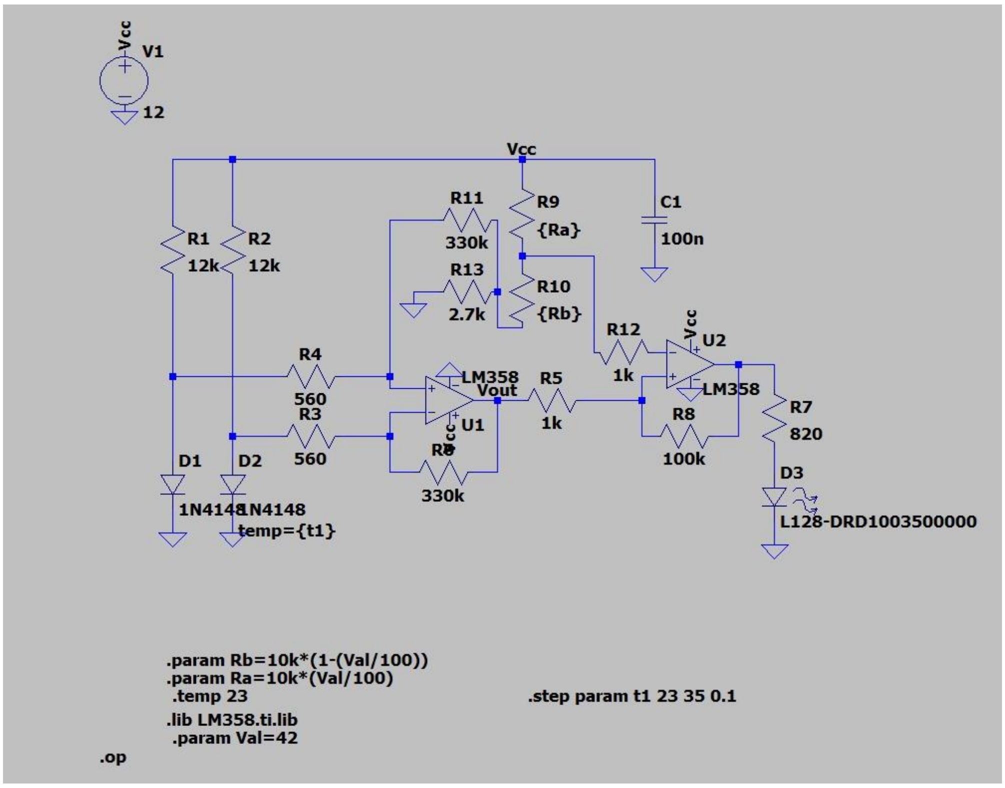


Figure 2: Designed Differential Temperature Sensor

Here, Vcc = 12V, and (Vcc−2)/4=2.5V. This value is satisfied with the desired 0.3V error difference as in the following figures and Table 1.

