Lecture 3: Thermistor

0. Review

1. Thermistor

2. Signal Conditioning + Processing

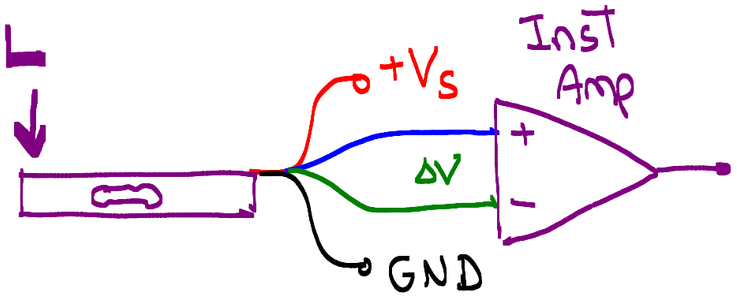
3. Temperature Sensitivity

- Hw1 due Thu (Jan 16) Hw1 material
  Quiz next Tue (Jan 21)
- PreLab 1 due at lab session

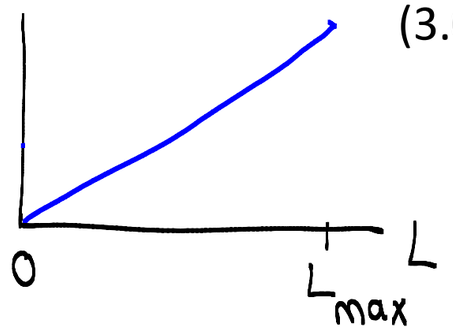
- Reading: Thermistor tutorial (pdf)
- PreLab 2 due next lab session

0. Review

① Load cells:



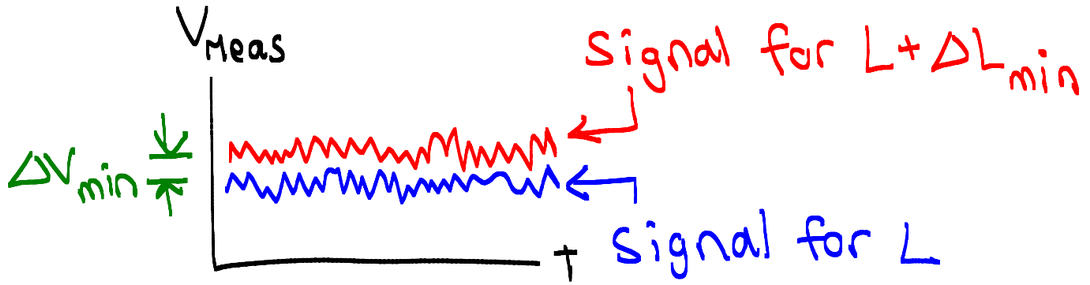
$$V_{MEAS} = A_1 \cdot V_S \cdot RO \cdot \frac{L}{L_{Rated}}$$ (ΔV)



(3.0)

② Sensitivity: $\Delta L_{MIN} = \frac{\Delta V_{MIN}}{\partial V_{MEAS}/\partial L}$

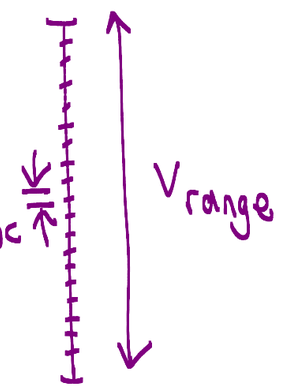
← Larger { $V_{n,rms}$, ΔV_{ADC}



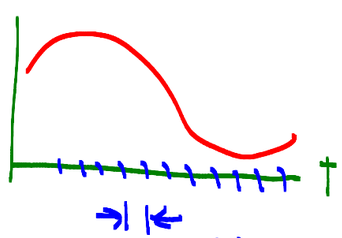
③ Analog-to-Digital Conversion

Vertical Resolution:

$\frac{V_{range}}{2^n - 1} = \Delta V_{ADC}$, V_{range}



Sampling Interval:



$\Delta t = 1/f_s$

1. Thermistor

A. Temperature Intro

Q: Why measure temperature?

