Today, we will:

- Review the pdf module: **Temperature Measurement**
- Do some example problems – temperature measurement

Example: Thermocouples

Given: A type S thermocouple is placed into an oven to measure the temperature. An ice bath is used as a reference junction in the normal fashion. The output voltage is 4.005 mV.

(*a*) To do: Calculate the temperature of the oven.

(*b*) To do: If ambient air ($T_{ambient} = 20^{o}C$) were used as the reference junction instead of the ice bath, what voltage would the thermocouple instrument read?

Solution:

Example: Thermocouples

Given: A type K thermocouple is used to measure the temperature in a freezer compartment. The reference junction is connected properly to an ice bath, and the voltage output from the thermocouple circuit is –2.721 mV.

To do: Calculate the temperature in the freezer compartment. *Give your answer in units of ^{o}C to three significant digits*. *Note*: Use the "brief" thermocouple tables for consistency (provided below for convenience).

Thermocouple Voltage Data – Table 9.2 of Wheeler, A. J. and Ganji, A. R., *Introduction to Engineering Experimentation*, Ed. 2, Pearson Education Inc. (Prentice Hall), Upper Saddle River, NJ, 2004.

TABLE 9.2 Millivolt Output of Common Thermocouples (Reference Junction at 0°C)

	Thermocouple type					
Temperature (°C)	T	E	J	K	R	S
−250	−6.181	−9.719		−6.404		
−200	−5.603	−8.824	−7.890	−5.891		
−150	−4.648	−7.279	−6.499	−4.912		
−100	−3.378	−5.237	−4.632	−3.553		
−50	−1.819	−2.787	−2.431	−1.889		
0	0.000	0.000	0.000	0.000	0.000	0.000
20	0.789	1.192	1.019	0.798	0.111	0.113
40	1.611	2.419	2.058	1.611	0.232	0.235
60	2.467	3.683	3.115	2.436	0.363	0.365
80	3.357	4.983	4.186	3.266	0.501	0.502
100	4.277	6.317	5.268	4.095	0.647	0.645
120	5.227	7.683	6.359	4.919	0.800	0.795
140	6.204	9.078	7.457	5.733	0.959	0.950
160	7.207	10.501	8.560	6.539	1.124	1.109
180	8.235	11.949	9.667	7.338	1.294	1.273

Solution:

Example: Thermocouples

Given: A type K thermocouple is used to measure three temperatures: $T_1 = 60.0^oC$, $T_2 = -50.0^oC$, and $T_3 = 180.0^oC$. The thermocouple voltages are measured properly with an ice bath reference at 0.00^oC.

(*a*) To do: Determine the voltage readings $V_{1\text{-}R}$, $V_{2\text{-}R}$, and $V_{3\text{-}R}$, for the three temperatures.

(*b*) To do: Using the voltages of Part (a), verify the law of intermediate temperatures.

Solution: