Name ______________________

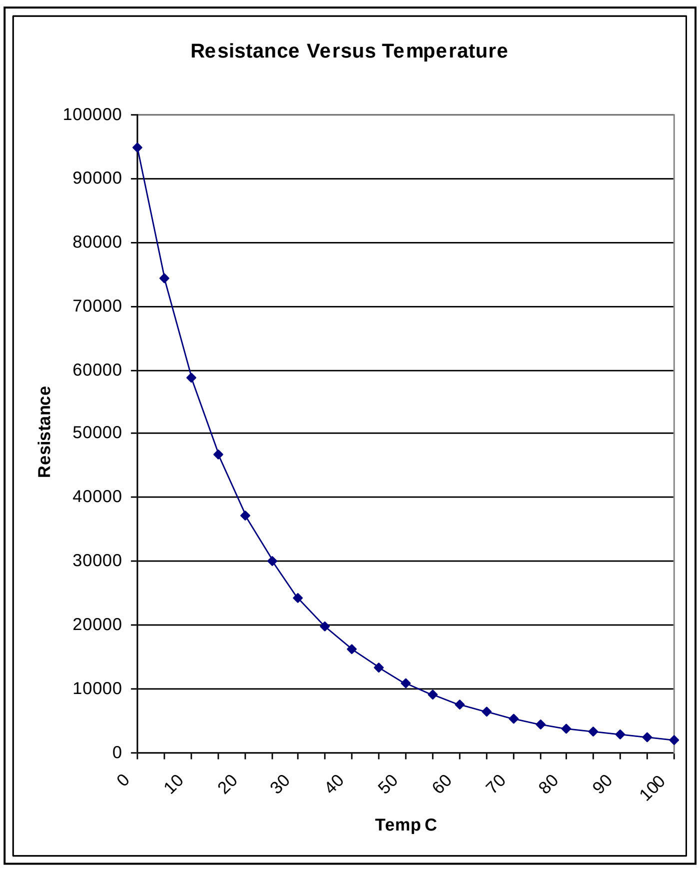
Lab Section ______________________

Sensors and Sensor Interfacing - Lab 1

Measuring Temperature with a Thermistor

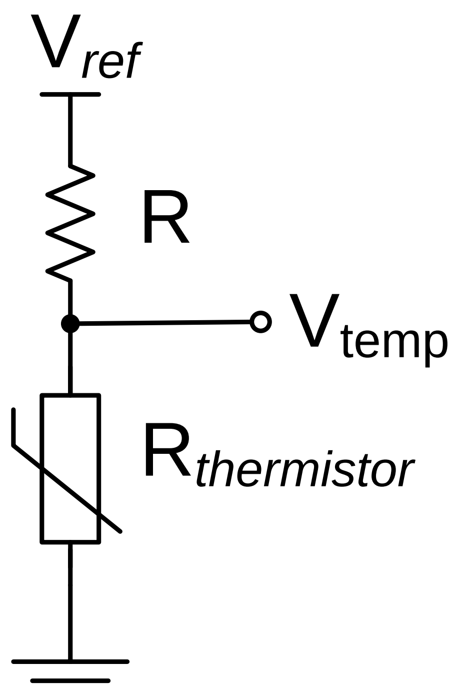
The thermistor is a common electrical component used for measuring temperature. A thermistor is essentially just a temperature sensitive resistor. Most thermistors have a negative temperature coefficient (NTC), meaning the resistance of the thermistor decreases as temperature rises. One problem often encountered when using thermistors for measuring temperature is that their temperature/resistance curve is not linear (as shown in the graph below).

Resistance Versus Temperature	
Temperature C	Resistance Ω
0	94980
5	74440
10	58750
15	46670
20	37300
25	30000
30	24270
35	19740
40	16150
45	13280
50	10970
55	9109
60	7599
65	6367
70	5359
75	4529
80	3843
85	3273
90	2799
95	2402
100	2069



The non-linearity of the thermistor is generally not a problem when it is integrated into a digital system where a look-up table can be used to properly convert the measurements.