① In medicine, external body temperature is an important indicator of health

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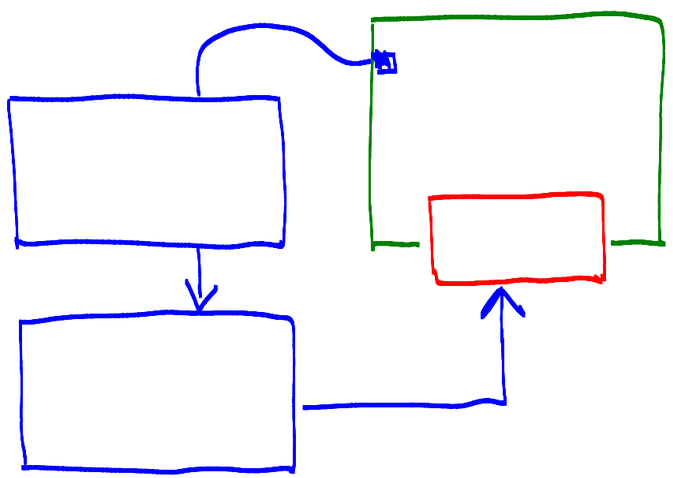
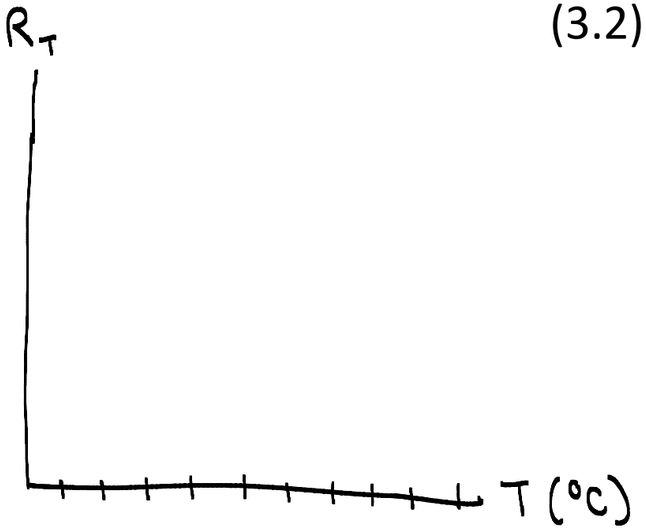
② Many biomedical experiments require temperature control



B. Thermistor Basics

(3.2)



- Similar concept to strain gauge, except:

① R_T

② R_T

③ R_T

④ Material

Ex:

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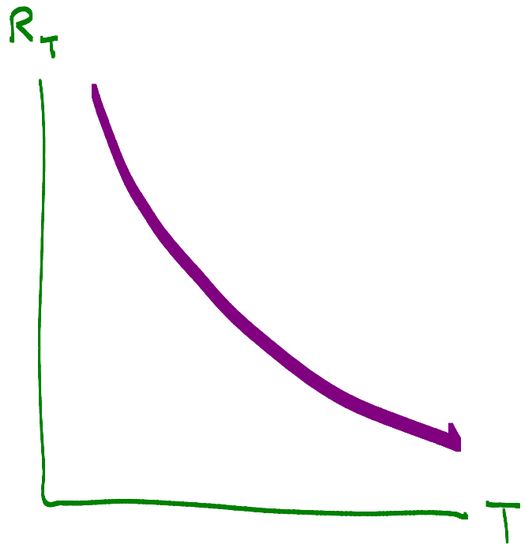
C. Negative Temp Coefficient (NTC)