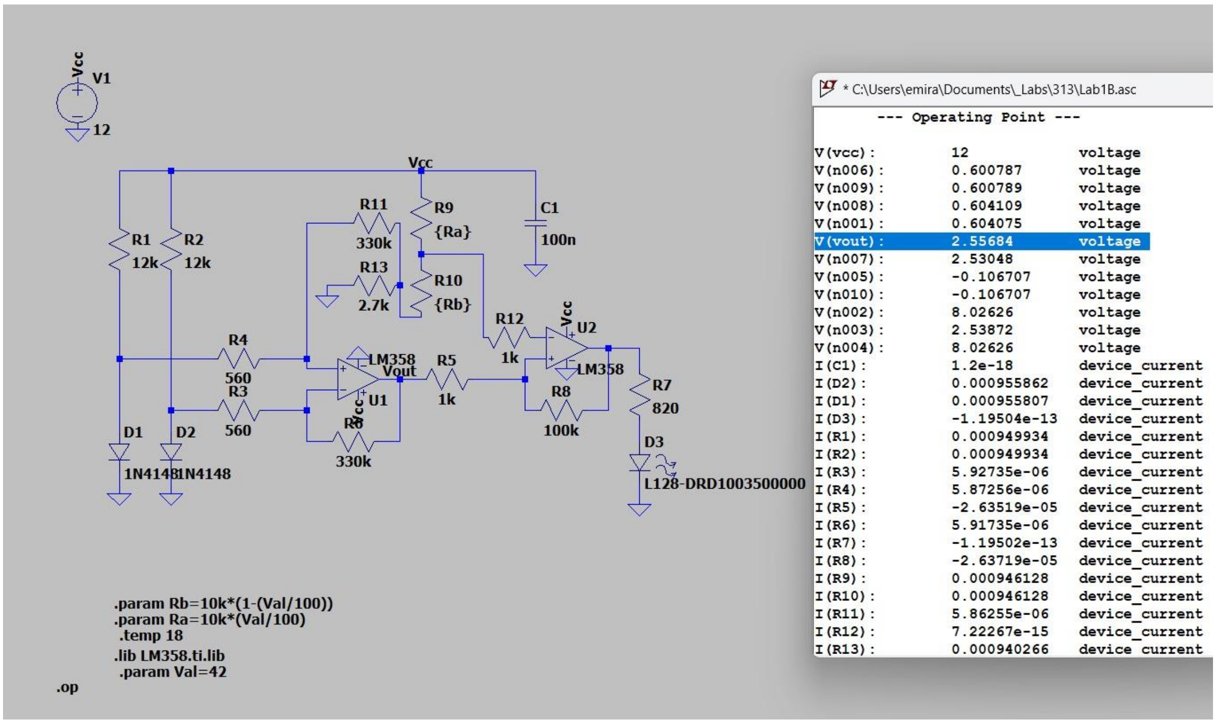


Figure 3: Temperature is 18°C

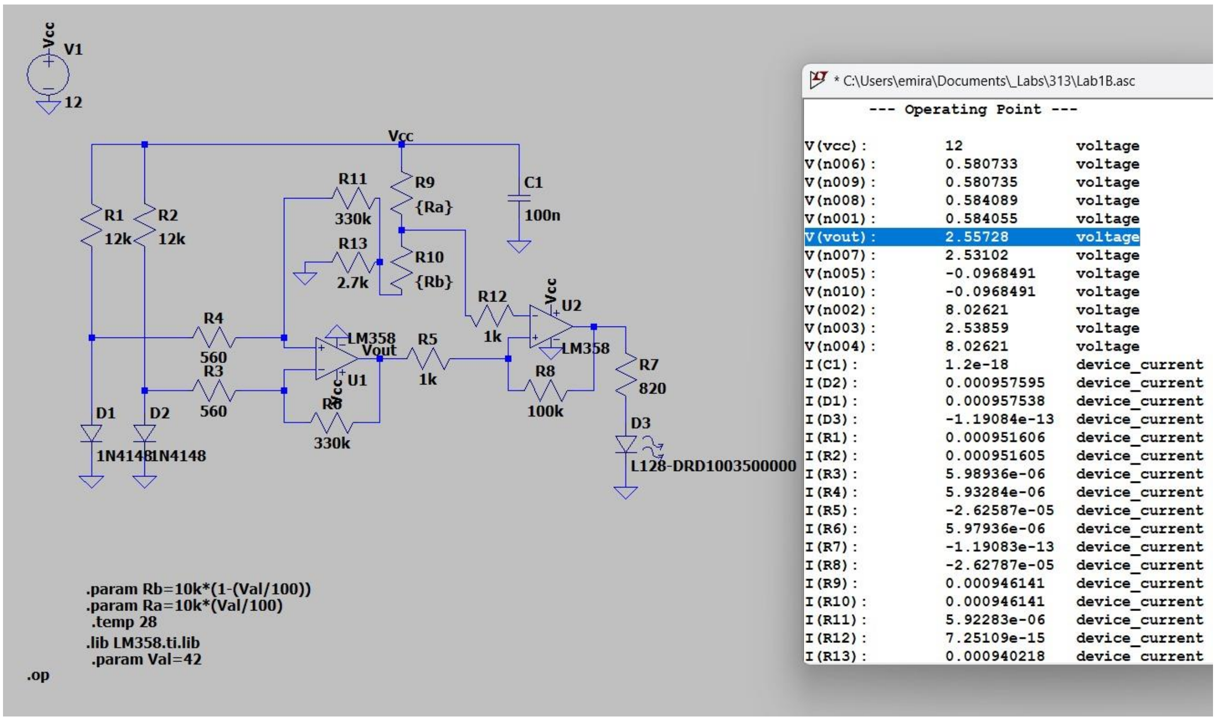


Figure 4: Temperature is 28°C

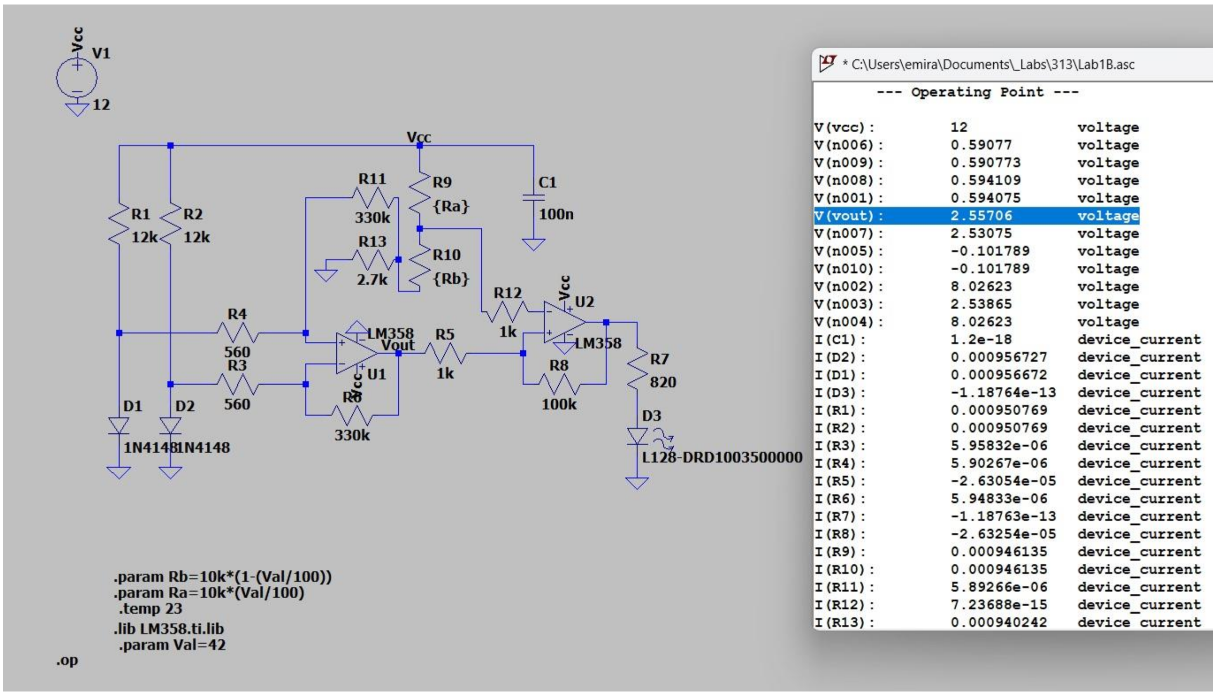


Figure 5: Temperature is 23°C

18°C	23°C	28°C
2.557V	2.557V	2.557V

Table 1: Change of Output Voltage with Change of Temperature

The following are the behavior of Vout and Diode Voltage. Vout increases 1.078V as temperature increases 1°C as in Figure 6, and Diode Voltage increases at 5 degrees above room temperature in the desired 0.1V range as in Figure 7.

