Sensors

🏆 A.1.4 Learning activity

Target

Make a temperature measuring sensor using an electronic circuit, using a simulator, a linear temperature **TMP36 Transistor** and a **LM741** operational amplifier.

✏️ Development

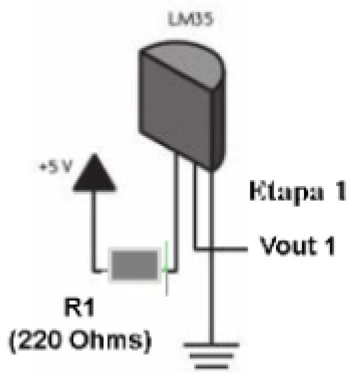
1. Use the following list of materials for the preparation of the activity

Quantity	Description	Source of consultation
1	Temperature sensor TMP36	TMP36
1	10k Potentiometer	10K Potentiometer
2	220 Ohm Resistors	220 Ohm Resistor
1	LM741 amplifier	LM741 amplifier
1	5Volts power supply	5V power supply

For further information, please consult the following links:

- Information and specifications of the TMP36 sensor
- Information and specifications of Operational amplifier LM741

2. Based on the image, assemble the stage 1 electronic circuit using a simulator, placing the LM35 transistor in the indicated position.



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1. Calculate, measure and record the values requested for Vout1, under the 3 conditions required in the attached table.

Number	Condition	Vout1 measured voltage	Voltage measured at R1	Indicated temperature
1	Minimum	.0999V	11mV	-40°C
2	Medium	.929V	11mV	43°C
3	Maximum	1.75V	11mV	125°C

