Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–VII • EXAMINATION – SUMMER • 2015

Subject Code: 170501 **Date:01/05/2015**
Subject Name: Chemical Reaction Engineering-I
Time:02.30pm-05.00pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 a) Differentiate Elementary and non-Elementary reactions. Discuss with example the various types of intermediate formed in non-elementary reactions. 07

b) Write a short note on temperature dependency from Arrhenius' law. 07

Q.2 a) State the various methods of analysis of kinetic data and explain any one of them in brief. 07

b) At 500 k the rate of a bimolecular reaction is ten times the rate at 400 K. Find the activation energy of this reaction using Arrhenius law and Collision theory. What is the percentage difference in the rate of reaction at 600 k predicted by these two methods? 07

OR

b) Show that the following reaction scheme is consistent with rate law and can explain the first order kinetic for decomposition of N_2O_5. 07
$N_2O_5 \rightarrow NO_2 + NO_3^*$ with rate constant k_1, $NO_2 + NO_3^* \rightarrow N_2O_5$ with rate constant k_2
$NO_2 + NO_3^* \rightarrow NO_2 + O_2 + NO^*$ with rate constant k_3, $NO^* + NO_3^* \rightarrow 2NO_2$ with rate constant k_4

Q.3 a) Discuss the analysis of total pressure data obtained in a constant volume system and also establish the relation used to calculate the partial pressure of gaseous component in reaction mixture. 07

b) Derive an integrated rate equation for an irreversible bi-molecular type second order reaction in terms of conversion. Also discuss its characteristics with respect to half life. 07

OR

Q.3 a) For a uni-molecular irreversible first order reaction in series A → R → S; Derive an 07

expression for concentration of reactant A, intermediate product R and final product S as a function of time. Find the expression in terms of time when formation of R becomes maximum.

b) The half life period for the various initial partial pressure of the gaseous reactant was given as follows: 07

P_{A0} (torr)	200	300	400
$t_{1/2}$ (Min)	150	99.8	75.3

Find the order of reaction.

Q.4 a) What is an autocatalytic reaction? For an autocatalytic reaction A + R → R + R show that 07

$$\ln\left[\frac{M+X_A}{M(1-X_A)}\right]=C_{A0}(M+1)kt\,.$$

b) A homogeneous liquid phase reaction with the stoichiometry and kinetics A → S, $-r_A = k\,C_A^2$, takes place with 50% conversion in a mixed flow reactor. 07

i) Find the conversion if this reactor is replaced by another mixed flow reactor having volume 6 times that of original, all else remain unchanged.

ii) Find the conversion if original reactor is replaced by a plug flow reactor of the same size, all else remains unchanged.

OR

Q.4 a) Derive the relation for fractional conversion in terms of Damkohler number for first order and second order reaction in mixed flow reactor with constant density system. 07

b) Derive the performance equation for steady state PFR for first order reaction for the case of constant density and variable density system. 07

Q.5 a) Derive the performance equation for equal sized CSTRs in series. 07

b) For reactions in parallel for two reactants; discuss the contacting patterns for various batch, semi batch and continuous reactor configuration for maximizing the desired product in case of high and low reactant concentrations. 07

OR

Q.5 a) Derive the performance equation for recycle reactor. 07

b) Write a short note on equilibrium constants from thermodynamics clearly indicating the equations. 07

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