



- Notes :
1. Answer **any six** question.
  2. Due credit will be given to neatness and adequate dimensions.
  3. Assume suitable data wherever necessary.
  4. Diagrams and Chemicals equations should be given wherever necessary.
  5. Illustrate your answer necessary with the help of neat sketches.
  6. Discuss the reaction, mechanism wherever necessary.
  7. Use of pen Blue/Black ink/refill only for writing the answer book.

1. a) Discuss the classification of reactors and how selection of reactor influences the economics of the process? Also explain the factors affecting mass transfer rate in the reactor. 9  
b) A second order reaction  $2A \rightarrow R$  is carried out with 2.5 mol/litre of A as initial concentration. Second order reaction rate constant is 0.0005 lit/mol -sec. Calculate the time required to achieve 75% conversion. 4
2. Explain the role of catalyst in a chemical reaction and the general characteristics of a catalyst. How will you determine the effectiveness of a catalyst? Derive an expression. 13
3. What do you mean by isothermal, non-isothermal and adiabatic operation of a reactor? Explain in details. An irreversible isomerization reaction is to be carried out in liquid phase at 165°C. The reaction is  $A \rightarrow R$  and it follows first order kinetics. Reaction rate expression is  $(-r_A) = k.C_A$ . Reaction rate constant  $k = 0.7 \text{ hr}^{-1}$  Activation energy  $E = 120 \text{ kJ/mole}$ . Heat of reaction  $\Delta H_r = 350 \text{ kJ/kg}$ . Specific heat capacity of reactants and products is  $1.95 \text{ kJ/kg}^\circ\text{C}$ . It is desired to have 98% conversion. Density of the reaction mixture is  $900 \text{ kg/m}^3$ . Calculate the volume of reactor to process 300 kg/hr of reactant and the temperature of the reaction mixture if the reactor is operated adiabatically. Value of gas constant  $R = 8.314 \text{ J/mol K}$ . How rate constant varies with temperature of the reaction mixture. 13
4. a) What are the types of deactivation of a catalyst and explain deactivation Kinetics. 7  
b) Explain the importance of residence time distribution and the dispersion model for a reactor. 7
5. Why recycle reactors are preferred in industries and explain its advantages? How will you evaluate the performance of a batch recycle reactor and CSTR recycle reactor? 13
6. What are the parameters to be defined for proper modelling for fluid flow, heat transfer, mass transfer and reaction kinetics of a fixed bed reactor? Discuss in details the salient features of a one -dimensional pseudo homogeneous flow model. 13
7. How to develop model equations for a trickle bed reactor for its design and how to estimate the weight of catalyst for such reactors. 13

8. How to develop rate equations for a slurry reactor and discuss the reaction - diffusion phenomena in such reactors.
9. What are the advantages of fluidized bed reactor over fixed bed reactor and discuss the salient features of modeling of such reactors in terms of hydrodynamic parameters. 13
10. a) In a plug flow reactor, a catalytic reaction is carried out at 3 bar pressure and 125°C. The reaction is  $A \rightarrow 3.5 R$ . The reactor contains 0.015 kg catalyst. Feed to the plug flow reactor is partially converted product of 28 litres/hr of pure unreacted component A. The following data is available: 7

Run	1	2	3
$C_{A_{in}}$ mol / lit	0.08	0.06	0.05
$C_{A_{out}}$ mol / lit	0.068	0.054	0.037

Gas constant  $R = 0.082$  lit - atm/mol K. Determine the rate expression to represent this catalytic reaction.

- b) Explain the methods of catalyst preparation and the function of catalyst promoter and inhibitor. 7

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