DELHI TECHNOLOGICAL UNIVERSITY

AE MTE PROJECT

BY MUSKAN GUPTA

ROLL NO – 2K19/SE/077

TOPIC: TEMPERATURE SENSOR (ELECTRONIC THERMOMETER) USING OPAMP

CONTENTS

ABSTRACT

This project represents the main concepts of LM35, operational amplifier and their usage in sensing temperature change and change LED lights due to change in voltage across them or rather change in temperature. It has been developed using Proteus simulation software.

INTRODUCTION

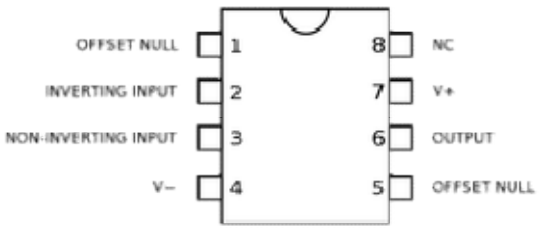
The **temperature sensor** is very useful in different ways. It can activate or deactivate any kind of device by observing a temperature. Its application is an electronic thermometer or a fire alarm circuit. So, in this tutorial, we will design a simple Temperature Sensor circuit using the LM35 IC.

If the temperature rises to a particular level the red Led glows which indicates the high temperature. While in other cases if the temperature falls below, the green Led glows which shows the low temperature.

The necessary hardware items required for Temperature Sensor Circuit:

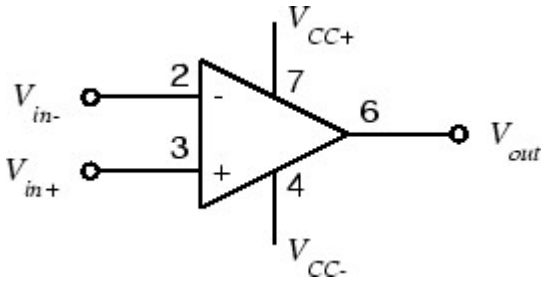
- LM35 Temperature Sensor
- LM741 Operational Amplifier
- The LED (Red, Green)
- Resistors (10k,2k,470 Ohm)
- 9V Battery with Clip
- Wires

OPAMP



An operational amplifier (or an op-amp) is an integrated circuit (IC) that operates as a voltage amplifier. An op-amp has a differential input. That

is, it has two inputs of opposite polarity. An op-amp has a single output and a very high gain, which means that the output signal is much higher than input signal.



Vout = AOL [(V+) – (V-)],
Where AOL = Open loop gain of opamp

Ideal characteristics of a OPAMP:

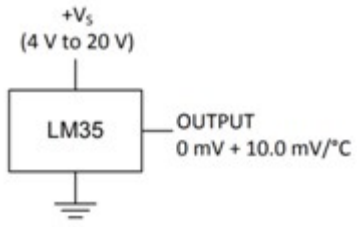
1. Opamp has high input impedance & low output impedance.
2. Zero common mode gain or infinite common mode rejection.
3. Infinite open loop gain AOL.
4. Infinite bandwidth.

** opamp is used as differentiator, integrator, comparator, current – voltage converter, voltage- current converter, etc.

LM35

LM35 is a precession Integrated circuit Temperature sensor, whose output voltage varies, based on the temperature around it. It is a small and cheap IC which can be used to measure temperature anywhere between -55°C to 150°C. It can easily be interfaced with any Microcontroller that has ADC function or any development platform like Arduino.

Power the IC by applying a regulated voltage like +5V (VS) to the input pin and connected the ground pin to the ground of the circuit. Now, you can measure the temperate in form of voltage as shown below.



If the temperature is 0°C, then the output voltage will also be 0V. There will be rise of 0.01V (10mV) for every degree Celsius rise in temperature. The voltage can converted into temperature using the below formulae.

V_{OUT} = 10 mv/°C × T

where

- V_{OUT} is the LM35 output voltage
- T is the temperature in °C

This project uses IC LM35 as a sensor for detecting accurate centigrade temperature. Linearity defines how well over a range of temperature a sensor's output consistently changes. Unlike thermistor, Linearity of a precision IC Sensors are very good of 0.5°C accuracy and has wide temperature range. Its output voltage is linearly proportional to the Celsius (Centigrade) temperature.
The LM35 is rated to operate over a -55° to +150°C temperature range.It draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air. LM35 Operates from 4 to 30 volts.

