



You are using the thermistor from lecture to measure temperature. You decide to use the circuit shown in Figure 1 and the ADC on the ESP32 to register the temperature. **Note that we've interchanged the position of the fixed resistor and thermistor from the discussion in class.** This will make the calculations a little easier, but you'll have to re-think the formulas!

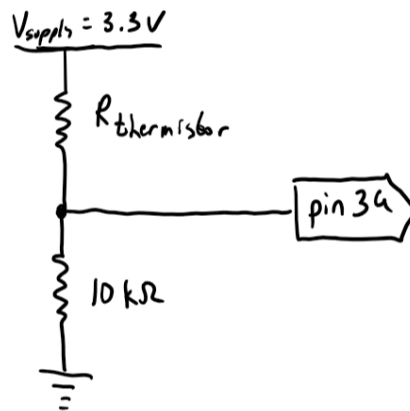


Figure 1: Schematic for temperature sensor circuit.

From the datasheet¹, the resistance of the thermistor can be approximated as,

$$R = R_0 e^{-B\left(\frac{1}{T_0} - \frac{1}{T}\right)} \quad (1)$$

where $B = 4300\text{K}$ is a constant specified by the manufacturer, and $R_0 = 10\text{k}\Omega$ is the resistance measured at $T_0 = 25\text{C}$. Note that the temperatures in Eq. 1 **need to be in Kelvin**, so you'll have to convert to and from Celsius.

The ESP32 has a 12-bit ADC and uses $V_{ref} = 3.3\text{V}$.

1. Calculate the output voltage of the voltage divider if the temperature is:

(a) 25 C

(b) 30 C

¹Oddly, I can't find the datasheet online anymore, so I'll spare you from having to look it up.

- (c) 33 C
2. Calculate the ADC result for the same temperatures:
- (a) 25 C
 - (b) 30 C
 - (c) 33 C
3. If the ADC returns a value of 2188, what are the minimum and maximum voltages that could return this value (ignoring noise and other imperfections).
4. What temperatures do these voltages correspond to?

We'll call the difference between the highest and lowest temperatures in that range the *resolution* of the system – it's the amount that the temperature needs to change to make the ADC result change by one number, or bit.

5. What would happen to the resolution if you used a 10-bit ADC instead of the 12-bit ADC above?
6. What would happen to the resolution if you used 5V instead of 3.3V for *both* the voltage divider supply and the ADC reference voltages?