Project: **Temperature Indicator**

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Lab Section: E

Graded by _____

Score _____

Introduction -
This design project centered around the creation of a circuit that takes the input of a temperature sensor and, in the range of 0 - 100 ℃, turns on or off certain LEDs at respective temperatures. This will be built with the supplied circuitry kit.

Design Requirements -
This circuit requires three LEDs to turn on and off at specific temperatures:

- Green:
    - On as it decreases below 30 ℃
    - Off as it increases above 40 ℃
- Orange
    - On as it increases above 40 ℃
    - Off as it decreases below 30 ℃
- Red
    - On as it increases above 100 ℃
    - Off as it decreases below 80 ℃

Components -
This circuit will be made from three comparators (one inverting, two non-inverting), a temperature sensor that scales at 10mv/℃, and three LEDs (Green, Orange, and Red).

The comparators will be comprised of various resistors and reference voltages, listed below:
Inverting (Green):

- Ra = 1kΩ Rb = 29kΩ
- Vref = 3.62v

Non-Inverting (Orange):

- Ra = 1kΩ Rb = 30kΩ
- Vref = 3.39v

Non-Inverting (Red):

- Ra = 1kΩ Rb = 15kΩ
- Vref = 8.44v

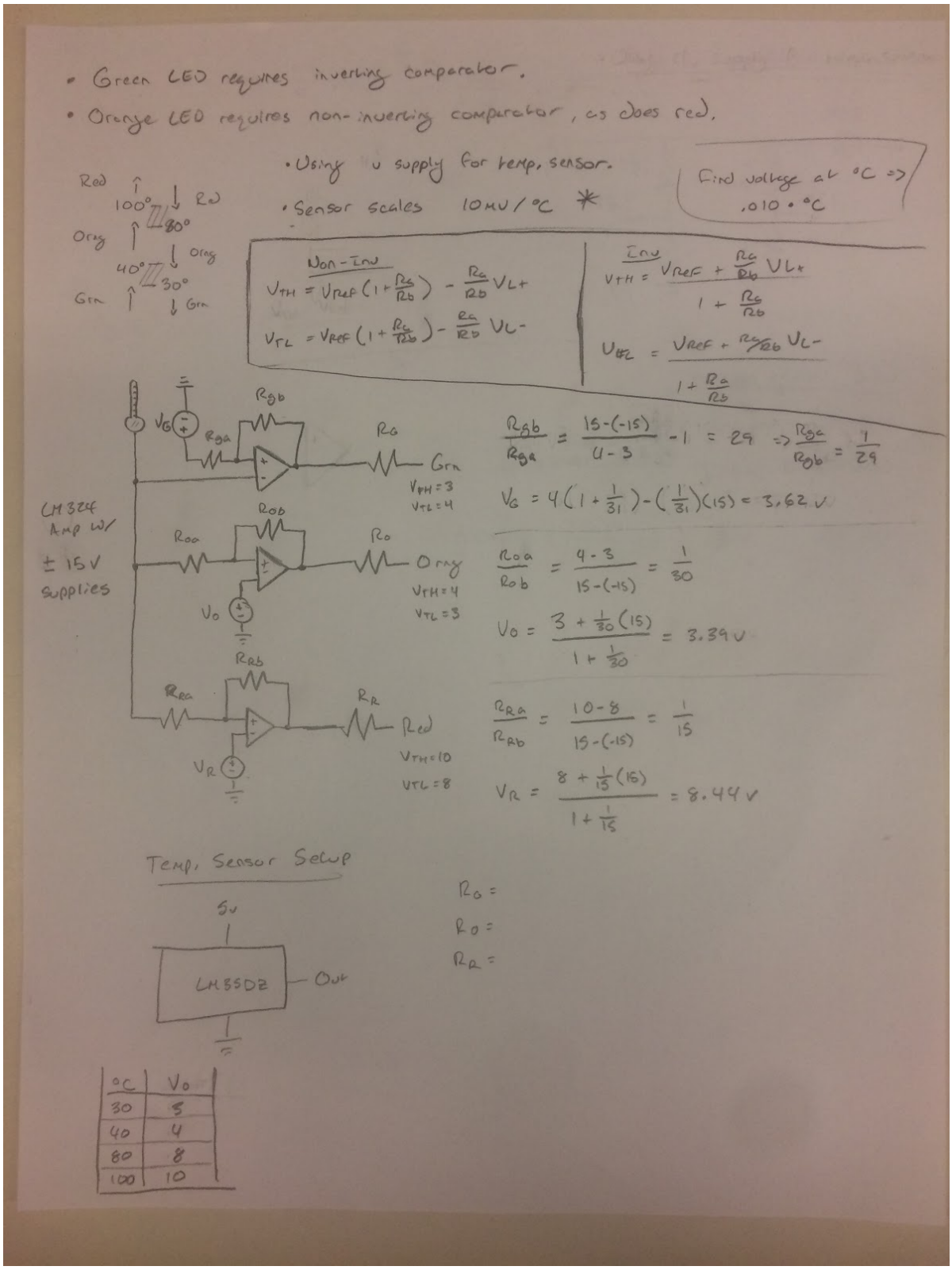
The reference voltages will be created with an 8.44v (Red) DC supply, and two voltage dividers:

- R1 = 1490Ω and R2 = 1kΩ, creating 3.39v (Orange)
- R1 = 1331Ω and R2 = 1kΩ, creating 3.62v (Green)

The temperature sensor will use an LM35DZ temperature sensor, scaling at 10mv/℃.

The three LEDs will use limiting resistors valued at 680Ω.

