**SIXTH SEMESTER B.TECH. DEGREE EXAMINATION**

**(2013 Scheme)**

Subject**:13.602** **Chemical Reaction Engineering-II (H)**

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

**MODEL QUESTION PAPER**

## Part A

*Answer all questions. Each question carries two marks.*

1. Sketch and explain the RTD curve for ideal Plug flow and ideal batch reactor.
2. Compare macro fluid and micro fluid behavior.
3. Distinguish between plug flow and dispersed plug flow.
4. With a suitable example illustrate the significance of inter stage heat transfer in adiabatic operations.
5. Summarize the effect of temperature on conversion for adiabatic reactions.
6. Discuss multiple steady states in exothermic CSTR operations.
7. Point out the significance of Frossling correlation in the study of heterogeneous reactions.
8. Analyze the role of temperature and particle size for experimentally determining the rate controlling step of a fluid particle non catalytic reaction.
9. Interpret Wagner modulus and Mears criterion for diffusion in heterogeneous catalytic reactions.
10. Discuss catalyst deactivation mechanisms.

(2x 10 = 20 marks)

## Part B

*Answer any one question from each module.*

### Module I

11a) Explain the stimulus response techniques for study of flow pattern in reaction vessels. (6 marks)

b) Obtain the relation between E, F and C curves. (6 marks)

c) Illustrate the dispersed plug flow model. (8 marks)

*OR*

12 A specially designed vessel is to be used as a reactor for a first order liquid reaction. The following concentration readings represent the response at the vessel output to a delta function tracer input to the vessel inlet. What conversion can be expected in this reactor if conversion in a CSTR employing the same space time is 82.18%.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Time sec. | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
| Tracer concn. | 0 | 3 | 5 | 5 | 4 | 2 | 1 | 0 |

(20 marks)

**Module II**

13a) Explain how heat of reaction varies with temperature when specific heats are functions of temperature. (10 marks)

b) Compute Ky at 10 atm if Kp at this pressure is 0.00381atm$^{-1}$ for ammonia synthesis reaction from hydrogen and nitrogen at 500ºC Assume ideal gas behaviour.

(10 marks)

*OR*

14.For an elementary reversible liquid phase reaction A ↔ R make a plot of the equilibrium conversion as a function of temperature. Determine the adiabatic equilibrium temperature and conversion when pure A is fed to the reactor at a temperature of 300 K

Data: $H°_A$(298K) = - 40,000 cal/mol

$H°_R$(298K) = - 60,000 cal/mol

$Cp_A$ = 50 cal/mol.K

$Cp_R$ = 50 cal/mol.K

K = 100,000 at 298 K (20 marks)

**Module III**

15. The catalytic reaction A→4R is studied in a PFR using various amounts of catalyst and 20 liter/hr of pure A feed at 3.2atm and 117ºC. The concentration of A in the effluent stream for various runs is as follows.

| | | | | | |
|---|---|---|---|---|---|
| Cat. used, kg. | 0.02 | 0.04 | 0.08 | 0.12 | 0.16 |

| | | | | | |
|---|---|---|---|---|---|
| $C_A$out (mol/liter) | 0.074 | 0.06 | 0.044 | 0.035 | 0.029 |

Devise a rate equation for this reaction using integral method of analysis. (20 marks)

*OR*

16 Define internal effectiveness factor and develop an expression for the same considering diffusion and reaction of reactant A through a single cylindrical catalyst pore. Assume first order reaction.
(20 marks)

**Module IV**

17. Using the shrinking core model for spherical particles of unchanging size, determine relations between time, conversion and particle size when diffusion through ash layer controls. Also sketch the result. (20marks)

*OR*

18a) Explain the factors affecting the design of fluid particle reactions. (10marks)

b) With proper sketches illustrate various contacting patterns for fluid solid reactions.

(10marks)