Slope =

Ex: 10K thermistor

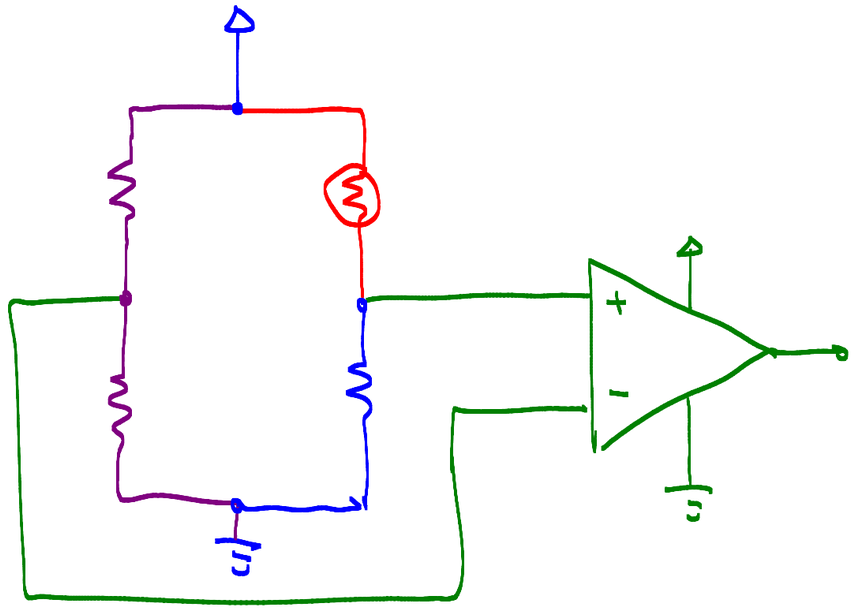
T	R_T	$\propto$	Slope $= \propto R_T$
10°C			
40°C			

2. Signal conditioning + processing

A. Signal Conditioning

use a _____ _____.

V_{MEAS} =



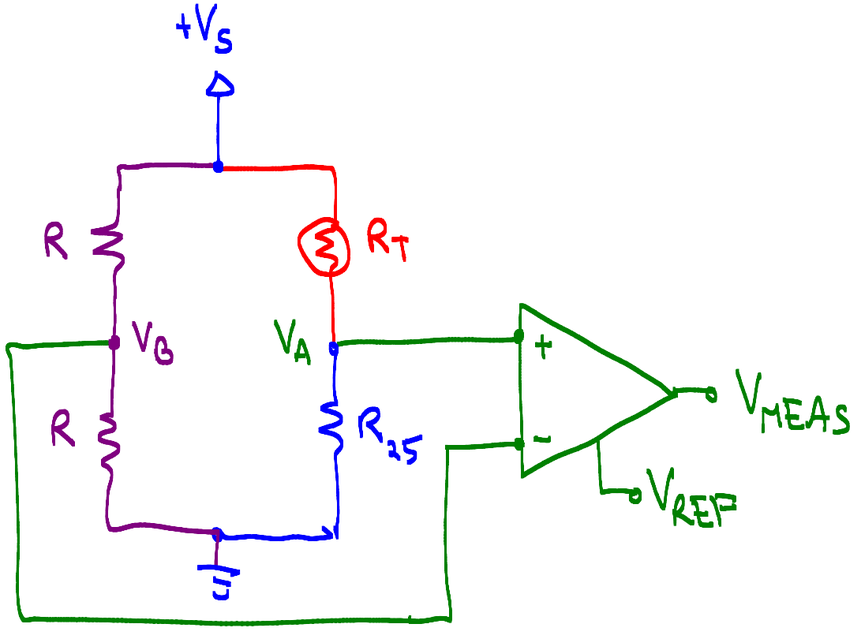
- As temp ↑,
- As temp ↓,

What is the measured signal?

