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

Question Paper Code: 95903

B.E./B.Tech. DEGREE EXAMINATION, DEC 2021

Fifth Semester

Chemical Engineering

19UCH503 - CHEMICAL REACTION ENGINEERING I

(Regulation 2019)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The rate constant for a first order reaction CO1- R

(a) depends on unit of time

(b) has units of reciprocal time

(c) does not change on changing the concentration units

(d) all of the above.

2. A certain first order reaction is half completed in 23 minutes. The rate constant for the reaction must be CO2- App

(a) 0.03 s^{-1} (b) 0.030 min^{-1} (c) 0.030 hr^{-1} (d) 0.110 min^{-1}

3. For identical feed composition ,flow rate , conversion and for zero order reactions the ratio of the volume of mixed reactor to the volume of PFR is CO1- R

(a) 0 (b) 1 c) < 1 (d) >1

4. For identical feed composition and flow rate, N plug flow reactors in series with a total volume V gives the same conversion as a single CO1- R

(a) plug flow reactor of volume V

(b) CSTR of volume V

(c) plug flow reactor of volume V/N

(d) plug flow reactor of volume NV

5. For any reaction the maximum attainable concentration of desired product in a plug flow reactor is — CO1- R

(a) always lower than that in a MFR (b) always higher than that in a MFR

(c) always same that in a MFR (d) None of the above

6. For the desired product formation $r_R/r_S = k1/k2.C_A^a.C_B^b$, to maximize the r_R/r_S when a and b are positive we have to maintain the concentration of A and B as — CO3- Ana

(a) low respectively (b) high and low respectively

(c) high respectively (d) low and high respectively

7. Estimate equilibrium constant (k_2) for a reaction with k_1=30.8, ΔH_R^o= -10938 cal/mol, for T_1 and T_2 as 298 and 600 respectively — CO2- App

(a) $3.15*10^{-3}$ (b) $2.83*10^{-3}$ (c) $4.0*10^{-2}$ (d) $1.5*10^{-3}$

8. For an ideal gas, fugacity is equal to — CO1- R

(a) temperature (b) pressure (c) concentration (d) none of the above

9. In which reactor distribution of residence times of fluid within the reactor happens — CO1- R

(a) Batch reactor (b) MFR

(c) Plug flow reactor (d) all of the above

10. The total area under E curve $\int E\,dt$ = — CO3- Ana

(a) 0 (b) 2 (c) 1 (d) α

PART – B (5 x 2= 10 Marks)

11. Define rate of reaction — CO1- U

12. What are continuous reactors? Give examples. — CO1- U

13. Give the expression for overall fractional yield for N mixed flow reactors in series. — CO1- U

14. Define optimum temperature progression. — CO1- U

15. What is residence time distribution in a reactor? — CO1- R

PART – C (5 x 16= 80 Marks)

16. (a) Discuss in detail about integral and differential method used to analyze rate data. — CO1- U — (16)

Or

(b) Derive the performance equation for a constant volume batch reactor with a neat sketch. . CO1- U (16)

17. (a) Explain in detail about the size comparison of MFR with PFR and derive expressions for first order reaction CO1- U (16)

Or

(b) Reactant A with C_{AO} = 26 mol/m^3 passes through four equal size mixed flow reactors in series (τ_{total} = 2 min) and reacts according to the reaction A→R .when the steady state is reached the concentration of A is found to be11,5,2 and 1 mol/m^3 respectively in the four reactors. For this reaction, find τ_{plug} as to reduce the concentration of A from C_{AO}=26 to C_{AF}= 1mol/m^3. CO2- App (16)

18. (a) Liquid reactant A decomposes as per the following reactions in parallel CO2- App (16)

A-→R

A-→S(desired)

A-→T

With r_R = 1, r_S=2 C_A and $r_T = CA^2$ and C_{AO} =2 in a feed. Determine the maximum concentration of desired product that can be obtained in a mixed flow reactor.

Or

(b) Substance A in a liquid reacts to form R and S according to the following reaction scheme: CO2- App (16)

A→R

A→S with $r_R = k_1 C_A^2$ and $r_S = k_2 C_A$, a feed with C_{AO} = 1.0, C_{RO}=0 and C_{SO}= 0.30 enters two mixed flow reactors in series (τ 1 = 2.5 min and τ 2=10 min).the composition of the exit stream from the first reactor is C_{A1}= 0.40, C_{R1}=0.20 and C_{S1}=0.70.find the composition of the exit stream from the second reactor.

19. (a) Discuss in detail about the adiabatic operations and derive the expression for energy balance and represent it graphically. CO1- U (16)

Or

(b) For the elementary liquid phase reaction A reversibly reacts with R construct a plot of equilibrium conversion as a function of temperature and conversion when pure A at a temperature of 27 ^{O} C (300 K) is fed to the reactor. CO2- App (16)

Datas: $\Delta H_{f\,A}$ = -40000 cal/mol

$\Delta H_{f\,R}$ = - 60000 cal/mol

C_{PA} = 50 cal/(mol.k), C_{PR}= 50 cal/mol .k

K = 100000 at 298 K

20. (a) The following results were obtained for a pulse tracer test carried on a piece of reaction equipment. CO1- U (16)

The output concentration rose linearly from zero to 0.5 μmol / dm^3 in 5 min, then fell linearly to zero in 10 min (after reaching a maximum value of 0.5 μmol / dm^3).

(i) Calculate the mean residence time.

(ii) Calculate the total reactor volume if the flow rate is 570 l /min.

Or

(b) A reactor with a number of dividing baffles is to be used to carry out the reaction CO5- U (16)

A →R, $-r_A = 0.05C_A$, mol / (l.min)

The results of a pulse tracer test are given below:

t,min	0	10	20	3	40	50	60	70
C	35	38	40	40	39	37	36	35

How many tanks in series would you suggest to model the reactor / will represent this reactor?