Output of IC is 10mv/degree centigrade for eg if the output of sensor is 280 mV then temperature is 28 degree C. so by using a Digital multimeter we can easily calculate the degree temperature. For trigger point we set the voltage of pin 2 of IC 741 by using preset or potentiometer.
Our aim of this project is not to construct a thermometer but to activate or deactivate a device at a particular margin temperature. For simplicity we have used 2 LED for indication of both low (Green) and high (Red) temperature.

WORKING PRINCIPLE

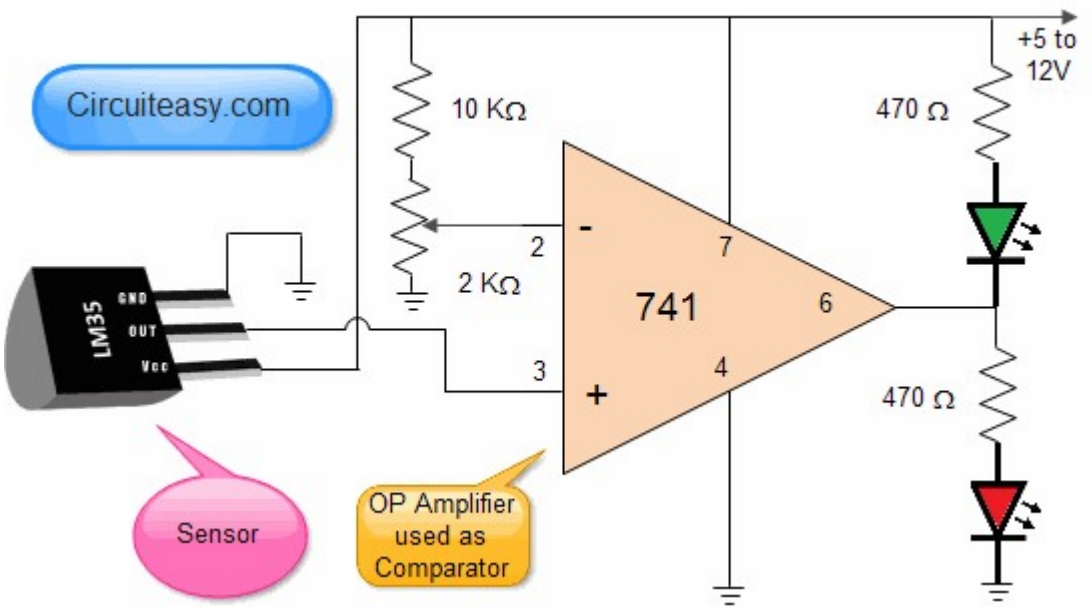
LM35 is an application of a digital thermometer and it also measures the temperature. It is a very famous and inexpensive temperature sensor. Its output varies according to the temperature around it. The range of the LM35 IC lies in between -55 degrees to 150 degrees. If the temperature is 0 degree the output will also be 0V. For every 10 degrees rise of temperature, there will be a rise of 10mv. The output of IC2 (LM35) increases in proportional to the temperature by 10 mV/°C, this varying voltage is feed to a comparator configuration of IC 741 (OP Amplifier).

OP Amplifier is among the most widely used electronic devices today. The op-amp is one type of differential amplifier. It has two input inverting (-) and non-inverting (+) and one output pin. We have used IC741 as non-inverting amplifier which means pin 3 is the input and the output is not reversed. This circuit amplifies the difference between its input terminals.

At first we set sensitivity (set a voltage by varying the 2KΩ pot) at pin no 2. If we consider that the sensitivity voltage as V1 & The output of LM35 (pin no. 3) as V2, then we can describe easily that what is happening.
If voltage V1> V2, then the output of the comparator at +V saturation, then the green LED is on and the red LED is off.
When the temperature increases that the output of LM35 is also increases, after a certain time when voltage V2 cross the voltage V1 then the output of the comparator at –V saturation , then the red LED is on and green LED if off.
When V1=V2 then the output is 0 and two LED is in off state. We have used IC741 as a non-inverting amplifier. As a comparator the output voltages will be