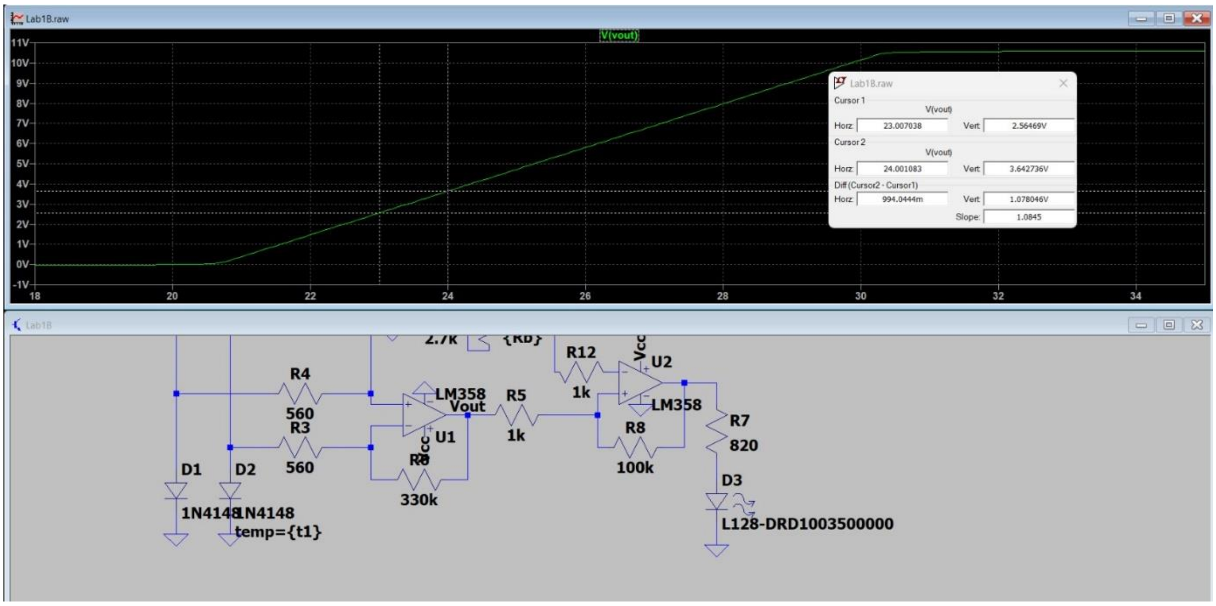


Figure 6: Vout, Increase of 1.078V

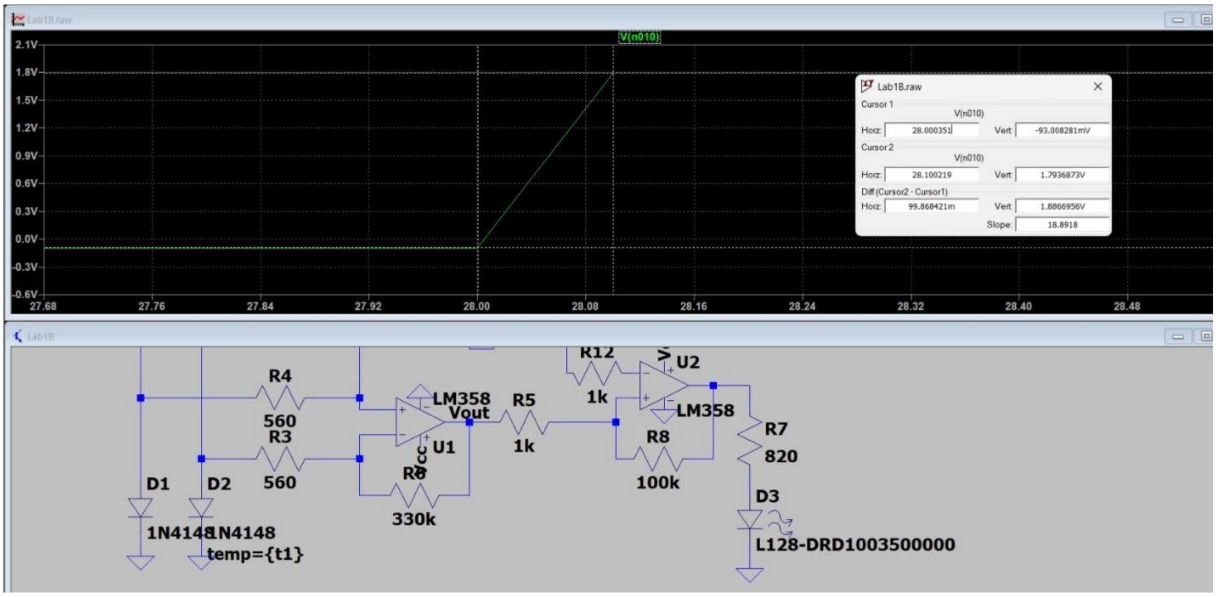
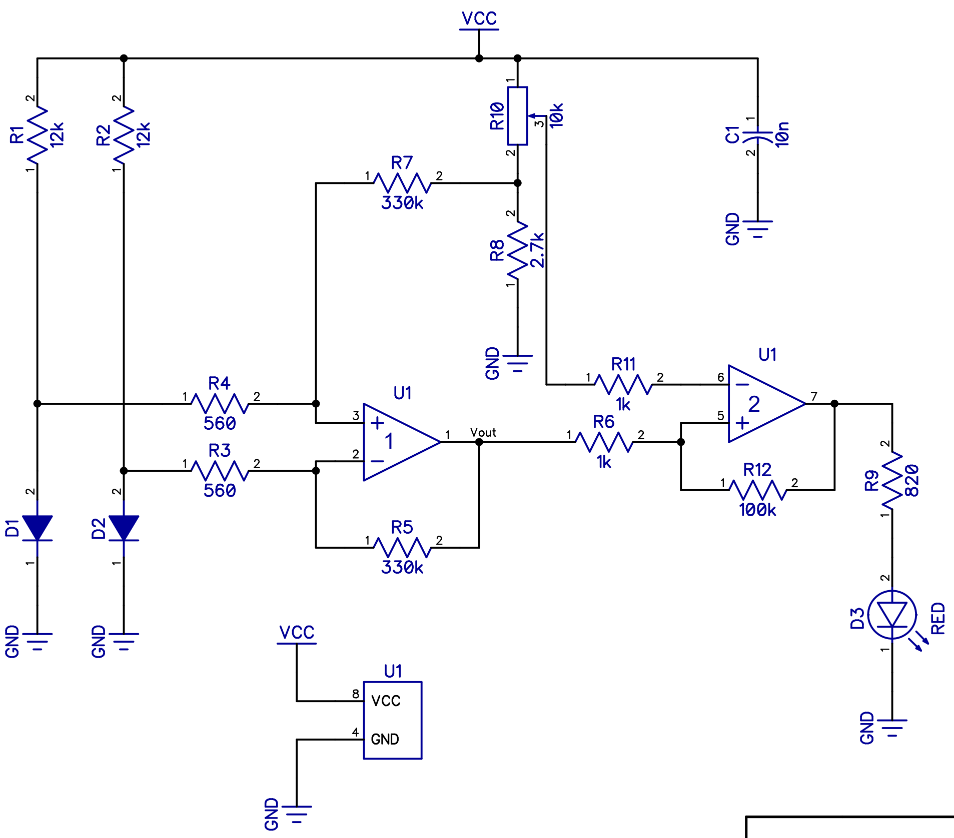


Figure 7: Increase of LED Voltage at 28°C in 0.1V Range

The following is the Diptrace Schematic's PDF file that includes a component list.

RevNo	Revision note	Date 29.09.2024	Signature	Checked

#	Value	Name	Quantity
1	10n	CAP100	1
2		1N4148	1
3		1N4148	1
4	RED	LED	1
5	12k	CFR25SJR-52-100K	1
6	12k	CFR25SJR-52-100K	1
7	560	CFR25SJR-52-100K	1
8	560	CFR25SJR-52-100K	1
9	330k	CFR25SJR-52-100K	1
10	1k	CFR25SJR-52-100K	1
11	330k	CFR25SJR-52-100K	1
12	2.7k	CFR25SJR-52-100K	1
13	820	CFR25SJR-52-100K	1
14	10k	RES_POT	1
15	1k	CFR25SJR-52-100K	1
16	100k	CFR25SJR-52-100K	1
17		LM358N	1
			17



Title		
Differential Temperature Sensor		
Size	Number	Rev
Date		Drawn by Emir Arda Bayer
Filename		Sheet