Pre-Lab 2

Michael Brodskiy

Professor: M. Onabajo

September 25, 2024

1. Using the equation:

$$i = I_s\left(e^{v/(nV_T)} - 1\right)$$

and the given measurements, we may write:

$$10^{-3} = I_s\left(e^{.62/(n.025)} - 1\right)$$
$$10^{-2} = I_s\left(e^{.69/(n.025)} - 1\right)$$

Since the exponential is greater than 1, we may simplify to:

$$\frac{10^{-3}}{e^{24.8/n}} = I_s$$
$$\frac{10^{-2}}{e^{27.6/n}} = I_s$$

$$I_s = .001e^{-\frac{24.8}{n}}$$
$$I_s = .01e^{-\frac{27.6}{n}}$$

We can combine the two equations to solve for n and I_s:

$$.001e^{-\frac{24.8}{n}} = .01e^{-\frac{27.6}{n}}$$
$$e^{-\frac{24.8}{n}} = 10e^{-\frac{27.6}{n}}$$
$$e^{\frac{27.6-24.8}{n}} = 10$$
$$\frac{27.6-24.8}{n} = \ln(10)$$
$$n = \frac{2.8}{\ln(10)}$$

$$\boxed{n = 1.216}$$

We then plug this into the earlier equations to find I_s:

$$I_s = .001e^{-24.8/1.216}$$

$$\boxed{I_s = 1.3889 \cdot 10^{-12}[\text{A}]}$$

We can verify by using the second equation for I_s:

$$I_s = .01e^{-27.6/1.216}$$

$$\boxed{I_s = 1.3889 \cdot 10^{-12}[\text{A}]}$$

It is difficult to measure the current in a reverse bias mode, however, because the diode may reach breakdown voltage by increasing the reverse voltage.

2. Read through, no questions ✓

3. Taking the forward voltage of the LEDs as .2[V], and the input as 8[V], we can make some relevant calculations, assuming each LED will form a "branch" consisting of a resistor and the LED itself. First, using the maximum power, we can calculate the maximum current, starting with the first (red) LED to turn on:

$$I_{max} = \frac{6 \cdot 10^{-2}}{.2} = .3[\text{A}]$$

Now, we find the resistance value:

$$R_{red} = \frac{8 - .2}{.3} = 26[\Omega]$$

We then cascade this with the next LED to turn on (yellow), and calculate (using the Zener rating):

$$I^2_{max} = \frac{1}{8} = .125[]$$

Summing this with the current flowing through R_{red}, we get:

$$I_{yel} = .425[]$$

From which we derive a resistor value:

$$R_{yel} = \frac{17 - 8}{.425} = 21.176[\Omega]$$

Repeating a similar process for green, we find:

$$R_{grn} = \frac{24 - 8}{.425} = 37.647[\Omega]$$

We combine the cascade, along with a 26[Ω] series resistor to get:

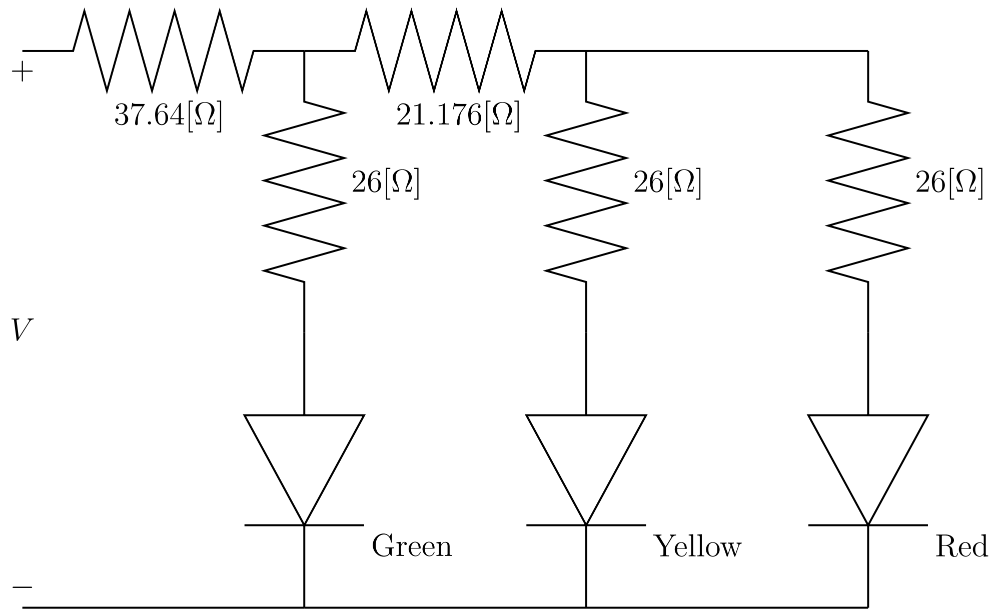

Figure 1: LED Configuration

This, however, is not the final step, as we need to add an additional diode in tandem with a resistor to maintain a safe operating range for the LEDs. Thus, our final circuit becomes:

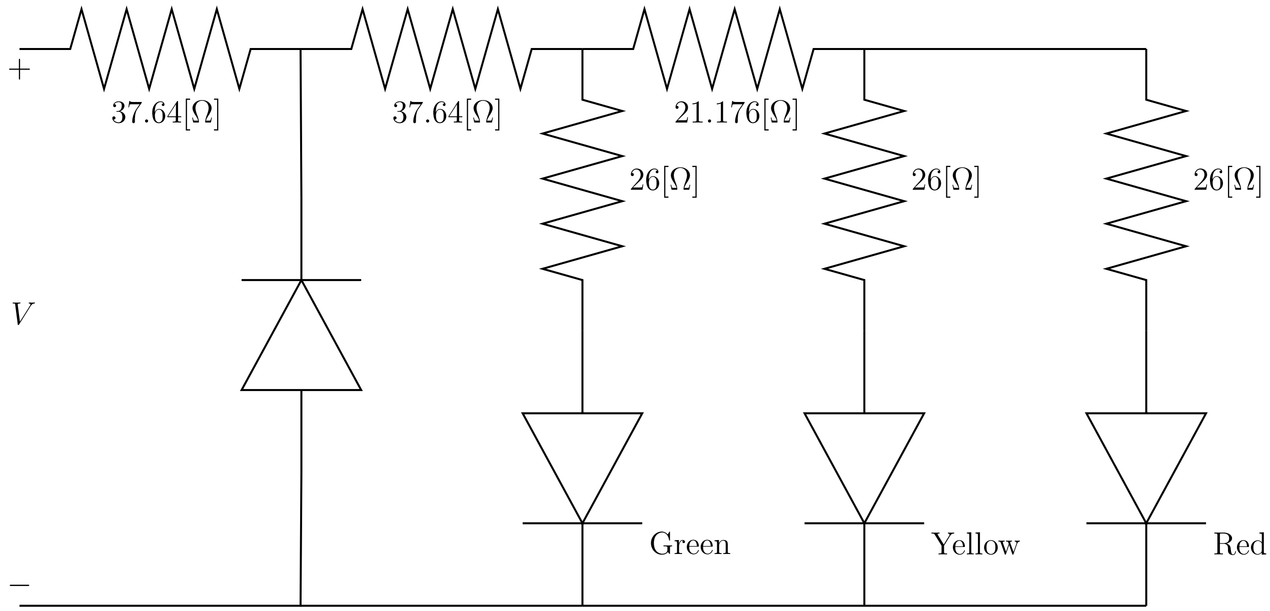

Figure 2: Final Configuration