Code No: RR410801

Set No.1

IV B.Tech. I Semester Regular Examinations, November -2005
TRANSPORT PHENOMENA
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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NOTE: Use of equations of change are permittted.

1. Write the equations for prediction of diffusivity of gases and liquids. Define the terms involved in the equations. [16]

2. Derive the analog of the Hagen-Poiseuille formula for the ostwald-de Waele (power law) model. [16]

3. Obtain an expression for concentration profile in a simple system of diffusion (gas-liquid) with homogeneous chemical reaction. [16]

4. Two vertical plates are spaced 6mm apart. One is maintained at 100^0C and the other at 20^0C. Air is flowing between plates at a pressure of 1atmosphere and you may assume that the volumetric flow of upward moving stream is same as that of downward moving stream. Evaluate average velocity of air if $\mu = 2 \times 10^{-6}$ poise. [16]

5. A natural gas mixture is contained in Pyrex tube. The inner and outer radius of the tubes are R_1 and R_2 respectively and the length of the tube is L. Obtain an expression for the rate at which helium will leak through the tube interms of the diffusivity of helium in Pyrex. The interfacial concentrations of the helium in the Pyrex and the dimensions of the tube. [16]

6. Explain the following:
   (a) The partial time derivative
   (b) Total time derivative
   (c) Substantial time derivative
   (d) Navier-stokes equation. [4+4+4+4]

7. Consider two concentric porous spherical shells of radii kR and R where kR is the radius of the inner porous sphere and R is the radius of the outer porous sphere. The outer surface of the inner one is at T1 and the outer surface of the outer one is at a lower temperature Tk. Dry air at a temperature Tk is blown outward radially from the inner shell into the intervening space and out through the outer shell. Develop an expression for the required rate of heat removal from the inner sphere as a function of the mass rate of flow of gas. Assume steady laminar flow and low gas velocity. Use both the equation of continuity and equation of energy. [16]

8. Explain the following theories:

(a) Bonssinesq's eddy viscosity

(b) Prandtl's Mixing length

(c) Von Karman's similarity Hypothesis. [6+6+4]

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Code No: RR410801 **Set No.2**

IV B.Tech. I Semester Regular Examinations, November -2005
TRANSPORT PHENOMENA
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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NOTE: Use of equations of change are permittted.

1. (a) Describe the diffusion phenomenon with an example. Define the terms mass concentration, molar concentration, mass fraction and mole fraction with symbols.

   (b) A gas mixture contains 50% of H2 and 50% of O_2 by volume. The absolute velocity of the species are -10 m/s and 12 m/s, respectively. What is the mass average velocity if total concentration of gas is 0.6 kmol/m^3. [8+8]

2. Derive a formula for the thickness of a film of Bingham fluid falling down a vertical flat surface at a rate 'm'. (g sec^{-1} per width of wall.) [16]

3. Show that the Nusselt number = 2, for heat conduction from a solid sphere to surrounding stagnant fluid. Use shell energy balance. [16]

4. Air at 27^0C flows normal to a 73^0C, 30mm o.d. water pipe. The air moves at 1m/s. Estimate the rate of heat transfer per unit length kinematic viscosity=1.624m^2/s, Thermal conductivity=0.0261W/mk, Npr for air=0.702. [16]

5. At steady state conditions oxygen diffuses through Nitrogen. The temperature is 0^0C and the total pressure is 1×10^5 (N/m^2). Consider Nitrogen as non-diffusing. The partial pressure of oxygen at two locations 2.2 mm apart is 12,500 and 6000 N/m^2 and its diffusivity is 1.81×10^{-5} m^2 / s. Determine the diffusion rate of oxygen. [16]

6. (a) Derive the equation of continuity considering rectangular co-ordinates.

   (b) Reduce the equation for incompressible fluids. [14+2]

7. Two large flat porous horizontal plates are separated by a relatively small distance L. The upper plate at y-L is at a temperature Tl and the lower plate at y = 0 is to be maintained at a lower temperature T0. To reduce the amount of heat that must be removed from the lower plate, a coolant gas is blow upward through both the plates at steady state. Develop an expression for the temperature distribution using the equation of energy. [16]

8. (a) Explain Isotropic turbulence.

   (b) Explain prandtl's mixing length and Von Karman's similarity hypothesis. [6+10]

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Code No: RR410801 **Set No.3**

IV B.Tech. I Semester Regular Examinations, November -2005
TRANSPORT PHENOMENA
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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NOTE: Use of equations of change are permittted.

