Time: 3 Hours   **Total Marks: 80**

N.B.: 1. Question No.1. is compulsory.
      2. Attempt any three questions out of remaining five questions.
      3. Assume suitable data and justify the same.
      4. Figures to the right indicate full marks

Q 1	(a)	Explain the Integral method of analysis of kinetic data.	05
	(b)	Derive the performance equation for CSTR.	05
	(c)	A common rule of temperature is that the rate of a reaction doubles for each 10°C rise in temperature. What activation energy would this suggest at a temperature of 25°C	05
	(d)	Short note on Optimum temperature Progression	05

Q 2   (a)   Experiment shows that the homogeneous decomposition of ozone proceeds at a rate   **10**

$$-r_{O3}=k\,[O_3]\,[O_2]^{-1}$$

(a) What is the overall order of reaction?

(b) Suggest a two-step mechanism to explain this rate.

    (b)   A 10-minute experimental run shows that 75% of the liquid reactant is converted to product by a ½ order rate. What would be the fraction converted in a half-hour run?   **10**

Q 3   (a)   Liquid reactant A decomposes as follows: **10**

$$A \rightarrow R \quad r_R = k_1 C_A^2 \qquad k_1 = 0.35 \text{ m}^3/\text{mol.min}$$

$$A \rightarrow S \quad r_S = k_2 C_A \qquad k_2 = 2.5 \text{ min}^{-1}$$

A feed of aqueous A (C_{A0} = 50 mol/m^3) enters a reactor, decomposes and a mixture of A, R, and S leaves the reactor. Find C_R, C_S and τ for X_A =0.8 in a mixed flow reactor

    (b)   For the irreversible first-order series reaction A$\rightarrow$ R$\rightarrow$ S, the values of rate constants k1 and k2 are 0.17 min-1 and 0.11 min-1, respectively, for reactions 1 and 2. i) Calculate the time at which the concentration of R is maximum, and ii) the maximum concentration of R.   **10**

Q4   (a)   A first-order reaction is carried out in a single CSTR, resulting in an 80% conversion of reactant A. It is proposed to put another similar CSTR in series with the first one. How will this addition affect the conversion of the reactant?   **10**

(b) What is an autocatalytic reaction? Discuss the types of reactors/reactor combinations **10** used to carry out this type of reaction.

Q 5 (a) The first-order homogeneous gaseous reaction A → 2.5 R is carried out in an isothermal **10** variable volume batch reactor at 2 atm pressure with 20 mole % inert present, and the volume increases by 60 % in 20 minutes. In the case of a constant volume reactor, determine the time required for the pressure to reach 8 atm if the initial pressure is 5 atm, 2 atm of which consists of inerts.

(b) From the steady-state kinetic runs in a mixed flow reactor, we obtained the following **10** data on the reaction.

$$A \rightarrow R$$

Find the space time needed to treat a feed with an initial concentration of 100 mol/m^3 to 80% conversion in a) Plug flow reactor, b) Mixed flow reactor.

Space time (min)	60	35	11	20	11
C_{AO} (mol/m^3)	50	100	100	200	200
C_A(mol/m^3)	20	40	60	80	100

Q 6 (a) The standard heat of gas phase reaction at 25 ^{0}C **10**

A+ B → 2R   is ΔH_R^0 = - 45000 J. This indicates the reaction is strongly exothermic. It is planned to run this reaction at 1000 ^{0}C. What is the value of heat of reaction at that temperature? Is the reaction still exothermic at 1000 ^{0}C?

Data: Cp_A = 35.5 J/mol.k Cp_B = 45.5 J/mol.k Cp_R = 70.5 J/mol.k

(b) An irreversible isomerisation reaction carried out in the liquid phase in a mixed reactor **10** A→R is a first-order reaction. Rate constant at 165 ^{0}C = 0.7 h^{-1}, Activation energy = 120000 J/mol, Heat of reaction = - 350 KJ/kg, Heat capacity of reactants and products = 1.95 kJ/kg.K, volumetric flow rate = 0.33 m^3/h Feed temp = 20^0 C, conversion expected = 95 % Calculate the reactor size and temperature of the reaction mixture if the reactor is operated adiabatically.