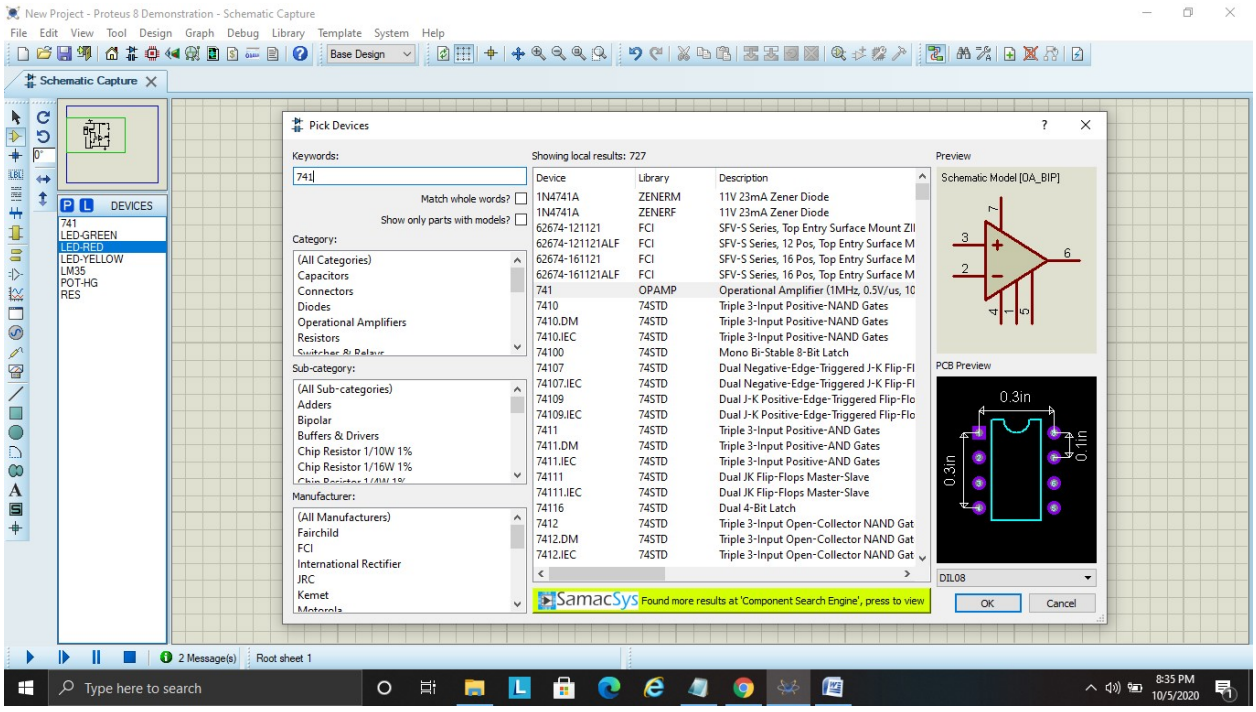
Vout = +Vsat when V1>V2
= -Vsat when V1<V2
= 0 when V1 = V2