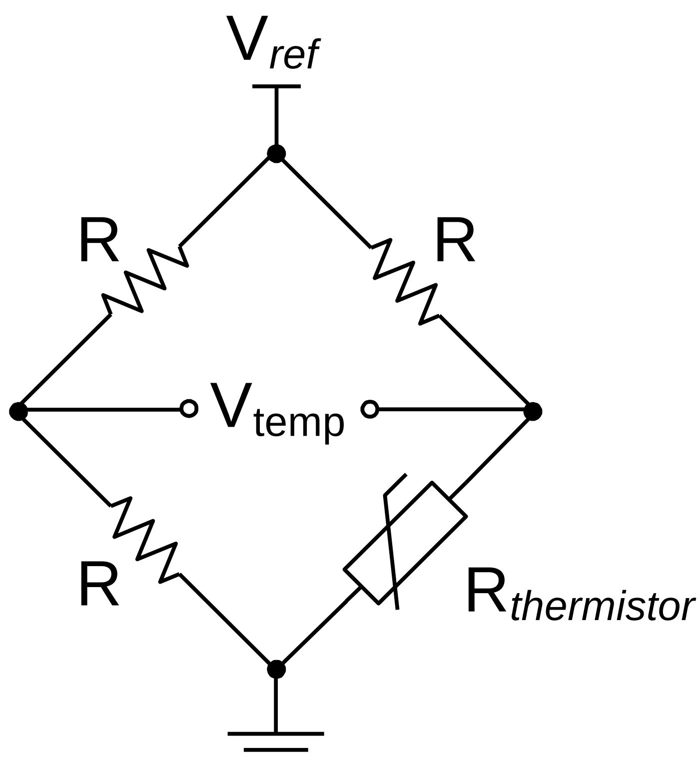
A simple way to convert a changing temperature into a changing voltage with a thermistor is to place it in series with a fixed value resistor creating a voltage divider. By placing a stable DC voltage across the pair, the varying thermistor resistance will result in a varying DC voltage at the junction of the two parts.



The voltage at the node V_{temp} represents current temperature as determined by the following voltage divider equation:

$$V_{temp} = V_{ref}\left(\frac{R_{Thermistor}}{R + R_{Thermistor}}\right)$$

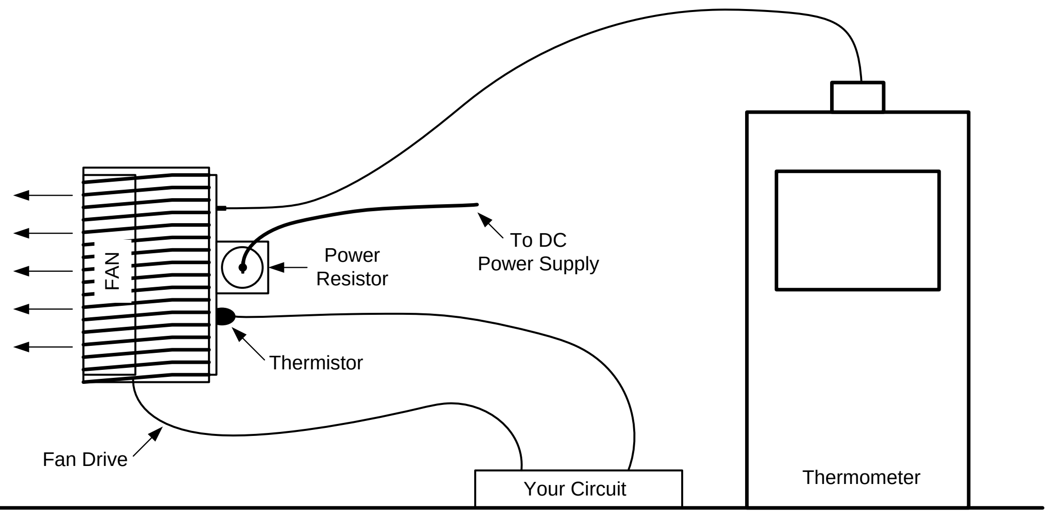
Wheatstone bridge:
Sometimes, the simple ground referenced voltage divider will not meet the performance requirements needed when converting a resistance to a voltage. A more precise method for converting a resistance in to a voltage can be achieved by using a Wheatstone bridge topology.



