Exam III
Take Home Exam
Assigned: Friday, November 12, 1999
Due: Monday, November 15, 1999 BEGINNING OF CLASS

This exam is to be completed on an individual basis. Any work discovered to have been done in conjunction with other people, regardless of whether they are currently in ChE 301 or not, will fail the entire exam.

Problem (1)

Consider the set of 3 nonlinear algebraic equations (that happen to describe the steady-state operation of a 1-1 heat exchanger with counter current flow).
Energy balance on the shell side fluid:

$$q = \dot{m}_{shell} C_{p,shell} \left| T_{out,shell} - T_{in,shell} \right|$$

Energy balance on the tube side fluid:

$$q = \dot{m}_{tube} C_{p,tube} \left| T_{out,tube} - T_{in,tubel} \right|$$

Energy balance for heat transfer:

$$q = UA \frac{\left(T_{shell,in} - T_{tube,out}\right) - \left(T_{shell,out} - T_{tube,in}\right)}{\ln\left(\frac{T_{shell,in} - T_{tube,out}}{T_{shell,out} - T_{tube,in}}\right)}$$

We are given the mass flow rates: $\dot{m}_{shell} = 20\frac{kg}{s}$, $\dot{m}_{tube} = 10\frac{kg}{s}$

We are given the heat capacities: $C_{p,shell} = 5600\frac{J}{kg \cdot K}$, $C_{p,tube} = 4200\frac{J}{kg \cdot K}$

We are given the inlet temperatures: $T_{shell,in} = 500K$, $T_{tube,in} = 200K$

We are given the overall heat transfer coefficient: $U = 1000\frac{J}{m^2 \cdot K}$

We are given the heat transfer area: $A = 10 \cdot Lm^2$ where L is the length of the heat exchanger in meters.

(a) If $L = 1$ meter, find the outlet temperatures, $T_{out,shell}$ and $T_{out,tube}$, and find the heat transferred, q.

(b) If $L = 2$ meters, find the outlet temperatures, $T_{out,shell}$ and $T_{out,tube}$, and find the heat transferred, q.

(c) Find the length, L, required to cool the shell fluid to 450 K ($T_{out,shell} = 450K$). What are the resulting values of $T_{out,tube}$ and q?

Problem 2.
Given the data file on the exam portion of the website, titled file.xm3_f99.dat, determine the coefficients of the best fit models of the form

$$y = b_0 + b_1 x + b_2 x^2$$

and

$$y = b_0 + b_1 x + b_2 x^2 + b_3 x^3$$

Clearly label which coefficients are which. Report standard deviations for each parameter. Report measures of fit for both models. Which model would you recommend using for the data? Explain.

Problem 3.

Provide a solution to

$$\underline{\underline{A}}\,\underline{x} = \underline{b}$$

where

$$\underline{\underline{A}} = \begin{bmatrix} 1 & 1 & 2 & 1 \\ 1 & 2 & 2 & 1 \\ 3 & 5 & 6 & 3 \\ 1 & 3 & 2 & 1 \end{bmatrix} \text{ and } \underline{b} = \begin{bmatrix} 1 \\ 2 \\ 5 \\ 3 \end{bmatrix}$$