Introduction to Sensors, Measurement and Instrumentation

Lab 2: Monitoring Temperature - Thermistor

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Graph of the cooling of water

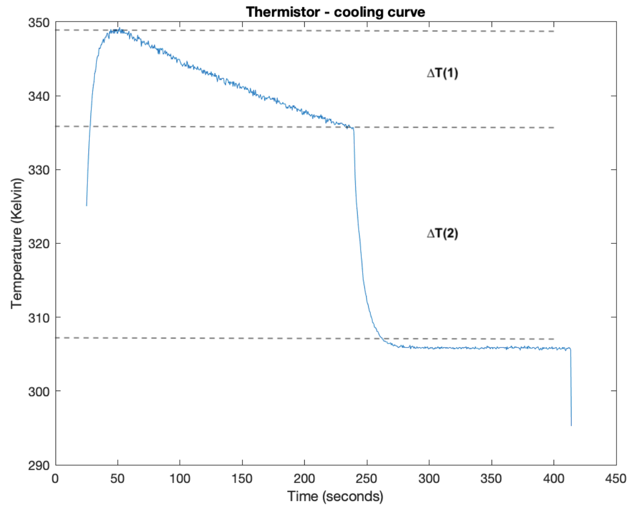

Figure 1: Thermistor - cooling of water (Temperature(K) vs Time(s)) - A thermistor was used with a 1000Ω resistor in a voltage divider circuit with 5 V DC input to design a temperature-sensing circuit. $\Delta T(1)$ and $\Delta T(2)$ represent the temperature difference obtained from the cooling of water in the experiment for boiling H_2O and the Same water + 20mL ice, respectively.

Analysis of $\Delta T(1)$ and $\Delta T(2)$

When 60mL boiling H_2O reaches the peak temperature (around 350K), it starts cooling constantly until it reaches 250 seconds and a temperature of 335K in the simulation and this temperature difference is represented by $\Delta T(1)$.

At 250 seconds, 20 mL ice H_2O is added to this solution. We observe a sharp drop in the temperature difference of around 30K in a short period of time (approximately 20 seconds), and it is represented by $\Delta T(2)$.

The difference in the cooling temperature behavior between $\Delta T(1)$ and $\Delta T(2)$ observed is due to the fact that boiling H_2O cools constantly in the experiment, whereas the addition of ice results in a steep drop in temperature instantly.

Circuit Diagram

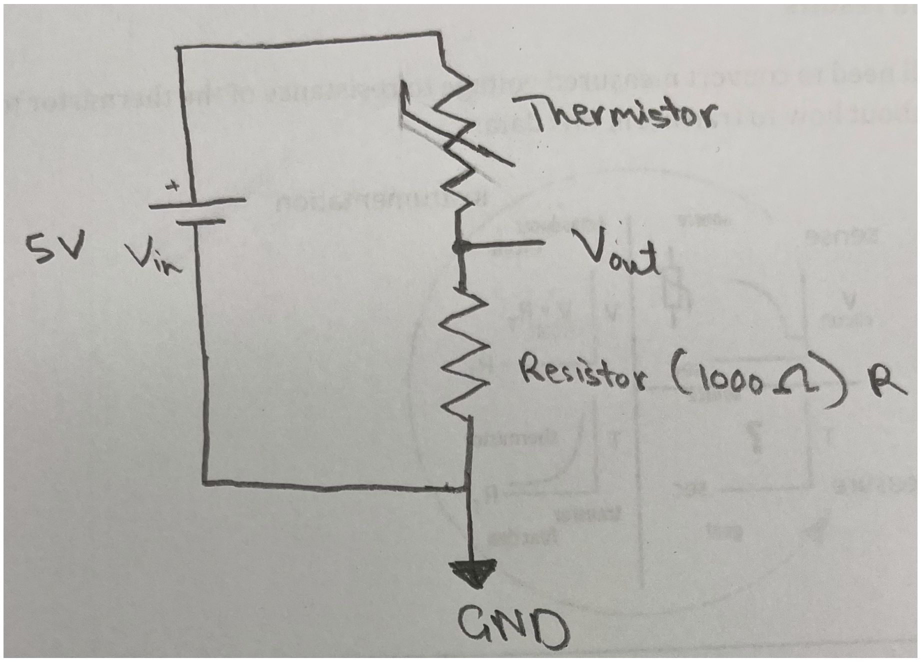

Figure 2: The circuit diagram represents a variable-resistor (thermistor) circuit with a 1000Ω resistor using the voltage-divider concept.

Implementation of cooling curve

```
clear; % clears memory - useful if you run many scripts in the same session
clf;

%take in data from csv file
tname='Lab2thermistor.csv'; % <-input your data file's name! test2.csv was exported from O-scope software with a line of headers
datatable  = readtable(tname);%makes data table with headers

%interpret data as times and voltages
time1  = datatable.t1; % stores the t1 column of data in a variable called time1
time1 = time1 + 400;
V1    = datatable.ch1; % stores the ch1 column of data in a variable called V1
time2    = datatable.t2; %stores the t2 column of data in a variable called time2
V2 = datatable.ch2; %stores the ch2 column of data in a variable called V2

```

```
R = (5000 - (1000.*V1))./V1;
a = log(R/1000);
b = a + (3528/298);
T = 3528./b;

%plot (you can change this section to suit your plotting needs!)
plot(time1(1:779),T(1:779)) %plots first channel
xlabel('Time (seconds)'); % add x axis label
ylabel('Temperature (Kelvin)'); % add y axis label
title('Thermistor - cooling curve');
```

Resistor Choice Explanation

We know that, $V_{out} = V_{in}(\frac{R}{R+R_T})$

In our experimental setup, $V_{in} = 5V$ and the resistance of the thermistor, $R_T = 1000\Omega$ at room temperature (298K). Therefore, choosing a resistor, $R = 1000\Omega$, gives a voltage-divider circuit with $V_{out} = 2.5$, ideally. This gives the ideal combination to optimize the measurement sensitivity and range desired for this experiment.

The Effect of Resistor Value

The choice of Resistor $R = 1000\Omega$ determines whether the instrument is sensitive enough to measure the temperature in the range of interest which lies in between $V_{out} = 2.5V$ to $V_{in} = 5V$.

The transfer function equation of the thermistor, $R = 1000\Omega * e^{-3528(\frac{1}{298}-\frac{1}{T})}$ gives the relationship between resistance and temperature of the thermistor. The temperature change in the experiment affects the amount of resistance offered by the thermistor, which as a result, affects the output voltage in the circuit. So, the optimal value of $R = 1000\Omega$ enables this variation in voltage due to the thermistor being measured in the desired range.