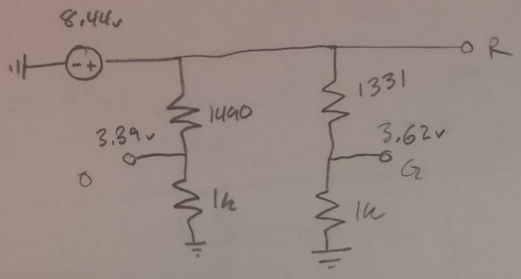
Notes and Written Diagram -



°C	V_O
30	5
40	4
80	8
100	10

Reference Voltages:

$$V = 8.44 \cdot \frac{1000}{1000 + R} \Rightarrow 8.44 \cdot \frac{1000}{V} - 1000 = R$$



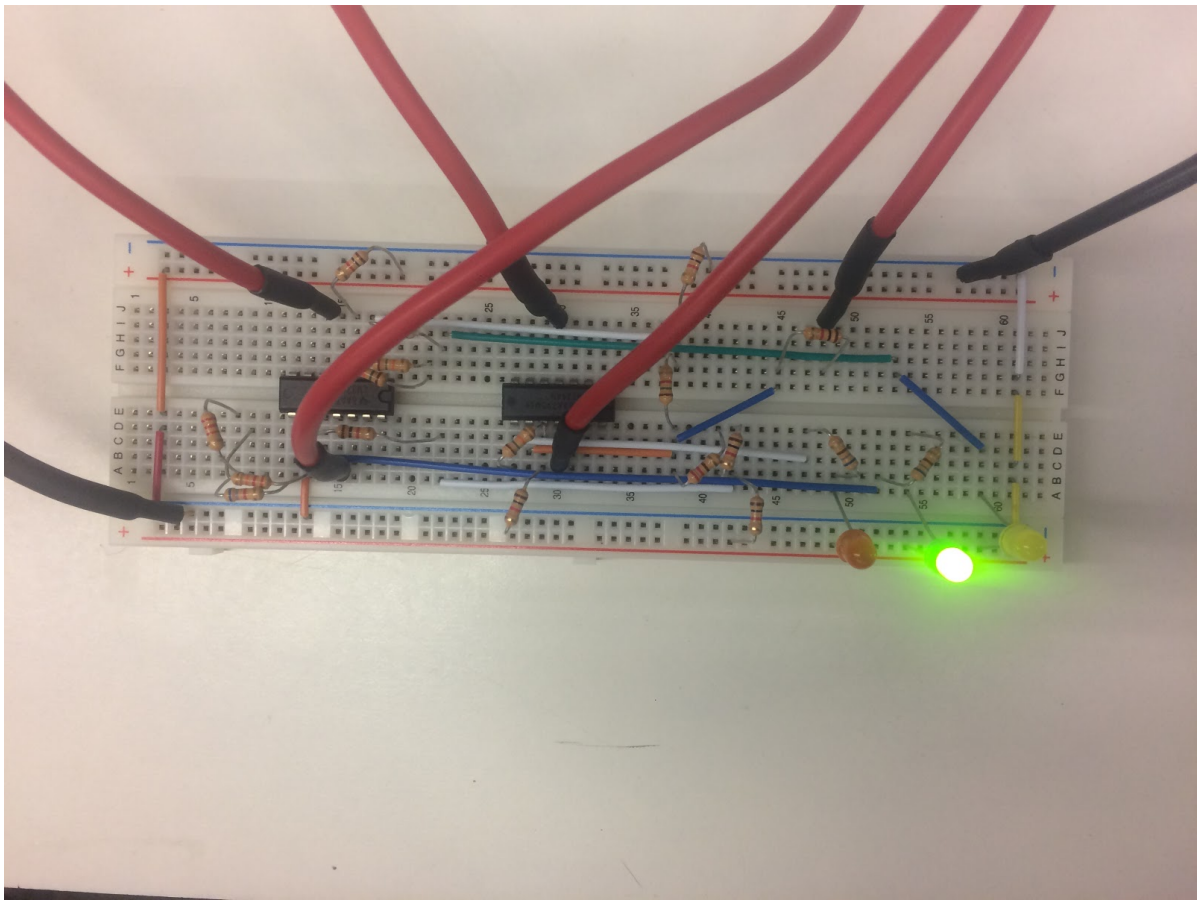
LED limiting resistors:

Comparator outputs 13.47v

LEDs shine brightly between 15-20mA

$$V = IR \qquad R = \frac{V}{I} = \frac{13.47}{.020} = \sim 680\,\Omega$$

Circuit Implementation -



Testing -

To test the circuit we forwent the temperature sensor in favor of a variable DC supply voltage. This was used to simulate the temperature sensor output at various voltages, as it was deemed difficult to test the circuit at one of the specified voltages of 100 ℃.

The circuit was tested with the test voltage (Vt) as so:

Testing rising hysteresis:

- Start Vt < 4v, ensure only the green LED is lit
- Raise Vt so that 4v < Vt < 10v, and ensure only the orange LED is lit
- Raise VT > 10v, and ensure only the orange and red LEDs are lit

Testing falling hysteresis:

- Start Vt > 10v, ensure only the orange and red LEDs are lit
- Lower Vt < 8, and ensure only the orange LED is lit
- Lower Vt < 3, and ensure only the green LED is lit

Conclusion -

This lab was focused mainly on the usage and composition of comparators in a real-world situation. We ended up having some issues with error on the green LED, but fixed it by raising the reference voltage and raising Rgb, effectively shortening the range of hysteresis. Overall, the circuit planning, computation, and creation went very smoothly.