Ex: Left side of bridge has R

Right side has R_{25}

V_{MEAS} =



Ex: $R_{25} = 10K$ $R_T = 18K$ $V_s = 5V$

$A_d = 3$ $V_{REF} = 2.5V$

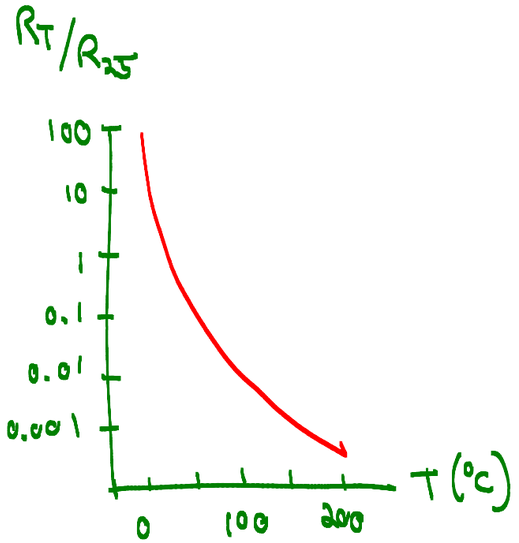
V_{MEAS} =

(3.6)

B. Signal Processing

Q: How to convert V_{MEAS} to a temperature value?

Step 1 :



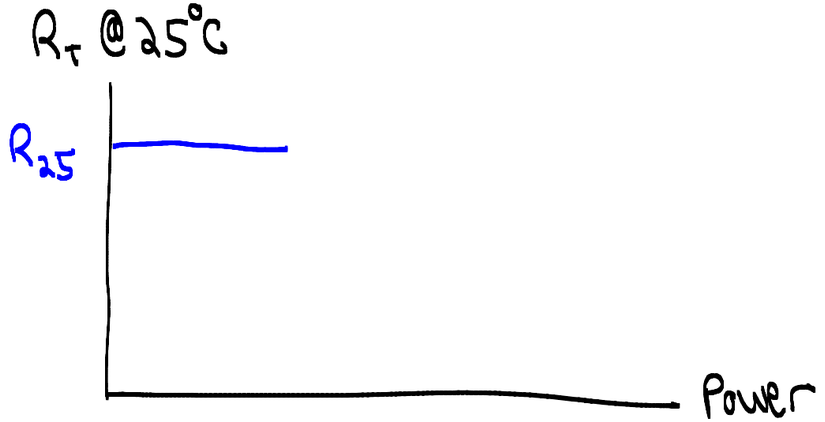
Step 2 :

C. Self-Heating

At $T = 25°C$, $R_T = R_{25}$ (e.g. 10K).

However, R_T dissipates power.

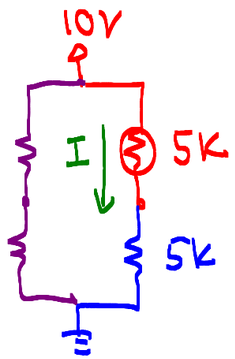
Q: How to compute self-heating?