Temperature = (Vout - 0.5) * 100

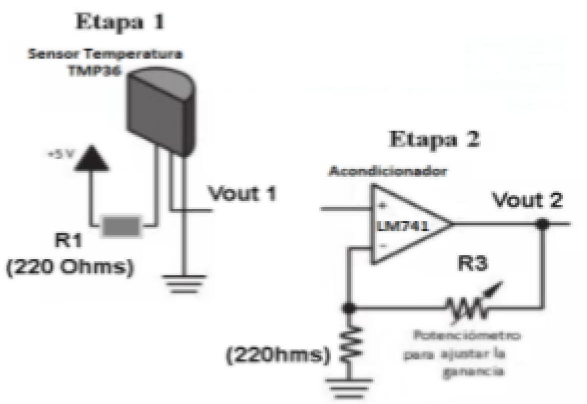
Substituting

Minimum = (.0999V - 0.5) * 100 = -40.01°C

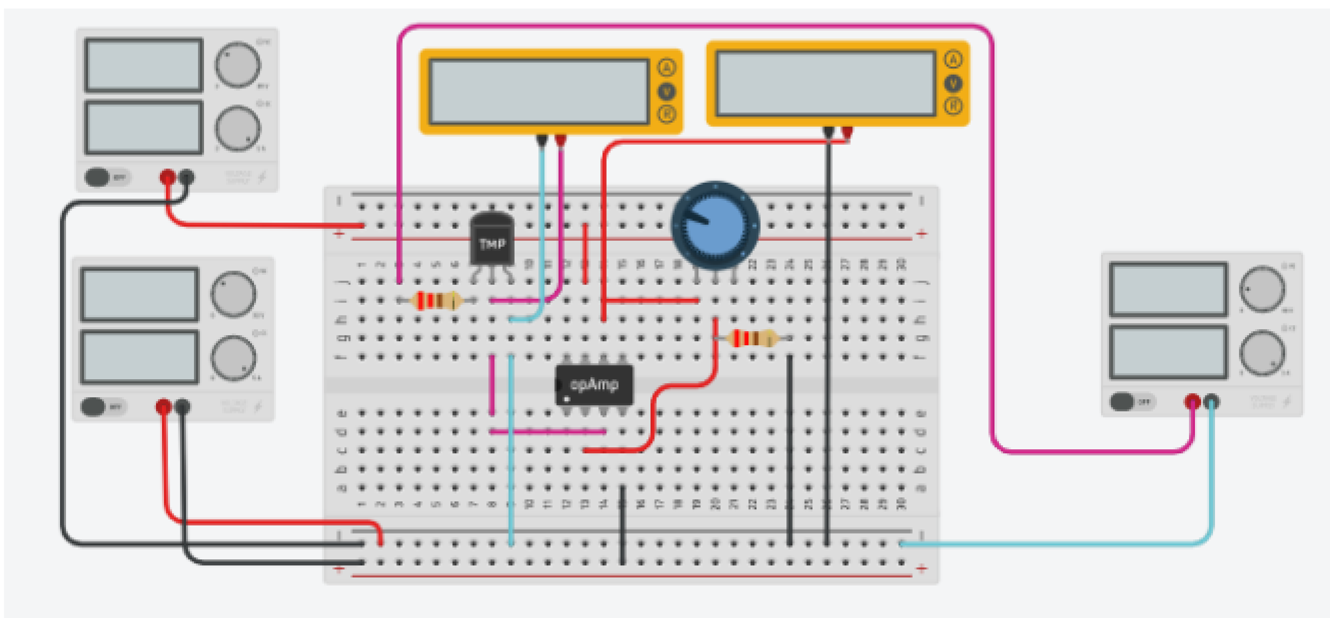
Medium = (.929V - 0.5) * 100 = 42.9°C

Maximum = (1.75V - 0.5) * 100 = 125°C

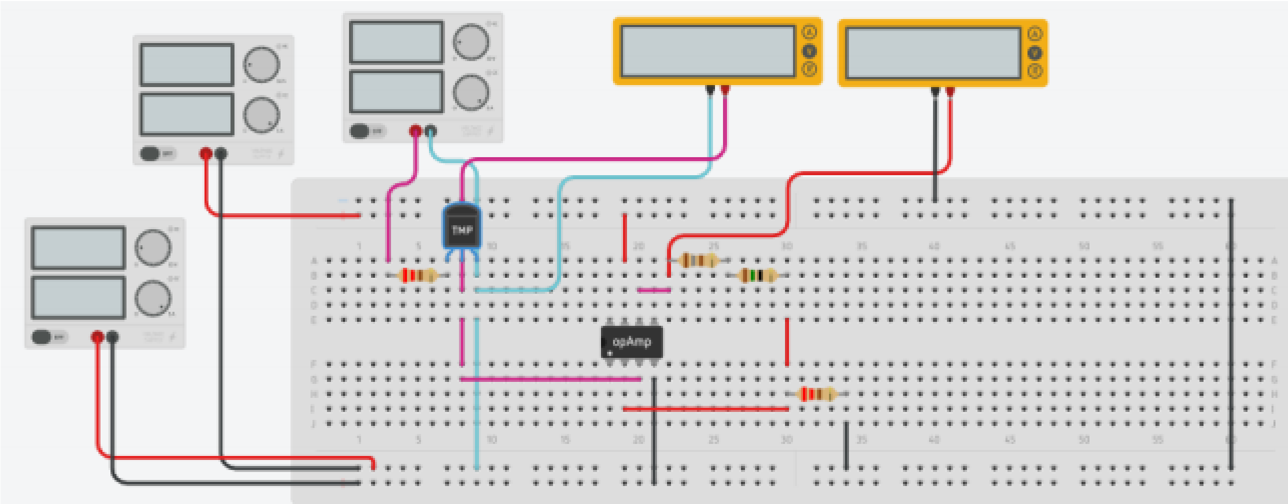
4. Using the image of the TMP36 transistor corresponding to stage 1, connect the Vout1 terminal to the non-investment terminal of the LM741, and assemble the circuit corresponding to stage 2.



Second stage using a potentiometer



Second stage using resistors with commercial values



5. **What value should R3 have in the Stage 2 circuit, to achieve Vout2 = 3.3 volts,** for the maximum temperature condition that the sensor is able to detect? As you can see the resistance R3 corresponds to a potentiometer, however resistance arrangements can be made to achieve a fine fit. Why do you think a **3.3 output voltage** is being requested?

