AE6705 Lab 1
Sensors and Signal Conditioning

Yunqing (JJ) Jia

August 30 2024

1. Using the rule above, show that the resistor R_{in} should be selected as 800Ω given the selected values for R_f and R_g.
   $R_g = 1k\Omega, R_f = 4k\Omega$, R_{in} is calculated as the equivalent resistance of R_f and R_g combined in parallel:

$$R_{in} = \frac{R_f \cdot R_g}{R_f + R_g} = \frac{4k \cdot 1k}{4k + 1k} = \frac{4 \times 10^6}{5 \times 10^3} = \boxed{800\Omega}$$

2. What resistor values should be used for the voltage divider to get $5V$ provided to the sensor if a $12V$ supply is used?
   Use $\boxed{R_1 = 1k\Omega}$ and a potentiometer for R_2. Set the resistance of R_2 to:

$$R_2 = \frac{R_1 V_{out}}{V_{in} - V_{out}} = \frac{1k \cdot 5}{12 - 5} = \frac{5}{7} \times 10^3 \approx \boxed{714\Omega}$$

3. Calculate the resistor values to set the gain of the amplifier at 10 for the same range of temperatures.
   Use $\boxed{R_g = 1k\Omega}$ and a potentiometer for R_f. Set the resistance of R_f to:

$$G = (1 + \frac{R_f}{R_g})$$

$$R_f = (G - 1) \cdot R_g = (10 - 1) \cdot 1k = \boxed{9k\Omega}$$

4. What gain should you use if you want the output of the amplifier to be $0.4V$ when measuring a temperature of $10°F$? When using this gain, what range of temperatures can be measured if your microcontroller can only read voltages between $400mV$ and $5V$?
   The temperature sensor output voltage is $10mV/°F$, so $10°F$ would output $100mV$=$0.1V$. For the output to be $0.4V$, the sensor reading needs to be amplified by a factor of:

$$G = \frac{V_{out}}{V_{in}} = \frac{0.4V}{0.1V} = \boxed{4}$$

   The temperature range can be calculated by converting the voltage limits to temperature values by dividing the amplified sensor voltage output ($40mV/°F$):

$$T_{min} = \frac{400mV}{40mV/°F} = 10°F$$

$$T_{max} = \frac{5000mV}{40mV/°F} = 125°F$$

   The temperature range that can be measured would be $\boxed{10°F \text{ to } 125°F}$