ChE 272 Introduction to Chemical Engineering Calculations University of Rhode Island
Professor Greenfield Spring 2007

Homework 1
due January 30, 2007

If you find yourself without enough information, make and justify a reasonable approximation. Please answer all parts of a question! (This is good practice for an exam setting.)

1. Chapra and Canale, problem 1.2
2. Chapra and Canale, problem 3.5
3. Chapra and Canale, problem 3.7. I know that you can do the calculation precisely without the "chopping" concept, but the point is to see the effect of chopping off the result. Be sure to show your work.
4. Download the two sets of time–temperature data from the course web page.
   (a) Plot these data using a computer program of your choice. Put both data sets on the same axes, i.e. make just one plot. (Also notice that the word "data" is plural, as in "data are . . . ," rather than singular.) Indicate in your answer which software program you used.
   (b) Given such data sets, a good way to estimate the uncertainty is by the variance σ^2 and standard deviation σ, which for large numbers of samples are defined by

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2$$

   where N is the number of samples and $\overline{x}$ is the average,

$$\overline{x} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

   Calculate the standard deviation for each data set. Then estimate the average **difference** in temperature between the two data sets and the uncertainty in this estimate.
5. You will learn in a thermodynamics class that the liquid-phase side of Raoult's Law is often written as $x_i\gamma_i P_i^{sat}$, where the *activity coefficient* γ_i corrects for deviations from ideal solution behavior. In some cases the activity coefficient is expressed mathematically as

$$\ln\gamma = (a_0 - a_1/T)\left(1 + (c_0 + c_1/T)\frac{x_i}{1 - x_i}\right)$$

   where a_0, a_1, c_0, and c_1 are constants, T is absolute temperature, and x_i is mole fraction. For such a case, derive an expression for the uncertainty in the vapor pressure $y_i P$ as a function of the uncertainty in the mole fraction and temperature, assuming that the vapor pressure is calculated using an Antoine equation. Assume that the uncertainties in the Antoine equation parameters and the $\ln\gamma$ parameteres are negligible.