To calculate this, first we need to use the Vout formula for an OpAmp:

$$Vout \ = \ Vin(1 \ + \frac{R1}{R2})$$

using said formula, we get the formula to calculate R2 (in this case R2 is equals to R3, the resistance value we're looking for)

$$R2 \ = \ R1(\frac{Vout}{Vin} - 1)$$

We substitute the values

$$R2 \ = \ 220 \ Ohm \ (\frac{3.3 \ V}{1.75 \ V} \ - \ 1)$$

$$R2 \ = \ 195 \ Ohm$$

Why do you think a 3.3 output voltage is being requested?

Because 3.3 volts is an standard among microcontrollers and boards such as the ESP32 or the Arduino family, also the Raspberry Pi microcomputer. And since the purpose of using this sensor is reading its data and these systems are used to read data from sensors, it makes sense to adjust the maximum value to 3.3V.

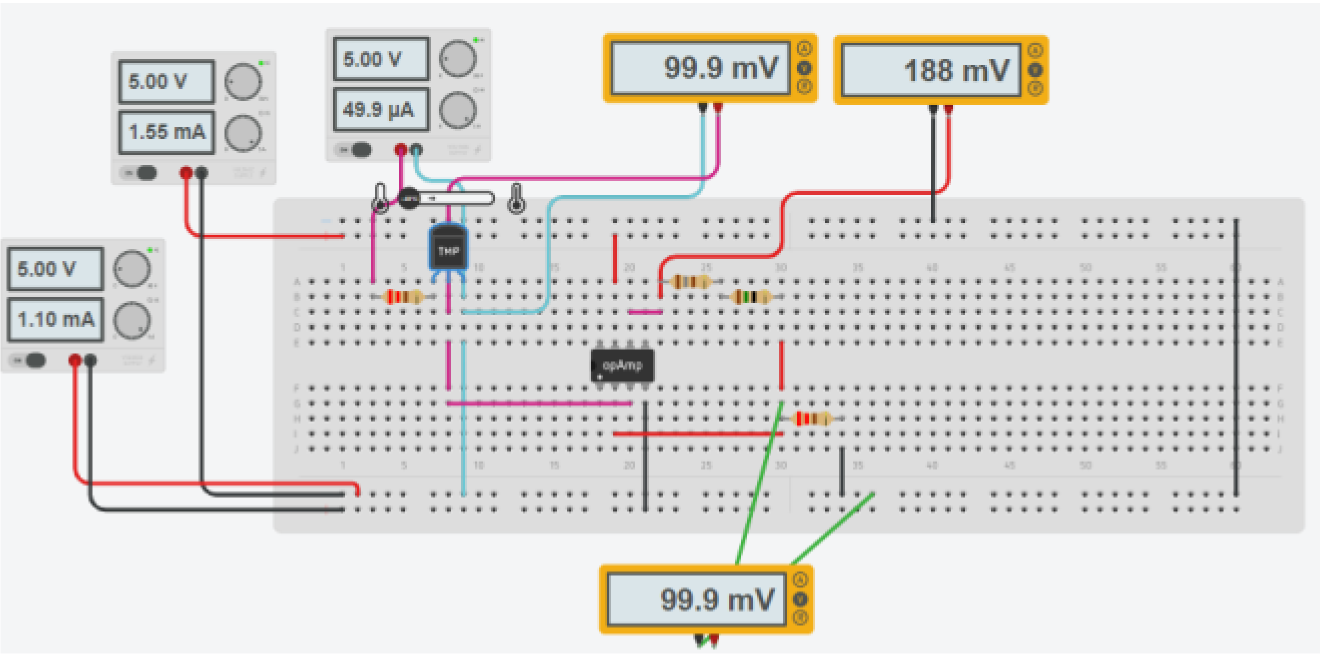
Setting 3.3V as the threshold also makes possible an analogic to digital conversion: where values below 3.3V will be taken as a digital 0 and if the sensor reaches its maximum temperature, a 3.3V will be in the output, meaning a digital 1.

6. Once the value R3 has been adjusted leave it there and record the values requested for Vout2, for the 3 conditions required in the attached table.

