INDIAN INSTITUTE OF TECHNOLOGY MADRAS

Department of Chemical Engineering

Simulation lab (CH2082)

Assignment 3 – (19/03/2014)

Instructions

1. Attempt all problems on your own.
2. You may discuss with the TAs for assistance.
3. All variables should be declared or initialized within your program
4. Name each program using the following convention using a combination of your roll number, assignment number and question number. i.e., if your roll number is CH12B001, name the program in the first question of the first assignment as follows:CH12B001_A1_Q1.m
5. Submit a single zipped folder (named accordingly e.g. CH12B001_A2) in moodle which contain matlab codes (m files) for each question and one pdf file (after publishing)
6. Comment wherever required

Questions

1. At room temperature, sucrose is hydrolyzed by the catalytic action of the enzyme sucrose as follows $\text{sucrose} \xrightarrow{\text{sucrase}} \text{products}$

   Given C_{A0} = 1 millimol/liter and C_{E0} = 0.01 millimol/liter. Kinetic data obtained in a batch reactor is given below.

C_A, millimol/liter	0.84	0.68	0.53	0.38	0.27	0.16	0.09	0.04	0.018	0.006	0.0025
t, hr	1	2	3	4	5	6	7	8	9	10	11

   Fit this data to the Michaelis Menton kinetic equation given by

   $$-r_A = \frac{k_3 C_A C_{E0}}{C_A + C_M} \quad \text{where} \quad C_M = \text{Michaelis constant}$$

   Find the constants k_3 and C_M considering $Y = C_A$ and $X = C_A C_{E0}/(-r_A)$ and expressing

   a. $Y=a_0X + a_1$
   b. $X=b_0Y + b_1$

   Compare the results.

2. Using fsolve, find x1 and x2 which satisfies the following equations. Start with the initial guess x_1 =1, x_2=6.

$$x_1^2 x_2^2 - 2x_1 - 5x_2^{0.5} + 5 = 0$$
$$x_1^4 - 6x_2^2 x_1 + 23 = 0$$

3. The friction factor f depends on the Reynolds number for turbulent flow in a smooth pipeaccording to the following relationship:

$$\frac{1}{\sqrt{f}} = -0.4 + \sqrt{3}\ln\left(\mathrm{Re}\sqrt{f}\right)$$

The above equation may be rearranged to be written in the standard forms: f = G(f) or F(f) = 0. With $f^{initial}$ = 0.01, find the friction factor for Re = 10^5 as follows:

a. Use an iterative procedure

b. Use the Matlab subroutine fsolve.

c. Repeat step 3 (i.e., solving using fsolve) for 10 different values of Reynolds number starting from 4000 to 10^6. Plot friction factor vs. Reynolds number in loglog scale.

4. Consider the water flow between two parallel plates of length 1m where the upper plate at y=3cm is fixed whereas lower plate at y= -3cm is moving at a velocity u=2m/s. Find the steady state velocity profile and find the maximum velocity. Pressure drop across the channel is 100Pa. Viscosity of water = 0.001 kg/m.s