Registration No :

Total number of pages : 02 **B.Tech.**

PCE5I101

5^{th} Semester Regular/Back Examination 2018-19

TRANSPORT PHENOMENA

BRANCH : CHEM

Time : 3 Hours

Max Marks : 100

Q.CODE : E294

Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II, and any two from Part-III.

The figures in the right-hand margin indicate marks.

Assume suitable notations and any missing data wherever necessary.

Answer all parts of a question at a place.

Part – I

Short Answer Type Questions (Answer All TEN)

Q1. Answer the following questions : (2 x 10)

(a) Define combined momentum flux.

(b) Define Stoke's law and its range of applicability.

(c) Define Newton's law of viscosity.

(d) What are the units of dynamic and kinematic viscosities?

(e) Write the Eucken's formulae for mono-atomic and polyatomic gases.

(f) Thermal conductivity varies with temperature linearly. At $T = T_0$, $K = K_0$, and at $T = T_1$, $K = K_1$write the equation relating K and T.

(g) How viscosity depends on temperature in case of fluids?

(h) How diffusivity varies with temperature in case of gases & liquids?

(i) Write Fick's Law of diffusion with constant concentration.

(j) Define Prandtl, Schmidt, and Lewis numbers.

Part – II

Focused-Short Answer Type Questions(Answer Any Eight out of Twelve)

Q2. Answer the following questions : (6 x 8)

(a) Explain types of fluids by showing them on shear stress and shear strain plot with mathematical expressions.

(b) Derive an expression for velocity profile when a Bingham fluid is flowing through a pipe of radius R vertically downward.

(c) What is the ratio of maximum velocity to average velocity forPower law fluid flowing inside a vertical tube downward, when velocity profile is given by the equation:

$$V_{rz} = \left[\frac{-\left[\left(\frac{P_0 - P_L}{L}\right) + \rho g\right]}{2\mu}\right]^{\frac{1}{n}} \left(\frac{n}{n+1}\right)\left[r^{\frac{n+1}{n}} - R^{\frac{n+1}{n}}\right],$$

Where the symbols are in there usual meaning.

(d) One method for determining the radius of a capillary tube is by measuring the rate of flow of a Newtonian liquid through the tube. Find the radius of a capillary from the following flow data :

Length of capillary tube:	50.02 cm
Kinematic viscosity of liquid:	4.03×10^{-5} m^2/s

Density of liquid: 955.2 kg/m^3
Pressure drop in the horizontal tube: 4.829×10^5 Pa
Mass rate of flow through tube: 2.997×10^{-3} kg/s

(e) Explain Free and Forced convection heat transfer.

(f) A heated sphere of radius R suspended in a large motionless body of fluid. Show that, $Nu = \frac{hD}{K} = 2$ where *h* is heat transfer coefficient, *D* is the diameter of sphere, and *K* is the thermal conductivity.

(g) What are the boundary conditions used for solving shell heat balance equation?

(h) Write combined heat flux equation and explain each term.

(i) Derive the equation for the temperature distribution for heat conduction with an electrical heat source.

(j) Derive an expression for mass flux in steady state equimolarcounter diffusion.

(k) A hollow solid sphere has its inner radius ($r = R_1$) and outer radius ($r = R_2$) maintained at concentrations C_{A1} and C_{A2}respectively.Obtain the concentration profile in the solid at steady-state condition.

(l) In studying the rate of leaching of a substance A from solid particles by a solvent B, the rate controlling step is diffusion of A from the particle surface through a stagnant liquid film thickness δ out into the main stream. The molar solubility of A in B is C_{A0} and the main stream is $C_{A\delta}$. Show that,

Rate of leaching is $N_{AZ} = D_{AB}(C_{AO} - C_{A\delta})/\delta$.

Part – III

Long Answer Type Questions (Answer Any Two out of Four)

Q3. Derive an expression for average velocity of Newtonian fluid flow between two vertical walls, separated by a distance 2B. Taking origin at midpoint of 2B distance, develop the expression from shell momentum balance equation. **(16)**

Q4. Develop a partial differential equation for forced convection through a pipe in dimensionless terms and mention the boundary conditions to solve the equation. **(16)**

Q5. Consider a long cylindrical nuclear fuel rod, surrounded by an annular layer of aluminum cladding. Within the fuel rod heat is produced by fission; this heat source depends on position approximately as, $S_n = S_{n0}\left[1 + b\left(\frac{r}{R_F}\right)^2\right]$, where,$S_{n0}$and *b* are known constants and *r* is the radial coordinate measured from the axis of the cylindrical fuel rod. R_F and R_C are the radii of fission and cladding materials. Derive an expression for temperature profile in the cladding material if the temperature at the outer surface of cladding is T_0. **(16)**

Q6. A droplet of liquid A of radius r_1, is suspended in a stagnant film of gas of radius r_2. Boundary conditions are $r = r_1$, $x_A = x_{A1}$ and $r = r_2$, $x_A = x_{A2}$. Taking the value of constant as $r_1^2 N_{Ar1}$, show that, **(16)**

$$N_{Ar1} = \frac{CD_{AB}}{r_2 - r_1}\left(\frac{r_2}{r_1}\right)\ln\left(\frac{x_{B2}}{x_{B1}}\right),$$

when $r_2 \rightarrow \infty$, what will be the expression for N_{Ar1}.