A **Reg. No. :** | | | | | | | | | | |

Question Paper Code: 57903

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2018

Seventh Semester

Chemical Engineering

15UCH703- CHEMICAL REACTION ENGINEERING-II

(Regulation 2015)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. Identify the pore size of microporous solids. CO1- R

(a) Size <2 nm (b) Size <0.7 nm (c) 2 nm <size<50 nm (d) Size >50 nm

2. Select the role of catalyst support in heterogeneous catalysis processes. CO1- R

(i) Provides Physical form to the catalyst
(ii) Increases heat transfer rate
(iii) Increases rate of adsorption
(iv) Increases mechanical resistance of the catalyst

(a) (i) and (ii) (b) (ii) and (iii) (c) (i) and (iv) (d) (ii) and (iv)

3. This of the following is not a fluid-particle reaction. CO2-U

(a) $ZnS + \frac{1}{2}O_2 \rightarrow ZnO + SO_2$ (b) $C + O_2 \rightarrow CO_2$ (c) $C + 2S \rightarrow CS_2$ (d) None of these

4. Indicate the assumptions involved in Langmuir adsorption isotherm. CO3- U

(a) Chemisorption and multilayer (b) Chemisorption and monolayer

(c) Chemisorption and non-ideal (d) Chemisorption, low occupancy

5. Thiele modulus of a gas phase I order isothermal reaction for a spherical catalyst is found to be. The catalyst effectiveness factor is CO3- R

(a) 0.6 (b) 0.8 (c) 0.1 (d) 0.12

6. In gas – solid reactions, D_a >>1 can be interpreted as CO3- U

(a) Greater Diffusion rate (b) Lesser heat transfer rate

(c) Lesser reaction rate (d) Greater reaction rate

7. Which of the following is true about progressive conversion model? CO4- R

(i) Reactant reacts continuously
(ii) Core of the reactant shrinks on reaction
(iii) Different rate at different locations within the particle
(iv) Uniform rate of reaction throughout the particle.

(a) (i) and (iv) (b) (i) and (iii) (c) (ii) and (iv) (d) None of these

8. The conversion – Time expression for constant size cylindrical pellet for film diffusion control is CO4- R

$(a)\ \frac{t}{\tau} = X_B \quad (b)\frac{t}{\tau} = X_B{}^{3/2} \quad (c)\frac{t}{\tau} = 1-(1-X_B)^{2/3} \quad (d)\frac{t}{\tau} = 1-((1-X_B)^{3/2}$

9. If the solubility of one reactant is very low in the other phase, the reaction takes place at / in CO5- R

(a) Interface (b) Bulk Phase (c) Both (a) and (b) (d) No Reaction

10. The best suited tower for G/L reactions are CO5- U

(a) Bubble Column (b) Spray column (c) Agitated tank (d) All the above

PART – B (5 x 2= 10 Marks)

11. Justify the need for catalyst support / carrier in heterogeneous catalytic reactions. CO1- R

12. Predict the global rate of reaction for the following heterogeneous reaction. CO2- E

$A(l) + B(s) \rightarrow C(l)$

13. Write the expression for concentration profile in a spherical catalyst. CO3- U

14. Give the conversion-time expressions for a flat plate. CO4- R

15. What is the multiphase reactor. CO5- R

PART – C (5 x 16= 80 Marks)

16. (a) (i) Nitrogen was employed to determine the surface area of 1.0 g sample of silica gel and results obtained shown in table below. The sample of silica gel was maintained at the normal boiling point of liquid nitrogen (77K). One molecule of nitrogen occupies 16.2×10^{-20} m^2 area of plane surface. Calculate the specific surface area of silica gel by the BET method. The saturated vapor pressure $\mathbf{p_0}$ of nitrogen at 77K is 101.3 kPa. CO1- E (10)

Equilibrium pressure p in [kPa]	5.0	6.3	7.5	9.0	11.2
Volume adsorbed, (STP), V × 10^6 [m^3]	6.7	7.0	7.2	7.4	7.7

(ii) Elaborate in detail about the different components of catalysts. CO1- R (6)

Or

(b) Indicate the methods of preparation of industrial catalysts. CO1- U (16)
Describe in detail about any two methods of catalyst preparation.

17. (a) For a reaction A< -> B+C when species C is not adsorbed on to the catalytic surface, derive the rate expression for the formation of the product. CO2- E (8)
(i) If adsorption is rate controlling.

(ii) If surface reaction is rate controlling CO2- E (8)

Or

(b) Recognize the importance of adsorption on solid catalysts. Write a detailed description on Langmuir treatment of adsorption and its limitations. List the assumptions involved. CO2- U (16)

18. (a) Derive the expression for concentration profile in a flat plate for the case of intraphase mass transfer, also obtain the relationship between Thiele modulus and effectiveness factor. CO3- App (16)

Or

(b) The results of the kinetic runs on the reaction A-> R made in an experimental packed bed reactor using a fixed feed rate F_{Ao} = 10 kmol/h are as follows: CO3- App (16)

W, kg catalyst	1	2	3	4	5	6	7
X_A	0.12	0.20	0.27	0.33	0.37	0.41	0.44

(i) Find the reaction rate at 40 % conversion.

(ii) For a feed rate of 400kmol/h to large scale packed bed reactor, find the amount of catalyst needed for 40 % conversion.

19. (a) For the following reaction determine the rate expressions and obtain the time - conversion relationship considering mass transfer as rate limiting step. CO4-Ana (16)

Or

(b) (i) Illustrate the Shrinking Core Model with neat diagram. CO4- U (6)

(ii) Solids of unchanging size (R=0.3 mm) are reacted with gas in a steady flow bench-scale fluidized bed reactor according to the SCM with the reaction steps as rate controlling. Following results is obtained on bench scale. CO4- E (10)

For F_o = 10 g/s, W=1000g, X_B = 0.75

Design a commercial scale fluidized bed reactor to treat 4t/h of solids of size R = 0.3 mm to 98 % conversion.

20. (a) (i) Derive the rate equation for the fluid – fluid reaction for instantaneous reaction with low C_B. Sketch the concentration profiles of the reactants for the reactions. CO5- U (8)

(ii) Recall the mechanism of surface renewal theory and describe with a neat sketch. CO5- U (8)

Or

(b) Describe in detail on different types of contactors/reactors that are used in Chemical process industries for carrying out gas-liquid reactions. CO5- U (16)