

# INDIAN INSTITUTE OF TECHNOLOGY MADRAS

## Department of Chemical Engineering

### Simulation lab (CH2082)

#### Assignment 3 – (19/03/2014)

#### Instructions

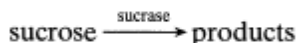
1. Attempt all problems on your own.
2. You may discuss with the TAs for assistance.
3. All variables should be declared or initialized within your program
4. Name each program using the following convention using a combination of your roll number, assignment number and question number. i.e., if your 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

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#### Questions

1. At room temperature, sucrose is hydrolyzed by the catalytic action of the enzyme

sucrose as follows



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

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

Find the constants  $k_3$  and  $C_M$

considering  $Y = C_A$  and  $X = C_A C_{E0}/(-r_A)$  and expressing

a.  $Y = a_0 X + a_1$

b.  $X = b_0 Y + b_1$

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 pipe according to the following relationship:

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

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

- Use an iterative procedure
  - Use the Matlab subroutine fsolve.
  - 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  $y=3\text{cm}$  is fixed whereas lower plate at  $y= -3\text{cm}$  is moving at a velocity  $u=2\text{m/s}$ . 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