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13/06/2025 TE CHEMICAL SEM-V C-SCHEME FOOD ENGG. QP CODE: 10086719

Time: 3 Hours   Total Marks: 80

N.B.
1. **Question No. 1 is compulsory**
2. **Attempt any three questions from the remaining five questions**
3. **Assume suitable data wherever necessary**

Q. No. 1
a. Write a short note on the important constituents of food.   [05]
b. Write a short note on size reduction in liquid foods.   [05]
c. Discuss the unit operation of blanching in food processing.   [05]
d. Write a short note on GMP (Good Manufacturing Practices).   [05]

Q. No. 2
a. Discuss hazard analysis and critical control points concerned with food safety. [10]
b. Discuss various membrane concentration processes in food processing   [10]

Q. No. 3
a. List the different types of alcoholic beverages and discuss the manufacturing process of anyone. [10]
b. Write short notes on the following.   [10]
   1. Refrigerant used in refrigeration of foods.
   2. Modified atmospheric storage.

Q. No. 4
a. Discuss important equipment used for size reduction in solid foods.   [10]
b. Discuss food fortification and food enrichment and also highlight the differences between them. [10]

Q. No. 5
a. Write short notes on the following.   [10]
   1. Aseptic processing
   2. Pasteurization.
b. Discuss the process of cheese manufacturing in detail.   [10]

Q. No. 6
Write short notes on the following **(Any four)**-   [20]
a. D and Z values.
b. Forming in food processing
c. Freeze drying.
d. Thermal processing of food.
e. Advantages of ambient temperature processing of foods

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(Time: 3 hours)   **(Maximum Marks: 80)**

N.B
1. **Question No. 1** is compulsory.
2. Attempt any **three** out of remaining **four** questions.
3. Refer steam table if necessary and indicate it clearly.
4. Assume suitable data if necessary and state it clearly.
5. Figures to the right indicate marks.
6. Illustrate answers with sketches wherever required.

Q1. (a) Calculate the heat loss by radiation by unlagged horizontal steam pipe, 50 mm   **05**
O.D. at 377 K to air at 283 K. Use emissivity, e = 0.9.

   (b) For one plane wall (slab) of uniform thickness prove that,   **05**

$$Q = \frac{\Delta T}{R}$$

   (c) Write a short note on flow arrangements in heat exchanger.   **05**

   (d) State the assumptions made in Nusselt's theory of condensation.   **05**

Q2. (a) A steel pipe 25 mm internal diameter and 33 mm outer diameter and insulated   **10**
with rockwool carries steam at 451 K. If surrounding air temperature is 294 K,
calculate the rate of heat loss from one metre length of pipe. the thickness of
insulation is 38 mm. Thermal conductivities of steel and rockwool are 44.97
W/(m.K) and 0.175 W/(m.K) respectively. The inside and outside heat transfer
coefficients are 5678 W/(m^2.K) and 11.36 W/(m^2.K) respectively. Contact
resistance between the pipe and insulation may be neglected.

   (b) A solid steel ball 50 mm in diameter and initially at a temperature of 723 K is   **10**
quenched in the controlled environment whose temperature is maintained at a
steady value of 363 K. Determine the time taken by the centre of the ball to
reach a temperature of 423 K if internal temperature gradient is neglected.
Data: h = 115 W/(m^2.K), ρ = 8000 kg/m^3, C$_p$ = 0.42 kJ/(kg.K).

Q3. (a) Air at a temperature of 523K flows over a flat plate 0.3 m wide, 1m long, at   **10**
a velocity 8m/s. If the plate temperature is 315K, find the rate of heat
transfer to the plate. Data at mean temperature : k=0.0364 W/m K. N$_{pr}$ = 0.69.
kinematic viscocity = 0.0004m^2/s.

81881   **Page 1 of 2**

(b) A 20 mm φ horizontal heater is maintained at a surface of 313K and submerged   **10**

in water at 298K. estimate the heat loss/ unit length of heater by natural convection.

Data:- Properties of water at mean temperature of 32.5 ^{0}C

$k = 0.63$ W/m K, $\beta = 3.04*10^{-4}$ K^{-1}, $\rho = 1000$ kg/m^3, $\mu = 8*10^{-4}$ kg /m-s,

$C_p = 4.187$ kJ/kg ^{0}C.

