

Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/M.Tech (CHE)/SEM-2/CH-8/2010**

**2010**

**ADVANCED REACTOR ANALYSIS**

Time Allotted : 3 Hours

Full Marks : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

Answer any five of the following.  $5 \times 14 = 70$

1. A liquid phase reaction  $A + B \rightarrow C$  is carried out in a CSTR to produce 1,00,000 kg/day of the product C (Mol. wt. 60). The aqueous solution of A (Mol. wt. 60) is continuously fed to the reactor containing  $2 \text{ kmol/m}^3$  of A along with an aqueous solution of B of same concentration and at same volumetric flow rate. Calculate the volume of reactor needed for achieving 90% conversion of A. The second order rate constant is given as  $0.08 \text{ m}^3/(\text{kmol}) \cdot (\text{sec})$  at the temperature of the reaction. 14
2. A tracer is introduced in a reactor and its concentration is measured at the outlet as follows :

Time (min)	1.0	2.0	3.0	4.0	5.0	10.0	20.0	30.0
Tracer								
Conc. (gm/min)	1.8	1.6	1.38	1.2	1.08	0.6	0.15	0.05

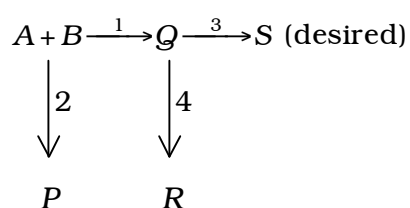
The fluid volume in the reactor is  $1.5 \text{ m}^3$  and the volumetric flow rate is  $0.1 \text{ m}^3/\text{min}$ . Calculate mean residence time in the reactor and compare it against hydraulic residence time.

14



3. a) Develop an expression for optimum conversion for maximum profit for a 2nd order reaction  $2A \rightarrow B$  carried out in a batch reactor. 6

- b) For the following reaction sequence mention the optimum temperature trajectory for the following cases :



Case I  $E_1 > E_2, E_3 > E_4$

Case II  $E_1 < E_2, E_3 < E_4$

Case III  $E_1 < E_2, E_3 > E_4$

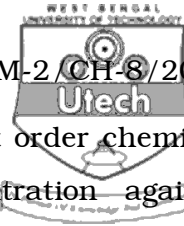
Case IV  $E_1 > E_2, E_3 < E_4$  8

4. Write short notes on the following :

- a) Autothermic Operation. 6
- b) Catalyst Effectiveness Factor. 4
- c) Ills of nonideal reactors. 4

5. Prove that for simultaneous reactions of identical orders, yield of selectivity is the same in a CSTR & PFR. 14

6. Describe with the help of mathematical expression 'steady state multiplicity' for a CSTR for liquid phase reactions. Discuss stability of a CSTR. 14



7. For longitudinal dispersion model with a 1st order chemical reaction the following relation of concentration against dispersion number has been obtained. Derive an expression for  $L_D/L_P$  against dispersion number for all other conditions remaining same.

$$\frac{C_A}{C_{A_0}} = \frac{4\beta e^{u_x L/2D}}{(1+\beta)^2 e^{\beta^2 u_x L/2D} - (1-\beta)^2 e^{-\beta^2 u_x L/2D}}$$

$$\text{where } \beta = \left[ 1 + 4\Re \left( \frac{D}{u_x L} \right) \frac{L}{u_x} \right]^{\frac{1}{2}}$$

Solve the above problem for small dispersion number  $\frac{D}{v_x L}$

$L_D$  = length of dispersed flow reactor

$L_P$  = length of plug flow reactor.

14

=====