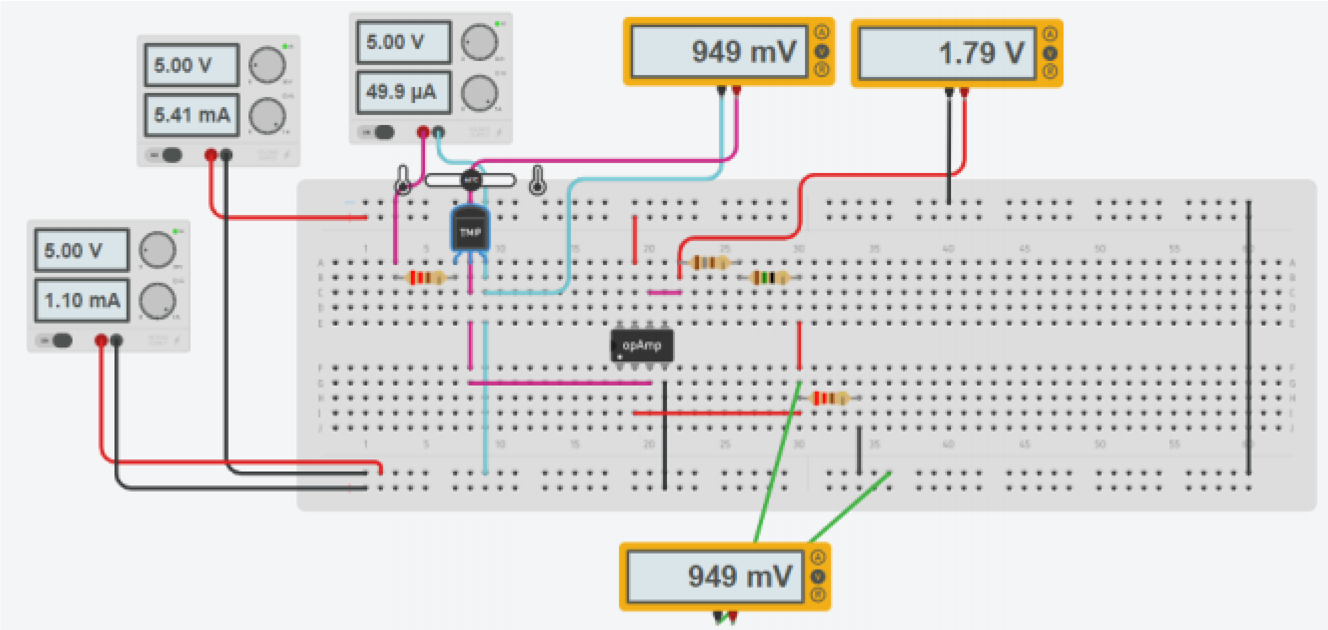
Number	Condition	Voltage measured at R2	Vout2 measured voltage	Indicated temperature
1	Minimum	99.8mV	188mV	-40 C
2	Medium	918mV	1.73 V	42 C
3	Maximum	1.75	3.3V	125 C

