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 = 0.9552×103 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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