ME 121 Homework 3

Group Assignment

1. Write a MATLAB code (or adapt one of the examples from class) to plot a histogram of a salinity calibration measurements. Print the number of data points, mean, standard deviation and median of each set of measurements. Summarize the calibration data in a table that looks like this:

Wt% NaCl	n	Mean	Standard deviation	Median
0				
0.05				
0.10				
0.15				

where n is the total number of readings for each calibration set. In addition to this tabular data, create a histogram of the raw readings. For each data set, include the histogram of the raw readings created with your MATLAB code. Include a copy of your MATLAB code and the histogram plot for each data set.

Individual Assignment

2. Use MATLAB and the table below to complete the following steps[1]. Do not use Excel or hand calculations, except to check your work. Turn in a brief description of the results, the plots and your MATLAB code. Note that a single MATLAB function can produce the entire solution to this problem.

Salinity (ppm)	500	600	700	800	1000	1200	1400	1700	2000
Resistivity at 20 °C (Ω m)	11.2	9.5	8	7.1	5.6	4.8	4.2	3.4	2.9
Resistivity at 30 °C (Ω m)	9.0	7.5	6.5	5.6	4.6	3.8	3.3	2.8	2.4

   a. Convert the salinity data (top row) to weight percent NaCl, assuming that the only source of salinity is NaCl. Plot the two curves for resistivity as a function of salinity (wt % NaCl) on a single set of axes: salinity on the horizontal axis and resistivity on the vertical axis.

[1] Data from Log Interpretation Charts – 2009 Edition, Schlumberger, 2009, p. 8. Resistivity at 500 ppm and 20 °C estimated by extrapolation.

b. Convert the two sets of resistivity values to resistance by assuming that the water between the electrodes behaves like a solid material for which the relationship between resistivity and resistance is

$$R = \frac{\rho L}{A}$$

where ρ is the resistivity, L is the length of the conductor and A is the cross section of the conductor. The resistance values you calculate are a prediction of the resistance in your salinity sensor as a function of salinity. The resistance as a function of salinity data is used for the next step. (Hint: R = 2847Ω at 800 ppm and 20 °C, but that value depends on what you have assumed for L and A.)

c. Use the `powfit` function (available on the dokuwiki web site) to make a curve fit to each of the two resistance versus salinity data sets. In other words, create one fit for resistance versus salinity (wt %) at 20 °C, and another fit for resistance as a function of salinity at 30 °C. Create a plot that shows the two original data sets using only symbols (do not connect the points with lines) and the curve fits as lines. The curve fits should be evaluated at many points on the interval between minimum and maximum salinity. (Hint: the solution is shown below. Again, the numerical values will depend on what you have assumed for L and A.)

d. Assume that the salinity sensor is used in a voltage divider having a fixed 10 kΩ resistor. Using the curve fits to resistance versus salinity, compute the analog output reading as a function of salinity (in wt % NaCl) for both temperature data sets. Plot the analog input reading versus salinity for both temperature curves on the same axes. As with part (c), the data you plot should have many points since it is generated from the curve fit, not the raw data in the table. (Hint: The analog input value is 796 at 800 ppm and 20 °C, which depends on what you have assumed for L and A. The shape of the final plot is show below.)

Hint: The following plots show the variation of resistance and analog output versus salinity for the data given in this problem. The magnitudes on the vertical axis will depend on the values of L and A you use.