Images of the simulation

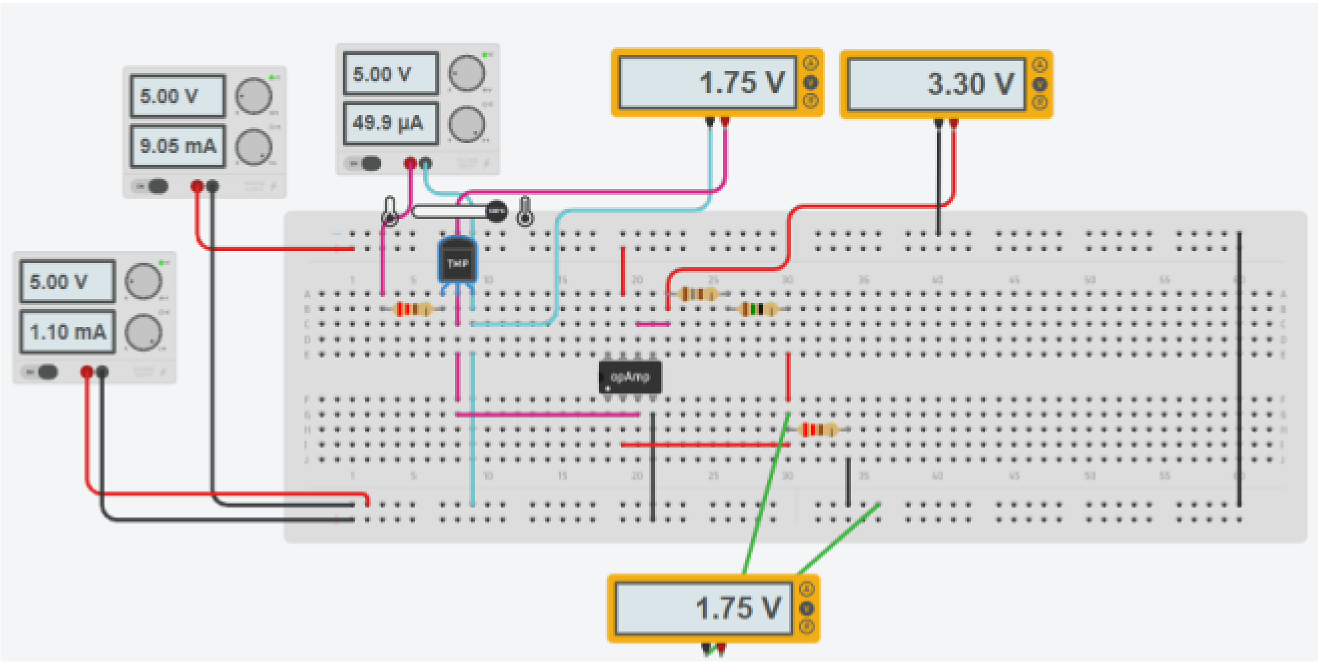
with minimum temperature(-40C)



with medium temperature(43C)



with maximum temperature(125C)



7. Plot Vout1 and Vout2, for the three conditions above, considering the "X" axis for the temperature values and the "Y" axis the voltage values, and place them within this section.