CIRCUIT DIAGRAM

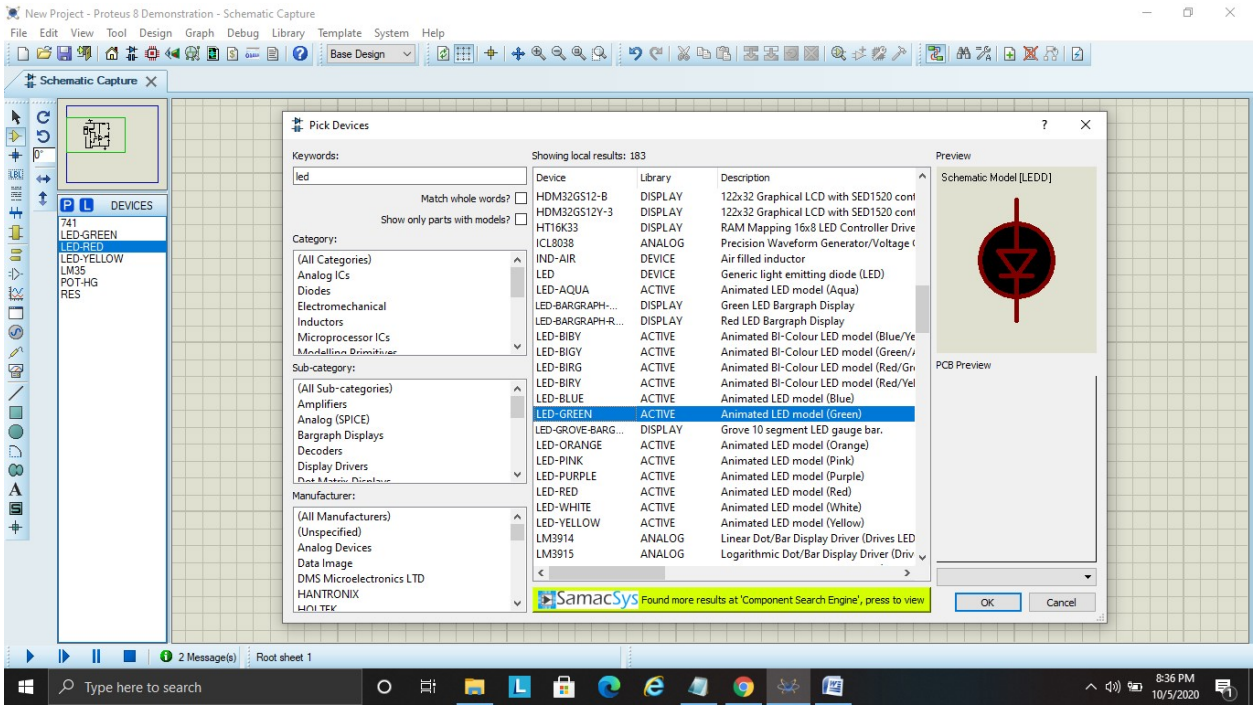


SIMULATION AND OUTPUTS