1. (a) Define local mass average velocity and local molar average velocity of multi-component systems with their corresponding equations and notation.

   (b) Determine the diffusivity of CO through a mixture of N_2 and O_2 in which the th concentration of CO is essentially zero. The gas mixture will be at 25^0C and 2 atm. pressure. Other data : $D_{CO-O2} = 0.185\ cm^2$/s at 273^0K, 1 atm. ; $D_{CO-N2} = 0.192\ cm^2$/s at 288^0K , 1 atm. [8+8]

2. Derive the analogue of Hagen-Poiseuille formulae for the power law model fluid flowing through a horizontal pipe of length L and radius R under pressure force, from shell momentum balance approach. [16]

3. A dimerization reaction 2A $\rightarrow A_2$ is being carried in a catalytic reactor. Assume that a diffusional resistance lies in the stagnant gas film of thickness and surrounding the catalyst surface. Derive an expression for the local rate of conversion of A to A_2 where the reaction is instantaneous. [16]

4. An oil acts as lubricant between two cylindrical surfaces. The outer cylinder has a radius of 0.05m and rotates at 9000rpm.The clearance between the two cylinders is 0.025cm. Find out the maximum temperature in the oil bath if the both wall temperature are kept at 70^0C. The properties of oil may be taken as follows.
μ=0.95poise,K=0.023J/s cm^0C, ρ=1220Kg/m3. [16]

5. An infinite horizontal slab uniform width 'h' has its upper and lower surface maintained at concentration Cao and Zero respectively. Determine the steady-state concentration profile in the slab. Calculate the flux for both surfaces at steady state conditions. [16]

6. Derive the Fourier Heat conduction equation in spherical co-ordinates. [16]

7. Liquified oxygen is stored in a spherical container surrounded by a spherical shell of porous insulating material. A thing gas space is left between the container and insulation. The opening in the insulation is stoppered. The evaporating oxygen leaves the container move through the gas space and then flow uniformly out through the porous insulation. Derive the equation for the rate of heat gain and evaporation using equation of energy. [16]

8. (a) Explain the curves for velocity distribution for turbulent flow in tubes for the region near the wall.
   (b) Explain the intensity of turbulence. [10+6]

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Code No: RR410801 **Set No.4**

IV B.Tech. I Semester Regular Examinations, November -2005
TRANSPORT PHENOMENA
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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NOTE: Use of equations of change are permittted.

1. (a) Write the equations for mass and molar fluxes in binary systems with their corresponding units.
   (b) Estimate the liquid diffusion coefficient of ethanol in a dilute solution of water at 10^0C. The molecular volume of ethanol is 59.2 cm^3/gmol. Ψ_B for water is 2.6 and M_B for water is 18. [8+8]
2. Derive a formula for the thickness of a film of a Bingham fluid falling down a vertical flat surface at a rate Γ (g sec^{-1} per unit width of wall). [16]
3. A circular fin of thickness B is fitted on a circular pipe of radius R_0. The wall temperature of the pipe is T_0 and that of ambient is T_a. The radius of the circular fin is R_1. Neglecting the heat loss from the edge, obtain a differential equation to predict temperature profile T (r) in the fin. Use shell energy balance. [16]
4. A current at 300amps is passed through a stainless steel wire of 2.5mm in diameter. The resisitivity of the wire is 100milli ohm-m and length of wire is 1.5m. It the outer surface temperature of wire is at 200^0C, calculate the center temperature of the wire. The thermal conductivity of the wire is 40W/m^0C. [16]
5. Consider the problem of drying of droplets. Derive the equation for diffusion through a spherical shell of raidus r1. The shell is surrounded by a spherical film of radius r2. Obtain the molar flux for the evaporating component A. [16]
6. (a) Derive an expression for temperature distribution in case of an incompressible Newtonian fluid between two coaxial cylinders in which the outer one is rotating and the inner one is stationary.
   (b) Explain the physical significance of Brinkman number. [12+4]
7. Consider an electrical wire suspended in a flowing fluid. The ends are mounted on solids maintained at temp. Ts and gas at constant temp Tg. The fluid flows past the wire. Although the wire is cylindrical it is thin enough so there are no radial temperature gradients. Heat is generated in the wire(due to current) at a rate Se. Using the Navier -Stokes equation
   (a) write the differential equation.
   (b) For this solution write the necessary boundary conditions

(c) Solve the equation for temperature profile in the wire. [6+2+8]

8. (a) Explain the qualitative comparison of laminar flow and turbulent velocity distribution

   (b) Explain Reynolds stresses. [10+6]

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