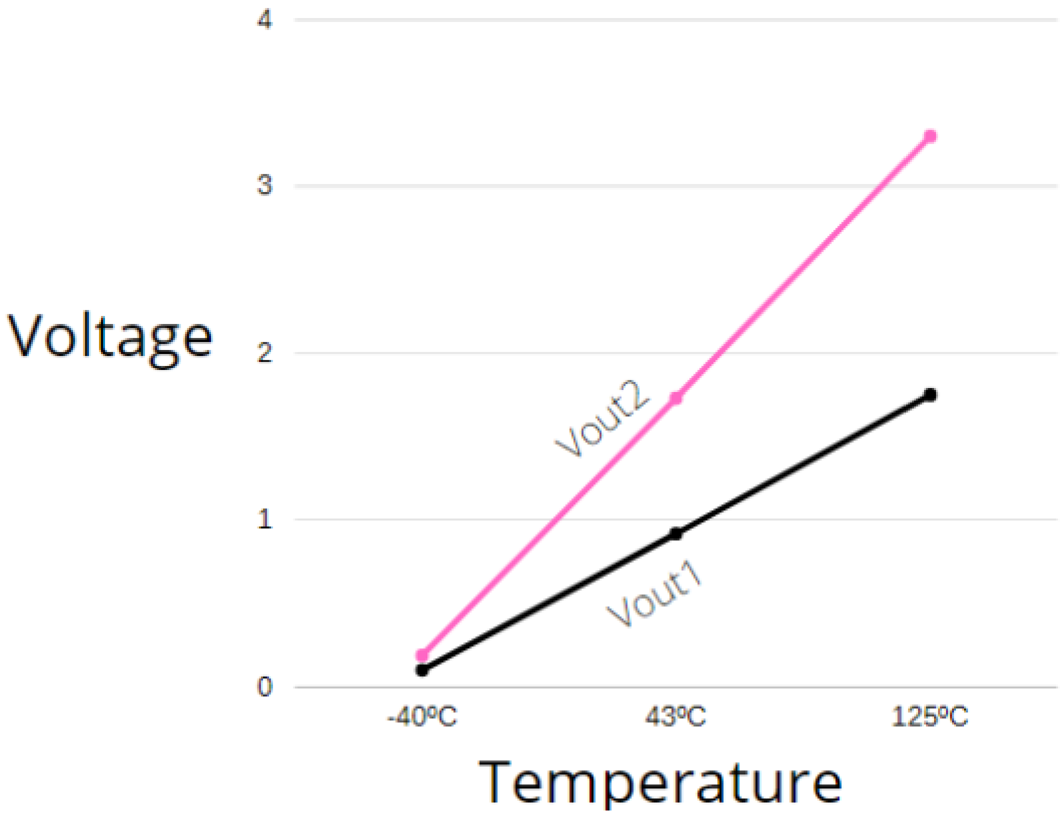
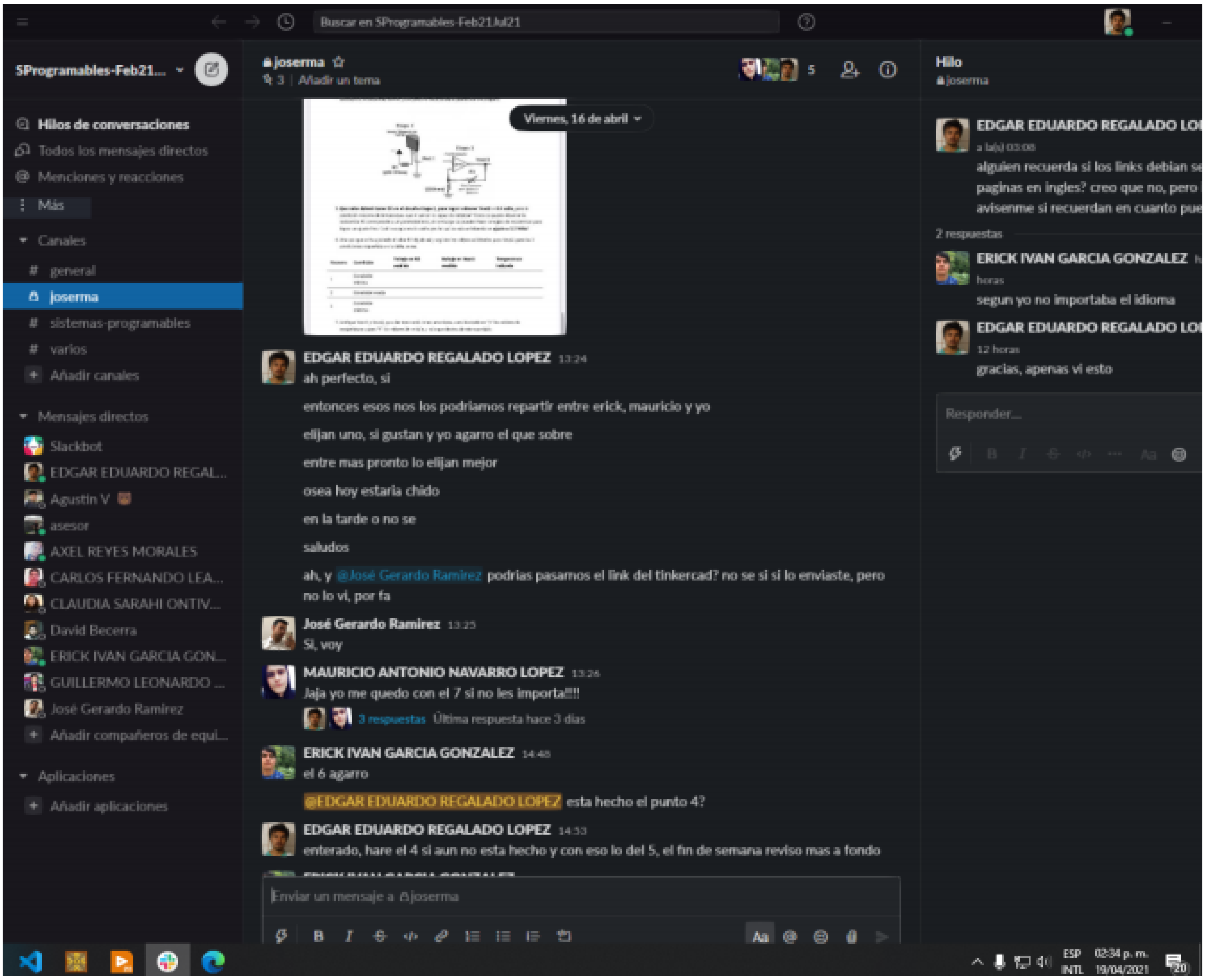
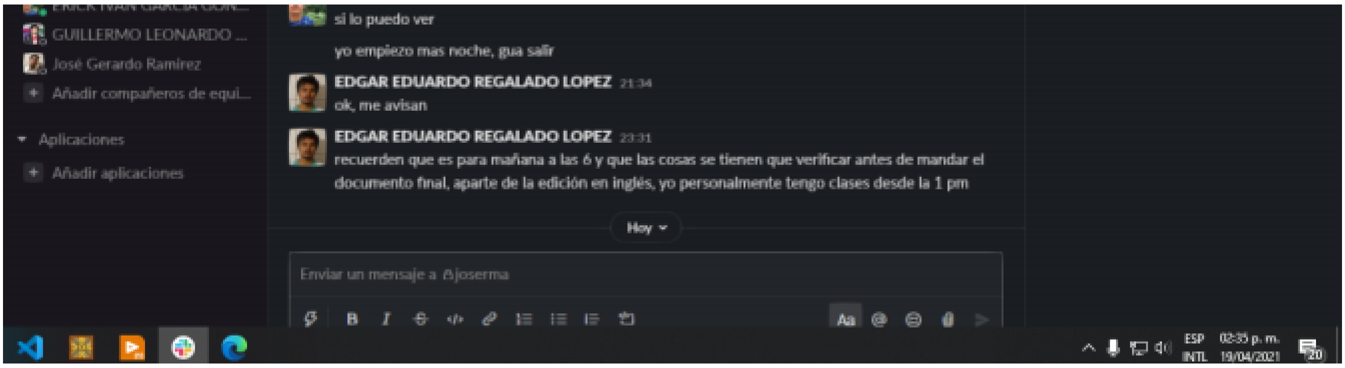


