MA 573
Mathematical and Experimental Modeling of Physical Processes I

Thermal Experiment Project Due Date: November 26, 2007

Thermocouple output voltages are highly nonlinear. The Seebeck coefficient, or voltage change per degree of temperature change, can vary by a factor of three or more over the operating temperature range of some thermocouples. For this reason, the temperature from thermocouple voltage readings must be approximated by polynomials. The polynomials, which can be used to change the voltage readings in microvolts to degrees Celsius and vice versa, are given in Tables 1 and 2. The thermocouple used in this experiment is of type T, which has a fast response time, is one of the oldest and most popular thermocouple for determining temperatures within the range from about 370 °C down to the triple point of neon (-248.5939 °C). Its positive thermoelement, TP, is typically copper of high electrical conductivity and low oxygen content (99.95% pure copper with an oxygen content varying from 0.02 to 0.07% - depending on sulfur content - and with other impurities totaling about 0.01%).

To compensate for the temperature difference between the measuring end and the cold junction (AMUX-64T multiplexer screw terminal), the following procedure can be used.

(i) Translate the ambient temperature into the corresponding voltage using the polynomial in Table 2.

(ii) Add the voltages from thermocouples readings to the voltage from step (i).

(iii) Translate the voltage results from step (ii) into the temperatures using the polynomial from Table 1.

Temperature range:	0 ^{o}C to 400 ^{o}C
Voltage range:	$0\mu V$ to $20872\mu V$
$c_0 =$	0.000000
$c_1 =$	2.592800×10^{-2}
$c_2 =$	-7.602961×10^{-7}
$c_3 =$	4.637791×10^{-11}
$c_4 =$	$-2.165394 \times 10^{-15}$
$c_5 =$	6.048144×10^{-20}
$c_6 =$	$-7.293422 \times 10^{-25}$
Error range:	0.03 ^{o}C to -0.03^{o}C

Table 1: **Type T Thermocouples** – Coefficients of the approximate inverse function giving temperature, u, as a function of the thermoelectric voltage, E, in the specified temperature and voltage ranges. The function is of the form $u = c_0 + c_1E + c_2E^2 + \cdots + c_iE^i$ where E is in microvolts and u is in degrees Celsius.

Temperature range:	0 ^{o}C to 400 ^{o}C
c_0 =	0.000000
c_1 =	$3.8748106364 \times 10^{1}$
c_2 =	$3.3292227880 \times 10^{-2}$
c_3 =	$2.0618243404 \times 10^{-4}$
c_4 =	$-2.1882256846 \times 10^{-6}$
c_5 =	$1.0996880928 \times 10^{-8}$
c_6 =	$-3.0815758772 \times 10^{-11}$
c_7 =	$4.5479135290 \times 10^{-14}$
c_8 =	$-2.7512901673 \times 10^{-17}$

Table 2: **Type T Thermocouples** – Coefficients of the approximate function giving the thermoelectric voltage, E, as a function of temperature, u, in the specified temperature range. The function is of the form $E = c_0 + c_1 u + c_2 u^2 + \cdots + c_i u^i$ where E is in microvolts and u is in degrees Celsius.