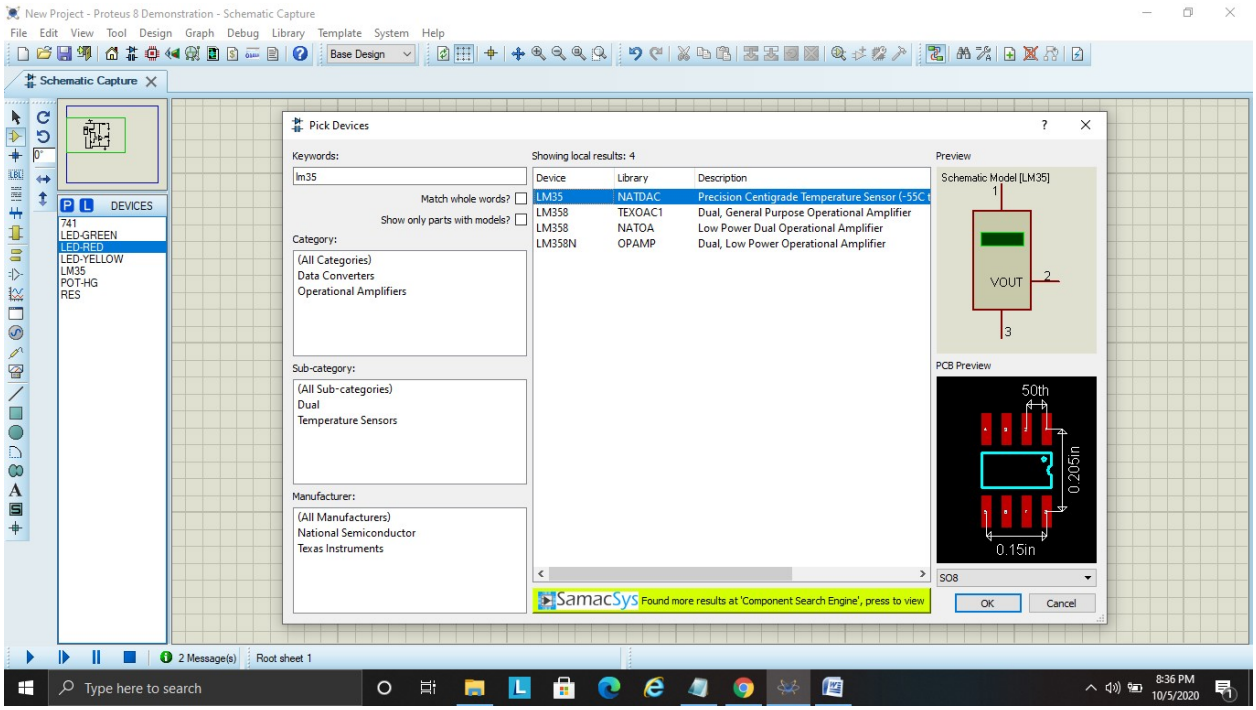
OPAMP-741



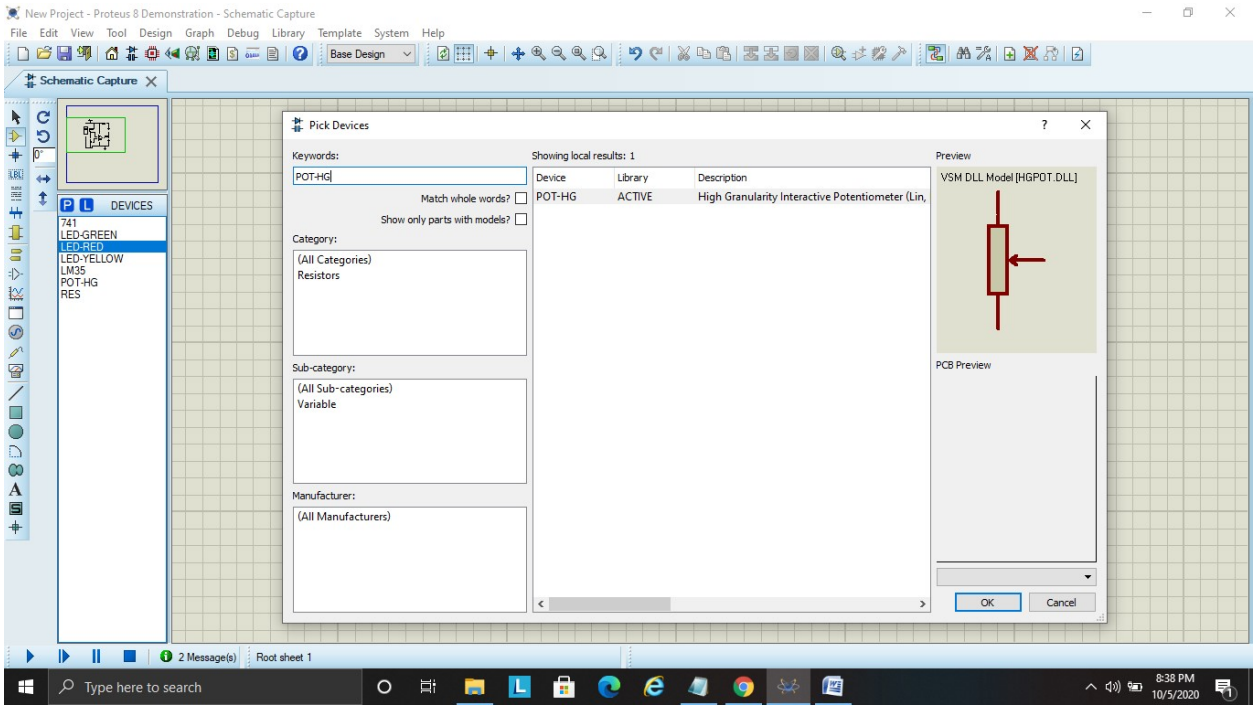
LED (RED & GREEN)



