1. a) Enlist reasons for deviations from two ideal flow patterns.
   b) Discuss in brief, micro and macro fluids. [15]

2. Write short notes on any two:
   i) Step response curves for large deviations from plug flow in closed vessels;
   ii) Step response curves for small deviations from plug flow;
   iii) Boundary conditions of the dispersion model. [15]

3. a) Give a brief account of the tanks in series model.
   b) Fit the tanks in series model to the following mixing up output data to a pulse input, and calculate the conversion, for the reaction \( A \rightarrow R, k = 0.18 \text{ min}^{-1} \)

<table>
<thead>
<tr>
<th>T, min</th>
<th>0-2</th>
<th>2-4</th>
<th>4-6</th>
<th>6-8</th>
<th>8-10</th>
<th>10-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>c,</td>
<td>2</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

[15]

4. a) For a first order reaction with \( z = 0 \), show that the performance equations for a macro fluid in plug flow and a micro fluid in plug flow are identical.
   b) Explain the mixing of two miscible fluids. [15]

5. Derive the expression for langmuir isotherm in solid catalyzed reactions. [15]

6. Discuss the spectrum of kinetic regimes in porous catalytic reaction system and explain the factors that influence the rate of reaction of particles. [15]

7. How much catalyst is needed in packed bed reactor for 80% conversion of 1000 m^3/hr of pure gaseous A (\( C_{A1} = \text{mol/m}^3 \)) if the stoichiometry and rate are given as \( A \rightarrow R, r_n = 8C_{A1}^2 \text{mol/kg-hr} \) [15]

8. A batch of solids of uniform size is treated by gas in a uniform environment. Solid is covered to give a non flaking product according to the shrinking core Model. Conversion is about 7/8 for a reaction time of one hour, conversion is complete in two hours. What mechanism is rate controlling. [15]
1. Show non-ideal flow patterns, which may exist in process equipment and explain them in brief. [15]

2. Discuss various aspects of fitting the dispersion model for small extents of dispersion. [15]

3. A reactor with a number of dividing baffles is to be used to run the reaction \( A \rightarrow R \) with \( \tau_0 = 0.05 \) s, mol/liter. min. A pulse tracer test gives the following curve:

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration (C)</td>
<td>35</td>
<td>38</td>
<td>40</td>
<td>40</td>
<td>39</td>
<td>37</td>
<td>36</td>
<td>35</td>
</tr>
</tbody>
</table>

(a) How many tanks in series is this vessel equivalent to?
(b) Calculate the conversion and compare with CSTR. [15]

4. A second order reaction occurs in a reactor system of mixed flow reactor followed by plug flow reactor. For simplicity take \( Co = 1 \), \( k = 1 \), \( r = 1 \) for each unit. Calculate the conversion for the following processing fluids.

(a) Micro fluid
(b) Macro fluid. [15]

5. What is the basis for the classification of catalyst? Explain about the type of catalysts used in hydrogenation and dehydrogenation reactions of commercial importance. [15]

6. In slurry reactor, pure reactant gases is bubbled through the liquid to reach the surface of the solid. Thus to reach the surface of the solid the reactant which enters the liquid must diffuse through the liquid film in to the main body of the liquid, and then through the film surrounding the catalyst particle. At the surface of the particle reactants yields products accounting to first order kinetics. Sketch the concentration profile of the gaseous reactant A. List out the resistances offered to the overall rate of reaction. [15]


8. Show that, \( \frac{1}{\tau} = 1 - 3(1 - X_p) - 2(1 - X_p)^2 \), when the overall reaction is controlled by ash layer and write the assumptions. [15]
B. Tech III Year II Semester Examinations, April/May - 2012
CHEMICAL REACTION ENGINEERING - II
(Chemical engineering)

Time: 3 hours Max. Marks: 75

Answer any five questions
All questions carry equal marks

1. Discuss about any two to account for non ideal behaviour:
   i) RTD of fluid;
   ii) State of aggregation of flowing material;
   iii) Earlyness or lateness of mixing. [15]

2. Write short notes on any two:
   i) Sensitivity of the E and F curves for the same flow;
   ii) Axial dispersion;
   iii) Step response curves for small deviations from plug flow. [15]

3. a) Give a brief account of the tanks in series model.
   b) A small diameter pipe 32 m long runs from the fermentation room of a winery to the bottle filling cellar. Some times red wine is pumped through the pipe, some times white, and when ever the switch is made from on to the other a small amount of 'house blend' rose is produced (8 bottles). Because of some construction in the winery pipeline length will have to be increased to 50 m. For the same flow rate of wine, how many bottles of rose we now expect to get each time we switch flow. [15]

4. a) For a zero order reaction, derive an expression for the conversion of a macro fluid in two mixed reactors of equal size connected in series. If the conversion for macro fluids is 99% what is the conversion for macro fluid have the same reaction rate?
   b) How to find a single fluid, explain. [15]

5. What are the steps involved in catalytic reactions? Explain in detail. [15]

6. Gaseous reactant A diffuses through a gas film and reacts on the surface of a solid according to a reversible first order rate, \(-A = k' (C_{A_s} - C_{A})\). Develop an expression for the rate of reaction of A accounting for both mass transfer and reaction steps. [15]

7. Distinguish between slow and fast deactivation of catalysts. What are the different experimental devices used for studying the above two types of deactivation? Explain with sketches. [15]

8. Spherical particles of zinc blende of radius 1 mm are coated in an 8% oxygen stream at 90°C and 1 atm. The reaction is \(2ZnS + O_2 \rightarrow 2ZnO + 2SO_2\).
Assuming that the reaction proceeds by shrinking core model and neglecting the film resistance. Calculate the time needed for complete conversion of a particle and the relative resistance of ash layer during this operation.
Data : Density of solid = 4.13 kg/m³, \(k = 0.02 m/s\), Effective diffusivity = 0.08 cm²/sec. [15]
1. Enlist procedures to account for non ideal behaviour of reactors. Discuss any one of them. [15]

2.a) Discuss in brief, the salient features of dispersion model.
   b) Show the step response curves for small deviations from plug flow. [15]

3.a) From a pulse input in to a vessel we obtain the following output signal.

<table>
<thead>
<tr>
<th>Time</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>9</th>
<th>11</th>
<th>13</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Con</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

we want to represent the flow through the vessel with the tanks in series model. determine the no. of tanks to use.

b) Give a brief account of the tanks – in series model. [15]

4.a) For a second order reaction derive an expression for the conversion of a macro fluid in mixed reactors of equal size connected in series. If the conversion for micro fluids is 99%, what is the conversion for macro fluid have the same reaction rate?
   b) Explain the mixing of two miscible factors. [15]

5. What is the basis for classification of catalyst? Explain about the types of catalysts used in hydrogenation and dehydrogenation reactions of commercial importance. [15]

6. Derive the expression for the effectiveness factor. [15]

7. Distinguish between slow and fast deactivation of catalysts. What are the different experimental devices used for studying the above two types of deactivation? Explain with sketches. [15]

8. Two small samples of solids are introduced in a constant environment oven and kept there for one hour. under these conditions the 4mm particles are 58% converted, and two mm particles are 87.5% converted. Find the time needed for complete conversion if 1mm particles of 1mm particles in this oven. [15]