Ex: $\delta = 5\ mW/°C$

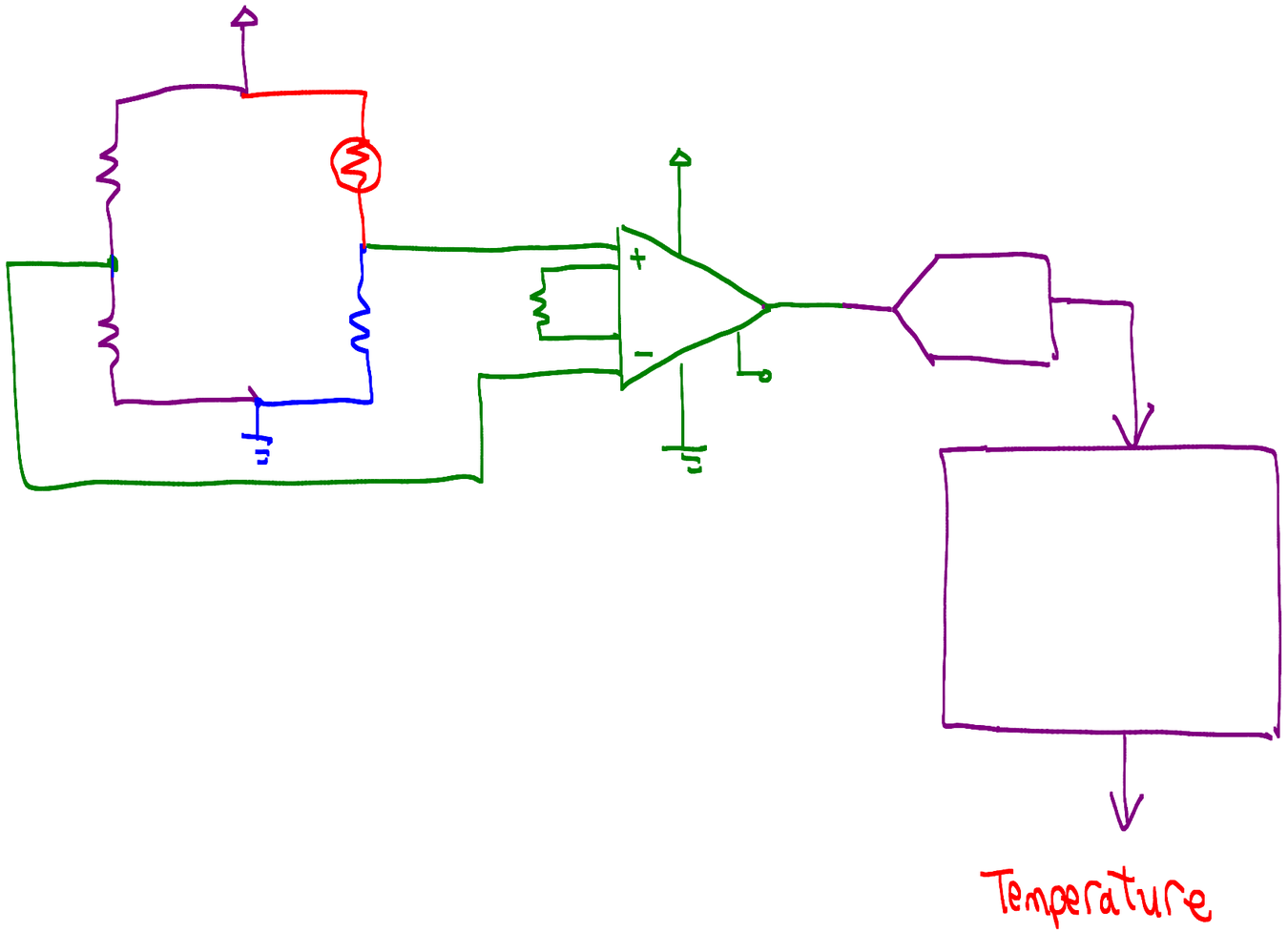
$R_T = R = 5K$

$V_s = 10V$



D. Overall System

- Signal conditioning is similar to strain gauge.