Photo evidence of the meetings of the team





Conclusions of each team member

Edgar Regalado

At first i thought we wouldn't use the opamp again, but after this practice i think that the opamp integrated circuit is very useful. Being able to adjust the voltage of a sensor to higher voltages is good because sometimes the voltage output of a sensor might be just too small to make something out of it, and just as mentioned in the 5th section, being able to convert values to 3.3v can be used as a way to convert analog signals into digital ones, which proves useful if we want to know wheter a condition is met or not without having to use software code

Mauricio Navarro

With the development of this practice, the objective of knowing a little more about the use and application of the TMP36 transistor in collaboration with the LM741 operational amplifier is fulfilled. It is possible to appreciate how with the TMP36 temperature sensor it delivers the information of the ambient temperature through the voltage on its signal pin causing the measured voltage to change, in the same way it is appreciated how the operational amplifier increased to the sensor signal of temperature causing the measured voltage to increase.

Erick García

While doing this practice, it was interesting to notice that TMP36 prety crealy; p rovides a voltage output that is linearly proportional to Celsius temperature, also that adjusting the voltage it is a great idea for different outputs on maybe different proyects.

Jose Gerardo

In this practice I learned that using a temperature sensor, which could provide ranges of values from 0.0999V to 1.75V depending on the temperature, the precision can be increased by using a conditioner, increasing the range of values from 0.304V to 4.5V, this being an integrated circuit normally carried by arduino sensor modules

💣 Rubrica

Criteria	**Description**	**Score**
Instrucciones	Each of the points indicated is met within the Instructions section?	10
Development	Each of the requested points was answered within the development of the activity?	60
Demonstration	The student presents himself during the explanation of the functionality of the activity?	20
Conclusions	A personal opinion is included of the activity by each of the team members?	10

🏫 Go to sensors

Enlace a mi github