Use $Nu = 0.53(Gr.Pr)^{1/4}$

Q4. (a) Two long planes A and B are maintained at 600 K and 300 K and their   **10**
surface emissivities are 0.8 and 0.5 respectively. Two thin radiation shields
C and D having emissivities 0.5 and 0.4 are introduced between two planes
the given planes. The given planes are in the order A, C, D and B. Assuming
all the planes to be infinitely long, find the rate of heat exchange per unit area
and steady- state temperatures attained by the planes C and D.

(b) Describe the various methods of feeding in Multiple Effect Evaporator.   **05**

(c) Derive equation for Reynold – Colburn Analogy.   **05**

Q5. (a) Saturated steam at 80 ^{0}C condenses at outside of a horizontal tube of 100 mm   **10**
O.D. and length L. The tube wall is maintained at 70 ^{0}C. When the tube was
kept vertical, it was observed that the rate of condensation was the same as
before. Find the tube length L and the rate of condensation per hour.

Data: The properties of condensate of film temperature of 75 ^{0}C are:

$k = 0.871$ W/(m.K), $\rho = 975$ kg/m^3, $\mu = 380.5*10^{-6}$ N.s/m^2,

Latent heat of condensation of steam $= 2300$ kJ/kg

(b) Show by dimensional analysis that Nusselt number is a function of Reynold's   **10**
number & Prandtl number for the case of heat transfer by forced convection.

Q6. (a) Derive the expression for log mean temperature difference for countercurrent   **10**
flow. Also state the correction in LMTD for 1-2 heat exchanger.

(b) It is desired to heat 230 kg/h of water from a temperature of 308 K to 366 K   **10**
with a oil having initial temperature of 448 K . The mass flow rate of oil is the
same as that of water. Use counter current flow. The following two double –
pipe heat exchangers are available:

HE-1 :   U = 570 W/(m^2.K)   A = 0.47 m^2

HE-2 :   U = 370 W/(m^2.K)   A = 0.94 m^2

Which heat exchanger should be used?

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Duration: 3 hours   **Total Marks: 80**

N. B. (i) Question number one is compulsory.
      (ii) Answer any three questions from the rest.
      (ii) Assume suitable data wherever necessary.

Q 1 Answer the following   Marks

  a. Differentiate between molecular diffusion and eddy diffusion.   5

  b. Explain film theory with suitable diagram showing concentration profile showing   5
     concentration-distance curve.

  c. Explain the concept of equilibrium with the help of equilibrium distribution of solute   5
     between gas and liquid phase at constant temperature.

  d. Write a short note on properties of ideal solvent for gas absorption.   5

Q2 a. Ammonia is diffusing through a stagnant gas film mixture of 33 %Nitrogen and   10
     67% Hydrogen by volume. The total pressure is 205 KN/m^2 abs. temperature is 55 ^{0} C.
     Calculate rate of diffusion of ammonia per m ^{2} through 0.5 mm thick film when
     concentration changes across the film from 10 % to 5% by volume ammonia.
     D $_{NH3-N2}$ = 0.196 cm^2 /sec., D $_{NH3-H2}$ =0.63 cm 2 /sec.

  b. Derive the equations for steady state molecular diffusion of A into non-diffusing B and   10
     equimolar counter diffusion of A and B for laminar flow.

Q 3. a. Compare Penetration theory and surface renewal theory of mass transfer.   10

  b. A large volume of pure gas B at 2 atm is flowing over the surface from which pure A   10
     is vaporizing. Liquid A completely wets the surface which is a blotting paper. Hence
     the partial pressure of A at the surface is vapour pressure of A at 298 K which is
     0.2 atm. The ky′ has been estimated to be 6.78 X 10^{-5} kmol/m^{2}sec mole fraction.
     Calculate N$_A$ and ky.
  .