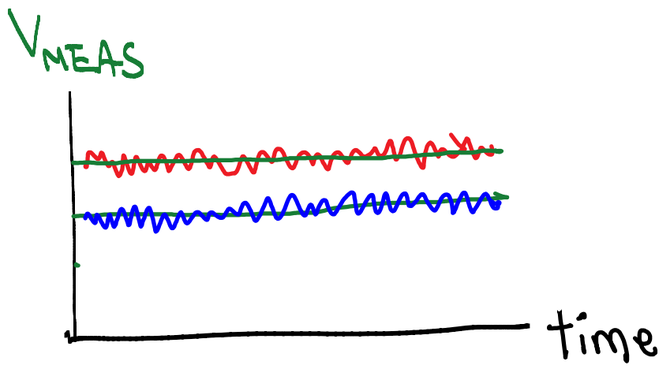


- Processing must convert

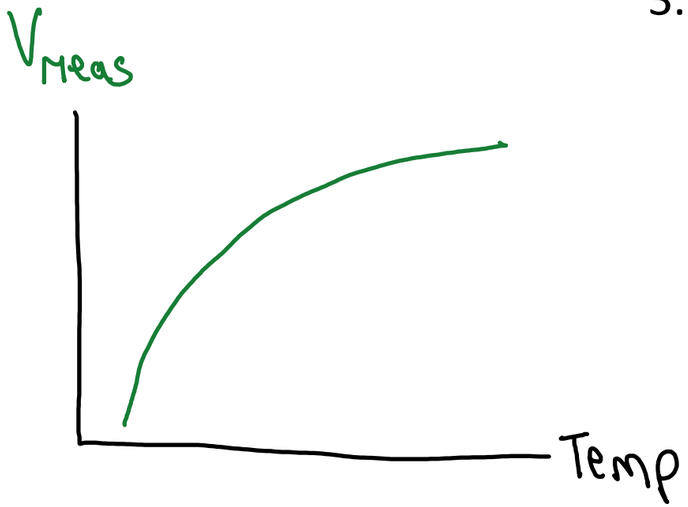
- Sensitivity

3. Temperature Sensitivity

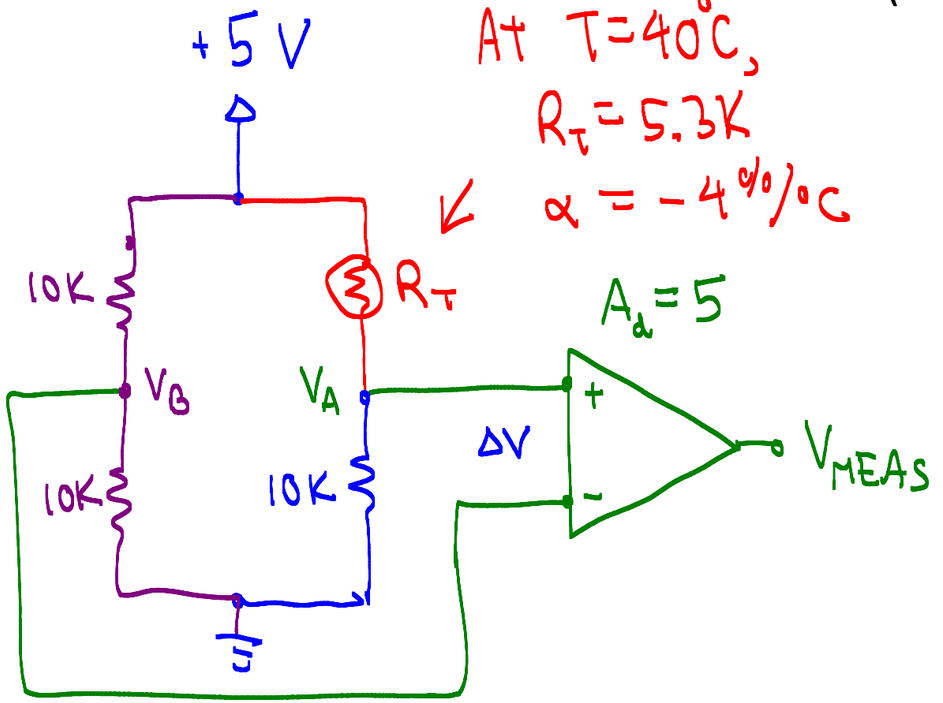
ΔT_{MIN} =



ΔV_{Meas} =



- Example: If $\Delta V_{MIN} = 10\,mV$, what is ΔT_{MIN}?



① Need

② use

So, $\frac{\partial V_{MEAS}}{\partial T} =$

③ Finally, $\Delta T_{MIN} = \frac{\Delta V_{MIN}}{\frac{\partial V_{MEAS}}{\partial T}} =$

NOTE: Suppose at $T = 25^{\circ}C \Rightarrow R_T = 10K$ and $\alpha = -4.3\%$

$\Rightarrow \frac{\partial V_{MEAS}}{\partial T} =$

$\Rightarrow \Delta T_{MIN} =$