Code No: NR410805 **NR**

IV B.Tech I Semester Supplementary Examinations, November 2005
PROCESS MODELLING & SIMULATION
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. The liquid phase hydrolysis reaction of acetic anhydride to form acetic acid is carried out in a constant volume adiabatic batch reactor. The reaction is exothermic with the following stoichiometry. $(CH_3C)_2O + H_2O \rightarrow 2CH_3COOH + Heat$.
   Derive mass and energy balances for the system assuming the reaction as first order. [16]

2. Write the component continuity equations for the following reactions taking place in a CSTR (continuous stirred-tank reactor):

   (a) Simultaneous reactions (first-order, isothermal)
   $\mathbf{A} \xrightarrow{k_1} \mathbf{B}$ $A \xrightarrow{k_2} \mathbf{C}$

   (b) Reversible (first-order, isothermal)
   $\mathbf{A} \underset{k_2}{\overset{k_1}{\rightleftarrows}} \mathbf{B}$

   State the assumptions made and explain the nomenclature used. [16]

3. An irreversible exothermic reaction is carried out in a single perfectly mixed non-isothermal CSTR. The reaction is A → B. The reaction is nth order in reactant A and has heat of reactλ (energy units/mole of A reacted). Negligible heat losses and constant densities are assumed. To remove the heat of reaction, a cooling jacket surrounds the reactor. Cooling water is added to the jacket at a constant volumetric flow rate. Develop a mathematical model for the system assuming that the CSTR has a perfectly mixed cooling jacket. State all the assumptions made and explain the notation scheme used clearly. [16]

4. Explain the steady state model and thermal equilibrium model for LPG vaporiser with a neat diagram. [16]

5. Derive the Mathematical Model equations for a Binary distillation column. [16]

6. Solve the equation dy/dx = x + y for five iterations by Euler's method with x(0) = 0, y(0) = 1 and a step size of 0.1. [16]

7. (a) Simulate the series of open loop three isothermal CSTRs using first order explicit Euler integration method.

   (b) Simulate the series of closed loop three isothermal CSTRs using first order explicit Euler integration method. [8+8]

8. Discuss the general "Newton - Rapshan" algorithm to determine the bubble point temperature for a binary system of components 1 and 2. Assume the system is ideal, Raoult's and Dalton's laws are applicable. [16]

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