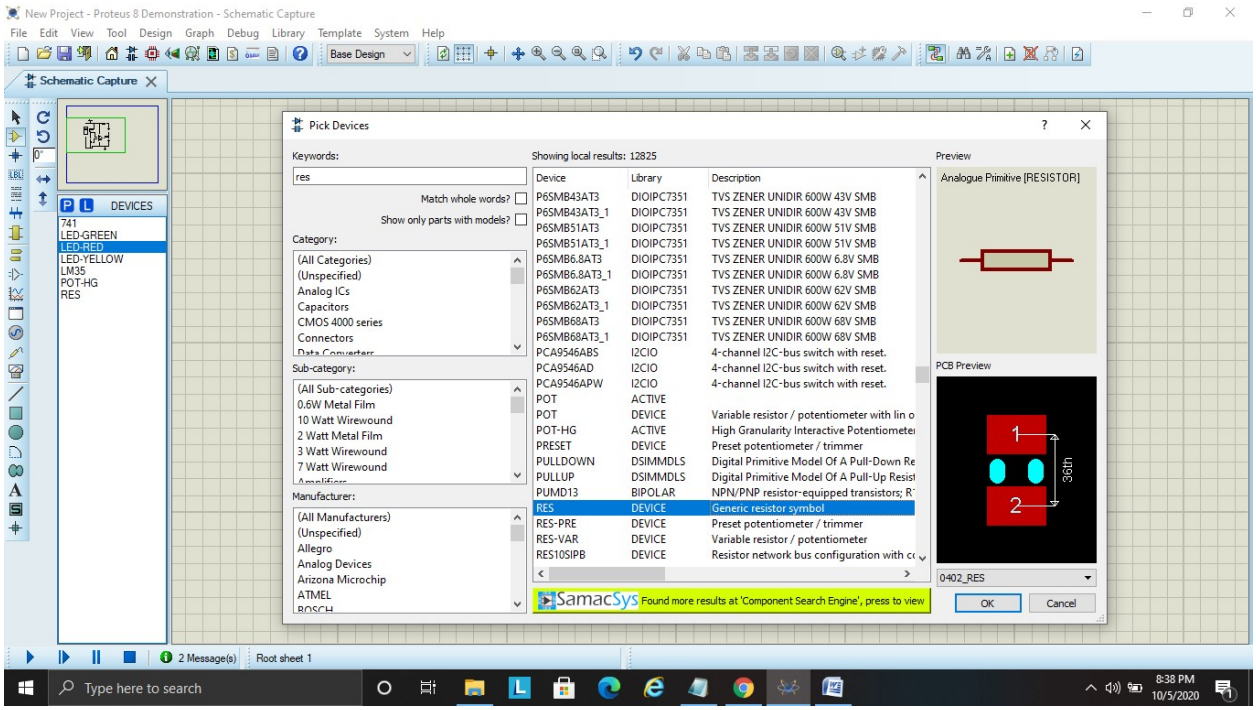
LM35



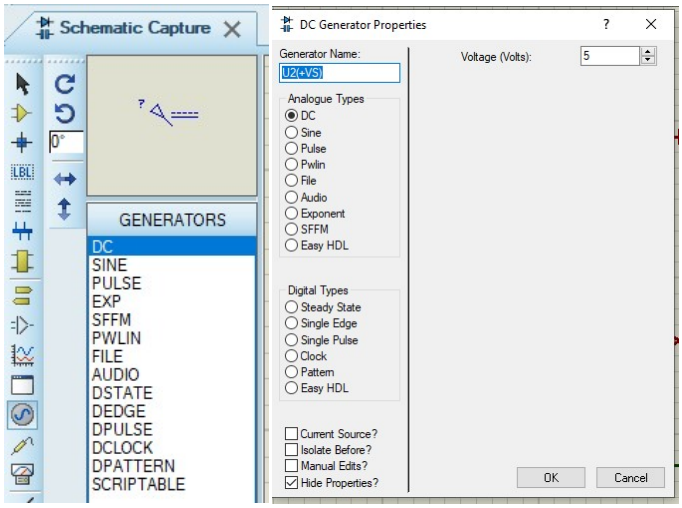
POT(Potentiometer)



