Reg. No.										

Manipal Institute of Technology, Manipal
(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: CHEMICAL REACTION ENGINEERING [CHE-307]

REVISED CREDIT SYSTEM

Time: 3 Hours **Max. Marks: 100**

Instructions to Candidates:

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

1A.	The reaction A+B→R is elementary. Write the differential rate equation and also derive integrated rate equation for constant volume and variable volume conditions. Assume isothermal operation. How will you analyze these equations?	**(12)**
1B.	What are the theories of chemical reaction rates?. How will you calculate rate constants using these theories?	**(04)**
1C.	The rate constants of a reaction are 0.0016 and 0.1625 $(sec)^{-1}$ at 10ºC and 30ºC. Calculate the activation energy.	**(04)**
2A.	Explain the two types of batch reactors used for the kinetic studies of gas phase reaction by giving neat sketches and kinetic data obtained.	**(06)**
2B.	We are planning to operate a batch reactor to convert A into R in the liquid phase by the reaction A→ R. The rate vs concentration data is given below. How long must we react each batch for a conversion of 77 % when C_{A0}=1.3 (mol /lit). What is the value of space time τ in a PFR for the same reaction for the same conditions?. Compare and comment.	**(14)**

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**	**0.1**	**0.06**	**0.05**	**0.045**	**0.042**

3A. The reaction **A → B** is to be carried out isothermally in a continuous flow reactor. Calculate both the MFR and PFR volumes necessary to consume 99% of A, when the entering molar flow rate is 5 moles/hr, by assuming the rate constants for the various reaction orders for the reaction as follows:

(i) k= 0.05 (mol/hr. lit)
(ii) k= 0.0001 $\mathbf{s}^{-1}$
(iii) k= 3 (lit/mol. hr)

The entering volumetric flow rate is 10 (lit/hr). Comment on the results obtained. **(12)**

3B. Consider the aqueous reaction A→ R with rate equation $(-r_A) = k\,C_A^{1.5}$ conducted in a CSTR. It is proposed to replace the present CSTR with one having double the volume. Find the conversion in the new CSTR for the same aqueous feed with C_{A0}=10 (mol /lit) and the same feed rate. **(08)**

4A. The aqueous decomposition of A is studied in an experimental mixed flow reactor. The results obtained in steady -state runs are given in the table. To obtain 75% conversion of reactant in a feed, C_{A0} = 0.8 (mol /lit), what holding time is needed in (i) a PFR (ii) a CSTR?. **(16)**

Concn. of A , mol/liter		Holding Time sec
In feed stream	In exit stream	
2	0.65	300
2	0.92	240
2	1.00	250
1	0.56	110
1	0.37	360
0.48	0.42	24
0.48	0.28	200
0.48	0.20	560

4B Compare the applications of CSTR and PFR for (i) the laboratory kinetics studies (ii) the production of industrially important chemicals. **(04)**

5A. Discuss the design procedures (analytical and graphical) for the calculation the exit concentration the cascade of A($C_{A,3}$) in case of an elementary reaction A→ R, for a CSTR cascade of 3 tanks connected in series in the following cases: (i) equal volume tanks isothermally operated (ii) unequal volume tanks isothermally operated (iii) unequal volume tanks non-isothermally operated. Give design equations and neat sketches for each case. **(10)**

5B. Explain : Maximization of rectangle method used for optimizing 2 CSTRs in series. **(04)**

5C. Write briefly on with neat diagrams: Batch and Continuous recycle reactors and their applications **(06)**

6A. Consider the elementary consecutive reactions: **A→B→C** with unequal rate constants for both the steps. Derive expressions for t_{max} and $C_{B\,max}$. Show the variation of concentration of A, B and C with respect to time in a graph. **(14)**

6B. Explain: Reactor selection procedure for autocatalytic reactions with neat sketches **(06)**