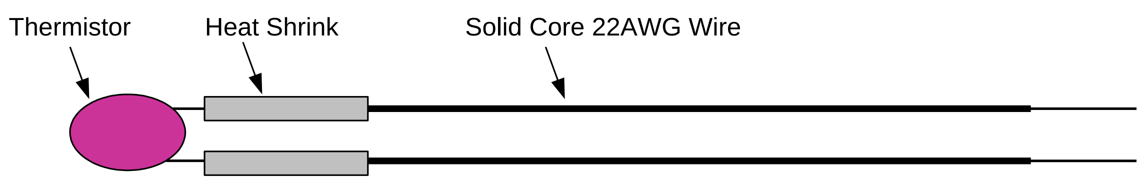
The output of the single element varying Wheatstone bridge can be computed with the following equation:

$$V_{temp} = V_{ref}\left(\frac{1}{2} - \frac{R_{Thermistor}}{R + R_{Thermistor}}\right)$$

Preparing the thermistor for the Lab:
In the following experiments the thermistor will be mounted to the heat sink away from the rest of the electrical circuits. To make this possible you will need to add a length of wire to the thermistor.



Use the long green 22 AWG solid core wire from the Jameco Wire Jumper Kits in the lab. Straighten the leads on both ends of the jumper wire. Solder a wire to each lead of the thermistor. To insulate the connection cover the solder joint with heat shrink tubing.



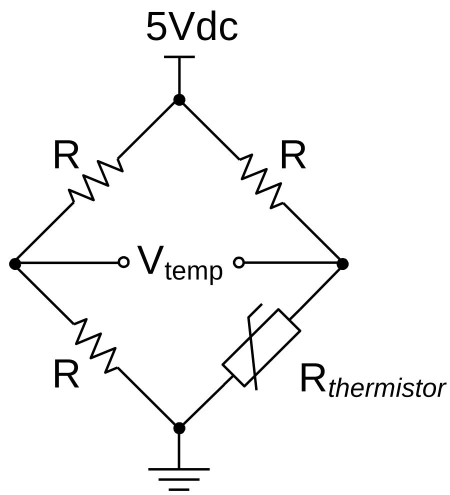
A demonstration will be given in the lab.

Making Measurements:

Now you will measure the resistance of the thermistor as a function of temperature. Use the Fluke 50s digital thermometer to make the temperature measurements. The first measurement will be at room temperature which is approximately 72° F. Take resistance measurements as a function of temperature by applying heat to your thermistor. Align the digital thermometer's thermal couple close to the thermistor for best results. Use the heat source provided in the lab to raise the temperature of the thermistor and take resistance measurements to complete the table below.

Thermistor Temperature vs. Resistance	
Temperature	Resistance
Room Temp. ________° F	_________Ω
80° F	_________Ω
85° F	_________Ω
90° F	_________Ω
95° F	_________Ω
100° F	_________Ω
105° F	_________Ω
110° F	_________Ω
115° F	_________Ω
120° F	_________Ω
125° F	_________Ω
130° F	_________Ω

Now build a circuit using the thermistor in a Wheatstone bridge topology. Use resistor values for the Wheatstone bridge that are approximately twice the "room temperature" value of your thermistor. Make sure the three resistors are matched in value within 1%. Use a V_{ref} of 5Vdc to power your circuit. Complete the table below:



Thermistor Temperature vs. Voltage	
Temperature	Voltage
Room Temp. ________° F	________mV
80° F	________mV
85° F	________mV
90° F	________mV
95° F	________mV
100° F	________mV
105° F	________mV
110° F	________mV
115° F	________mV
120° F	________mV
125° F	________mV
130° F	________mV