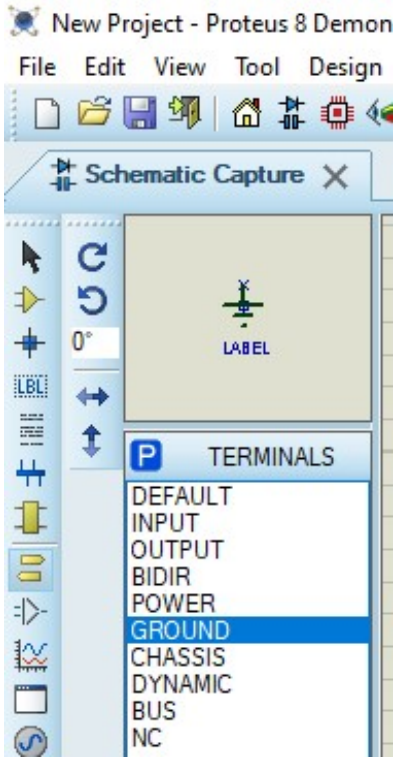
Resistance



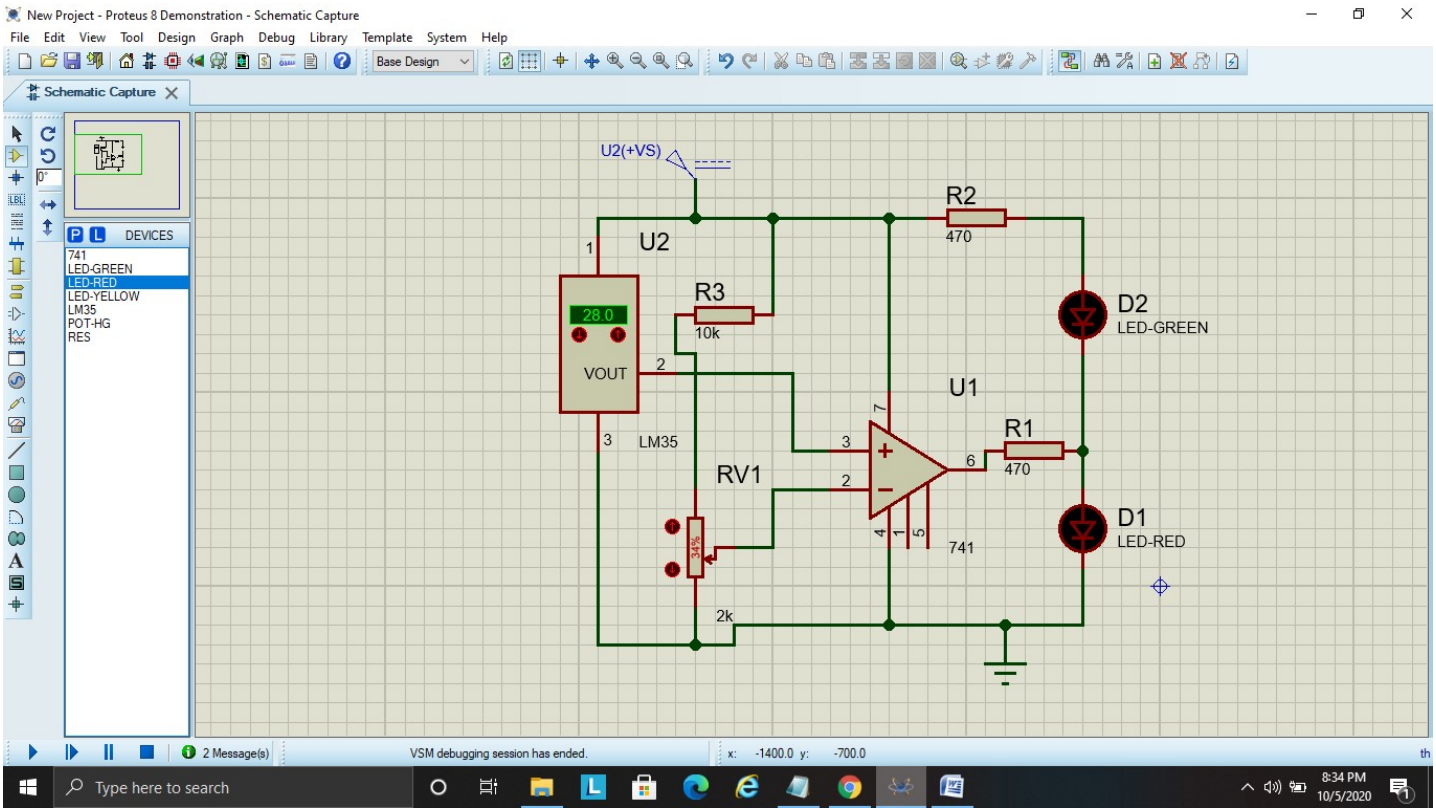
DC voltage



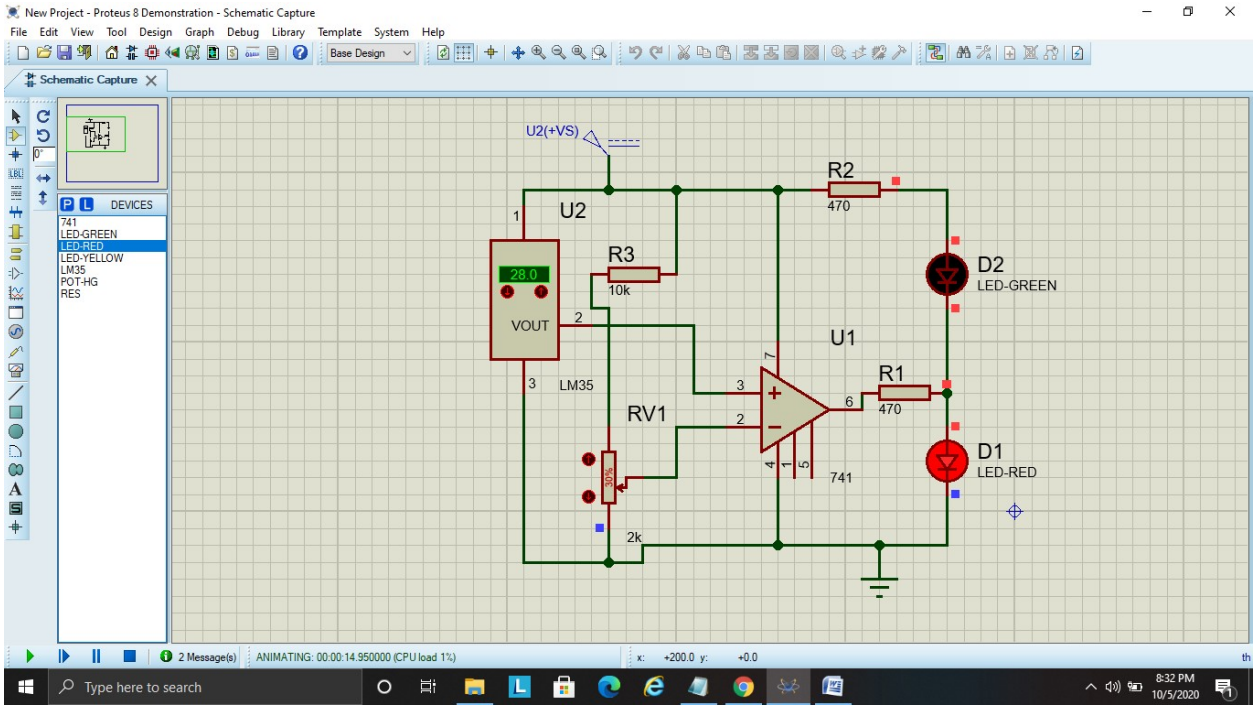
GROUND

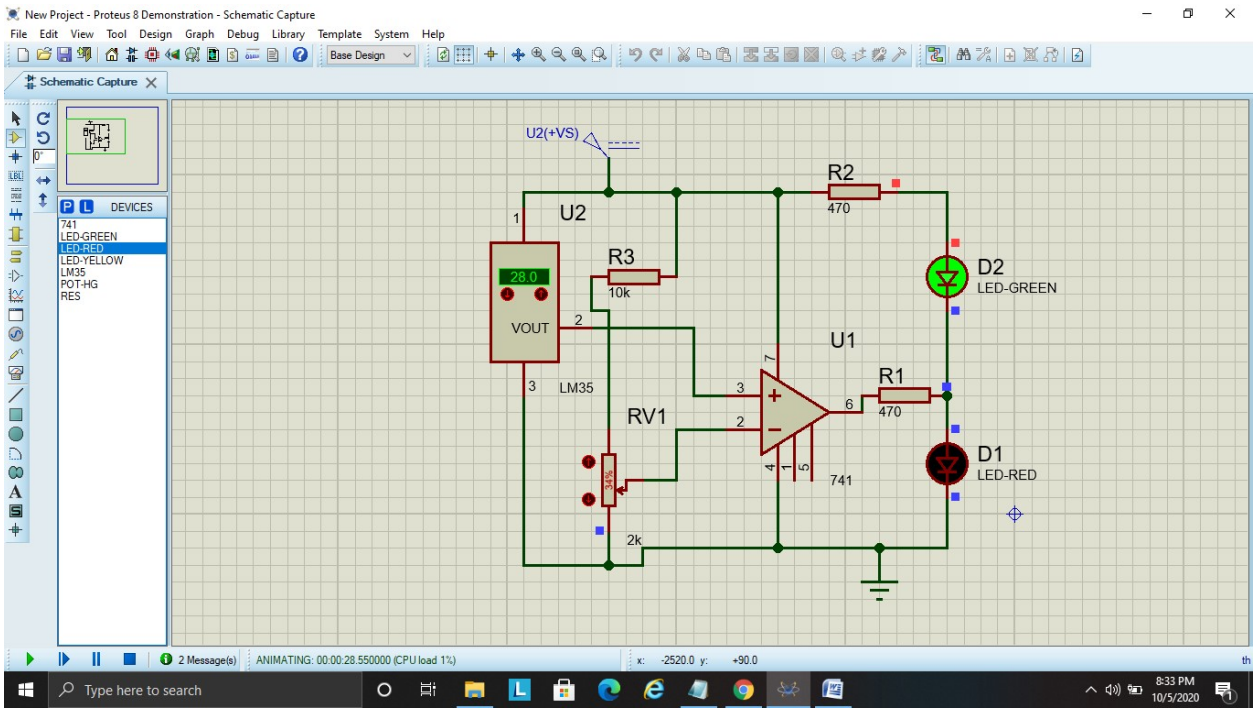


CIRCUIT



OUTPUT





ACKNOWLEDGEMENT

I would like to express my special thanks to our Professor Mr. Lokesh Gautam, who gave me such a wonderful opportunity to do my first review of my project.

CONCLUSION

The two LEDs are used at the output to indicate the high and low temperatures. As the temperature rises, it increases the voltages of a comparator; the comparator then amplifies the difference of voltages and indicates about high or low temperature by triggering the Led. This temperature sensing can be very well used in measuring the temperature of an environment, monitoring Battery temperature or providing thermal shut down for a system when required.

REFERENCES

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