Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

V SEMESTER B.TECH.(CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: CHEMICAL REACTION ENGINEERING –I [CHE 307]

(29/11/2016)

Time: 3 Hours **MAX. MARKS: 100**

Instructions to Candidates:

- Answer **ANY 5 FULL** questions.
- Missing data may be suitable assumed and indicated properly

1A.	At 227 ° C the rate of a bimolecular reaction is 10 times the rate of reaction at 127° C. Find the activation energy for this reaction (i) from Arrhenius law (ii) from collision theory. What is the percentage difference in the rate of reaction at 327 ° C predicted by these two theories?	**(10)**
1B,	Sodium hydroxide (B) reacts with ethyl acetate (A) in liquid phase in a batch reactor under isothermal conditions. Develop the differential and also integrated rate equations for this reaction when (i) M=1.0 (ii) M≠1.0. How will you analyze of all these rate equations. Show the relevant graphs also.	**(10)**
2A.	Explain the following methods used for kinetic analysis of the rate equations: (i) Method of excess (ii) Half life method.	**(05)**
2B.	At room temperature sucrose is hydrolyzed by the catalytic action of the enzyme sucrose as follows: Sucrose → Products, using sucrase as the enzyme catalyst. Starting with the Sucrose concentration of C_{A0}= 1mmol/liter and an enzyme concentration C_{E0}= 0.01 mmol/liter, the following kinetic data are obtained in a batch reactor <table><tr><td>CA * 10^{-2} mmol/lit</td><td>84</td><td>68</td><td>53</td><td>38</td><td>27</td><td>16</td><td>9</td><td>4</td><td>1.18</td><td>0.6</td><td>0.25</td></tr><tr><td>t, hr</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td></tr></table> Determine whether the data fits the Michaelis- Menten equation : $(-r_A) = k_3 C_A C_{E0} / (C_A + M)$. If so evaluate the constants k_3 and M.	**(15)**

3A. The liquid phase irreversible reaction $A \rightarrow B+C$ is carried out in a CSTR. The kinetic data is given in the following table. Pure A enters the reactor at a concentration of 2 (mol/lit). Determine the rate equation for this reaction List the assumptions you make. **(08)**

Run No.	1	2	3
Space time, minutes	14.8	100	1200
Reactor exit concentration,(mol/lit)	1.5	1.0	0.5

3B. For a liquid phase reaction $A \rightarrow R$ the kinetic data in batch reactor is given in the following table. You are planning to operate a flow reactor for this reaction. (i) What size of MFR is required to achieve 75% conversion of feed stream of 1000 mol of A/hr at a C_{A0}= 1.2 mol/lit ? (ii).What is the size of PFR required under the above operating conditions (iii) When (at what conversion) will the volume of PFR becomes equal that of an MFR under identical operating conditions? **(12)**

C_A,mol/lit	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.3	2.0
(r_A),mol/lit.min	0.1	0.3	0.5	0.6	0.5	0.25	0.10	0.06	0.05	0.045	0.042

4A. The homogenous gas reaction $A \rightarrow 3R$ follows second- order kinetics. Develop an expression for the volume when this reaction conducted a PFR. **(08)**

4B. The homogenous gas reaction $A \rightarrow 3R$ follows second- order kinetics. For a feed rate of 4m3/hr of pure A at 5 atm and 350 ˚C, an experimental reactor consisting of a 2.5 cm ID , 2m long pipe gives 60% conversion of feed. A commercial plant is to treat 320m3/hr of feed consisting of 50%A and 50% Inerts at 25 atm and 350 ˚C to obtain 80% conversion. **(12)**

(i) How many 2.5 cm ID , 2m long pipes are required?
(ii) Should they be placed in parallel or series?

Assume plug flow in the pipe, negligible pressure drop, and ideal gas behavior.

5A. Explain the step by step graphical procedure for a given reaction for: (i) the determination of exit concentration of CSTR cascade of 3 equal size tanks (ii) the determination of the exit concentration of reactor cascade of 3 unequal size tanks (iii) the determination of N equal size tanks for the given exit concentration (iv) the determination of N unequal size tanks for the given exit concentration. Give the relevant equations used in the procedure. **(10)**

5B. Consider the elementary consecutive reactions: $\mathbf{A \rightarrow B \rightarrow C}$ with unequal rate constants for both the steps is conducted in a CSTR. Derive expressions for $\zeta_{\mathbf{max}}$ and $C_{\mathbf{Bmax}}$. Show the variation of concentration of A, B and C with respect to time in a graph. List the assumptions you make. **(10)**

6A. Explain the maximization of rectangle method used for optimization of volume ratio of 2 CSTRs connected in series with neat figure. **(08)**

6B. For the parallel reactions: $A+ 2B \rightarrow U$…… (i) $2A+B- \rightarrow D$ …(ii) , give the various contacting patterns to maximize the selectivity of the desired product D. Use both the batch and flow systems. List the assumptions you make. **(12)**