Q 4 a. A countercurrent plate absorber is to be installed for scrubbing an air mixture   10
     containing 5 % ammonia by volume. The scrubber is fed with water containing 0.002
     mole ammonia per mole of water. The scrubbing water rate is 1 mole water per mole
     ammonia. It is required to absorb 85% of ammonia present in the gas by operating the
     absorber at 20 ^{0}C. Y=0.8X. Calculate the concentration of ammonia in the outgoing
     liquid and number of stages required.

  b. With suitable diagram explain the calculation for minimum liquid gas ratio in   10
     absorption

Q 5 a. In laboratory test, the rate of drying was found to be 0.5×10^{-3} kg/m^{2}s when the moisture content reduced from 0.4 to 0.1 on dry basis. Critical moisture on dry basis is 0.08. A tray dryer is used for drying 100 kg of the same material on dry basis under identical conditions. The area of the material is 0.04 m2/kg of solid. Calculate the time required to reduce the moisture content from 0.3 to 0.2 on dry basis.   10

   b. Draw and explain typical rate of drying curve under constant drying conditions showing different regions of drying.   10

Q 6 Write short notes on any 4:   5 each
    A. adiabatic saturation temperature.
    B. comparison of packed and tray towers.
    C. Adiabatic saturation curve
    D. Diffusion through porous solid.
    E. Drum dryer

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84263

11/06/2025 TE CHEMICAL SEM-V C-SCHEME TP QP CODE: 10080342

Time: 3 Hours   Marks:80

N. B.:   (1) Question No. 1 is compulsory.

                   (2) Attempt any three questions from remaining five questions.

                   (3) Assume suitable data if necessary.

Q. 1 Answer any five questions   (20)

   a) Interpret any two dimensionless numbers from analogous transport diffusivities.

   b) Explain Analogy between heat and mass transfer.

   c) Write the Navier-Stokes Equation and define the terms involved.

   d) Explain and write Fourier's law of heat conduction in three dimensional form.

   e) What is diffusion? What factors may cause diffusion to occur?

   f) What is molecular and convective flux, explain.

Q. 2

(a) Derive an expression for equation of continuity   (10)

(b) A copper wire 10 mm diameter and 4.6 m long has a voltage drop of 0.6 volts, find the maximum temperature in the wire if the ambient air temperature is 298.15 K and the heat transfer coefficient h is 32.37 W/m^2 K, Lorenz constant for copper = 223×10^{-8} volt^2 /K^2, Thermal conductivity of copper at 298.15 K = 384.1 W/m K   (10)

Q. 3

   a) Find the radius of capillary tube which is used to measure the rate of flow of viscous fluid flow through the tube.   (10)

      Given:

      Length of capillary = 50.02 cm

      kinematic viscosity of fluid = 4.03×10^{-5} m^2 sec^{-1}

      Density of Fluid = 0.9552×10^3 Kg/m^3

      Pressure drop across capillary tube = 4.766 atm

      Mass rate of flow through tube = 2.997×10^{-3} Kg/sec

   b) A viscous fluid is in laminar flow in a slit formed by two parallel walls at a distance 2B apart. Derive a differential momentum balance and obtain an expression for distribution of momentum flux. What is the ratio of average to maximum velocity in the slit?

                                                                                           (10)

Q. 4

(a) An electric current of 200 Amp is passed through stainless steel wire having radius r =1.26 mm and length L=91cm. The wire has a resistance of 0.126 Ω. The outer surface temperature T_w is held at 422.1 K. The average thermal conductivity is k= 22.5 W/m. K. Calculate the centreline temperature.   **(10)**

(b) Derive an expression for conduction in an electrical heat source.   **(10)**

Q. 5

   a)   A value of $D_{AB}= 0.151$ cm^2/sec has been found for the system CO_2-air at 293K and 1atm. Calculate D_{AB} at 1500K by the following methods. a) Slattery Equations, b) Chapman Enskog Equation

      Data: For non-polar gas pairs, b = 1.823, $(\Omega_{DAB})_{1500}= 0.734$, $(\Omega_{DAB})_{293} = 1.047$ **(10)**

   b)   Derive an expression for Diffusion with homogenous chemical reaction.   **(10)**

Q. 6

   a)   A small capillary tube with an inside diameter of 2.2×10^{-3} m and length of 0.317 m is being continuously used to measure the rate of flow of liquid having density 990 kg/m^3 and viscosity of fluid, $\mu = 1.13\times10^{-3}$ Pa.s. The velocity of liquid is 0.275 m/sec. Calculate the pressure drop.   **(08)**

   b)   Explain the temperature and pressure dependence of diffusivity.   **(06)**

   c)   Derive Fourier's law of conduction.   **(06)**

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