Registration No. : | | | | | | | | | | |

Total number of printed pages – 2

B. Tech

PCML 4301

Sixth Semester Back Examination – 2015

TRANSPORT PHENOMENA

BRANCH : CHEM

QUESTION CODE : M 364

Full Marks – 70

Time : 3 Hours

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*Answer Question No. **1** which is compulsory and any **five** from the rest.*
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.

1. Answer the following questions : 2×10
   (a) Define Newton's Law of viscosity.
   (b) Define Stoke's law.
   (c) Verify that "momentum per unit area per unit time" has the same dimensions as "force per unit area".
   (d) How viscosity and thermal conductivity depends ontemperature in case of low density gases ?
   (e) Define thermal conductivity.
   (f) State Eucken formula for thermal conductivity.
   (g) What are the boundary conditions used for solving shell heat balance equation ?
   (h) Write the shell mass balance equation.
   (i) What is diffusion and its applications in mass transfer operations ?
   (j) Define Prandtl, Schimdt, and Lewis numbers.
2. (a) 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 the capillary from the following flow data : 6

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

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(b) Classify types of fluids. 4

3. (a) Derive an expression for velocity profile, when Newtonian fluid flows between two vertical walls, separated by a distance 2B, taking origin at midpoint of 2B distance. 8

(b) Specify the interface boundary condition in a system for solving momentum transport problems. 2

4. (a) 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. 8

(b) What are the boundary conditions used for solving shell heat balance equation ? 2

5. (a) Write the formula for overall heat transfer coefficient for a composite wall consisting of four different layers with same thermal conductivities with different thicknesses. 3

(b) Derive an expression for determining the mass flux of a liquid, diffuse through a stagnant gas film where the gas is non-diffusing. 7

6. 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 :

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

When $r_2 \to \infty$ what will be the expression for N_{Ar1}. 10

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7. (a) Derive an expression for mass flux in steady state equimolar counter diffusion. 6

(b) What are the basic steps for solving steady state mass transfer problems ? 4

8. Write short notes on any **two** : 5 × 2

(a) Equation of continuity

(b) Conduction and convection

(c) Viscosity, thermal conductivity, and diffusivity

(d) Sources of heat generation.
