Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII EXAMINATION – WINTER 2015

Subject Code: 173601 **Date:09/12/2015**

Subject Name: Basics of Catalysis

Time: 10:30am to 1:00pm **Total Marks: 70**

Instructions:

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

1 (a) Explain different steps in a catalytic reaction with a neat sketch and description. 07

(b) What is catalysts? Explain different types of catalysts. 07

2 (a) What are different methods to analyse the kinetic data? Explain in brief. 07

2 (b) Derive an expression for concentration and time for a second order homogeneous reaction with respect to A by an integral method. The equation is in the form as: 07

$$2A \rightarrow P$$

OR

2 (b) The thermal decomposition of nitrous oxide (N_2O) in the gas phase at 1030 K is studied in a constant volume vessel at various initial pressure of N_2O at 290 mm Hg. The half-life data is obtained as follows: 07

p_0 (mm Hg)	52.5	139	290	360
$t_{1/2}$ (sec)	860	470	255	212

$$2N_2O \rightarrow 2N_2 + O_2$$

Determine the rate equation that fits the data.

3 (a) Derive a performance equation for a catalytic plug flow reactor for a first order reaction. 07

3 (b) Discuss dissociative adsorption of a catalytic reaction with a neat sketch and rate expression. 07

OR

3 (a) Discuss molecule adsorption in a catalytic reaction with neat sketch and the rate expression. 07

(b) What are the different type of surface reaction takes place on a catalytic surface? Explain 07

the mechanism with neat sketch and the rate expression.

4 (a) The catalytic reaction 07

$$A \rightarrow 4R$$

is studied in a plug flow reactor using various amounts of catalyst and 20 l/h of pure A feed at 3.2 atm and 117°C. The concentrations of A in the effluent stream is recorded for the various runs as follows.

Run	1	2	3	4
Catalyst used, kg	0.02	0.04	0.08	0.16
$C_{A,out}$, mol/l	0.074	0.06	0.044	0.029

Find the rate equation for this reaction, using the integral method of analysis.

4 (b) Explain in a catalytic reaction how heat effects during reaction is considered. Explain it with appropriate expressions. 07

OR

4 (a) Derive an expression for the effectiveness factor for a rectangular slab in terms of Thiele modulus. Consider the edges of the slab are sealed and diffusion is taking place in one direction only. 07

4 (b) Discuss mechanism of deactivation of catalysts. 07

5 (a) An experimental rate measurement on the decomposition of A is made with a particular catalyst 07
(i) Is it likely that film resistance to mass transfer influences the rate?
(ii) Could this run have been made in the regime of strong pore diffusion?
Data:
For spherical particle:
d_p= 2.4 mm or $L=r/3$, D_e=5x10^{-5} m^3/hr.mcat, k_g=300 m^3/h.m^{2}cat, C_{Ag}=20 mol/m^3, $-r'''_{A,obs}$=10^5 mol/hr.m^{3}cat.
Assume that reaction is of first order.

5 (b) Explain Michaelis –Menton reaction for enzyme reaction. 07

OR

5 (a) The homogeneous gas decomposition of phosphine 07

$$4PH_3(g) \rightarrow P_4(g) + 6H_2$$

proceeds at 649°C with the first order rate

$$-r_{PH_3} = (10/hr)C_{PH_3}$$

What size of plug flow reactor operating at 649°C and 460 kPa can produce 80% conversion of feed consisting of 40 mol of pure phosphine per hour?

5 (b) Write a short note on temperature time trajectory for a catalytic reaction? 07

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