# Spring 2009 ENCH250 Homework Assignment List

Raymond A. Adomaitis
Department of Chemical and Biomolecular Engineering
and Institute for Systems Research
University of Maryland
College Park, MD 20742

## HW 1 - due 2/6/09

1. Read Chapter 1
2. Start a MATLAB session; determine if MATLAB's built-in `log` function corresponds to the natural or base 10 logarithm by computing $\log(10)$.
3. Start ChemCAD; determine the outlet temperature of a stream that results from mixing 1 kg/hr of water at 10 degrees C with another stream of water with flowrate 2 kg/hr and temperature of $50^o$C.

## HW 2 - due 2/6/09

1. Chapter 1, problem 1
2. One day this week, look up the high and low temperatures recorded at 5 major cities in the United States. Arrange the temperature data and the city and state names in a MATLAB struct data type. Compute the mean values of both the high and low temperatures.
3. Create the following arrays

$$\mathbf{A} = \begin{bmatrix} 1 & 2 & 1 & 2 \\ 3 & 4 & 3 & 4 \\ 1 & 2 & 1 & 2 \\ 3 & 4 & 3 & 4 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1 & 2 & 1 & 2 \\ 3 & 4 & 3 & 4 \end{bmatrix}$$

   by first creating the array

$$\mathbf{C} = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$

   and then forming $\mathbf{A}$ and $\mathbf{B}$ from an array of $\mathbf{C}$ arrays in a tiling pattern.

## HW 3 - due 2/13/09

1. Chapter 1, problem 3
2. Chapter 3, problems 1, 2, 4 (use the \ operator, not `linearsystemsolver.m`)

3. A point on a circular wheel traces a curve called the cycloid as the wheel rolls in a straight line. The cycloid is defined with the parametric equation

$$\begin{aligned} x &= r(t - \sin t) \\ y &= r(1 - \cos t) \end{aligned}$$

Plot the cycloid for $r = 1.5$ and $0 \le t \le 8\pi$ by defining a finely spaced vector of points $\mathbf{t}$ and using that vector to compute vectors $\mathbf{x}$ and $\mathbf{y}$.

## HW 4 - due 2/20/09

1. Chapter 1, problems 4, 5
2. Chapter 3, problems 5, 7
3. Using the **:** operator, write a two-line MATLAB script to first extract the odd rows from matrix **A**; calling that result matrix **B**, then extract the even columns from **B** to form **C**; test your example with `A = round(10*rand(5))`.
4. The two-column matrix **february** has days listed in the first column, and the average temperature in the second. Using a **for** loop, check each temperature and write out those dates corresponding to below-zero temperatures. Test your result with `february = [1 -2; 2 3; 3 0; 5 -5; 6 10]`.

## HW 5 - due 3/6/09

1. (From the last HW assignment) The two-column matrix `february` has days listed in the first column, and the average temperature in the second. Using a `for` loop, check each temperature and write out those dates corresponding to below-zero temperatures. Test your result with `february = [1 -2; 2 3; 3 0; 5 -5; 6 10]`.
2. Look up the definition of the two sorting algorithms: *bubble sort* and *insertion sort*. Write two `MATLAB` functions that implement the two sorting routines. The input to each function must be a row or column vector, the two output variables are the sorted vector (in ascending order) and a vector of indices for the sorted array that indicate the original positions of the sorted elements in the input array. Test your functions with the row array `A=[ 4 2 -1 -1 0 10 3 2 8 7 6]`, printing the results of each iteration as the sorting algorithms proceed. Which algorithm requires fewer iterations?
3. Consider the following vapor-liquid equilibrium data

| $T(^oC)$ | 138 | 75 | 120 | 90 | 69 |
|---|---|---|---|---|---|
| $x_h$ | 0 | 0.79 | 0.11 | 0.40 | 1 |
| $y_h$ | 0 | 0.97 | 0.50 | 0.84 | 1 |

   (a) Using the the more efficient of the two sorting functions above, write a script to plot the mole fraction data $x_h$, $y_h$ as a function of temperature. Draw lines connecting the data points, and place the symbol 'o' at each data point.

(b) Create a function which takes as input a temperature between 69 and 138$^o$C, performs a linear interpolation to find the corresponding values of $x_h$ and $y_h$. Test your function for values T = 75, 80, 130, and 140$^o$C.

## HW 6 - due 3/13/09

1. Problems 3.8, 3.9 3.10, 4.1

## HW 7 - due 4/3/09

Fluid in a tubular heat exchanger at temperature $T$ is heated/cooled by a heat exchange fluid at temperature $T_x$; an energy balance on the fluid gives

$$mC_p\frac{dT}{dz} = h(T_x - T)$$

subject to inlet condition $T(z=0) = T_o$. For this problem

1. Compute the particular solution $T(z)$, setting $\lambda = h/(mC_p)$
2. Compute and plot the solutions for $\lambda = 2$ and $\lambda = -2$; for both cases use $T_o = 300K$ and $T_x = 500K$
3. For the cases above, for what value of $z$ does the fluid reach 95% of its final temperature

## HW 8 - due 4/10/09

1. HW 10.1, 10.3, 10.4

## HW 9 - due 4/17/09

1. Problem 10.3 as stated using lodesolver.m for all four A matrices (this involves no hand calculations).
2. 10.5, but only the 2nd, 4th, and 6th A matrices
3. 10.6

## HW 10 - due 4/24/09

1. On Friday we derived the following equations for heat transfer in the ground near the Earth's surface:

$$\begin{aligned} dT_1/dt &= (T_2 - 2T_1 + T_0)/\Delta_z^2 \\ dT_n/dt &= (T_{n+1} - 2T_n + T_{n-1})/\Delta_z^2 \quad n = 2, \ldots, N-1 \\ dT_N/dt &= (T_{N+1} - 2T_N + T_{N-1})/\Delta_z^2 \end{aligned}$$

with $T_0 = 30^oC$, $T_{N+1} = 5^oC$ and $T_j(t=0) = 5^oC$, $j = 1, \ldots, N$. For $N = 10$, compute and plot the solutions for $t = 0, 0.01, 0.1, 0.2, 0.5, 1, 5$.

## HW 11 - due 5/1/09

1. Problems 14.1, 14.2, 14.4