Registration No.										

Total number of printed pages – 02

B.TECH
PCML4301

6th Semester Regular / Back Examination 2015-16
TRANSPORT PHENOMENA

BRANCH : Chemical
Time : 3 Hours
Max Marks : 70
Question Code : W554

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 x 10**

(a) Classify types of fluids in shear stress-shear strain plot only.
(b) How viscosity and thermal conductivity depend ontemperature in case of low density gases?
(c) Define Stoke's law.
(d) Write equation of continuity.
(e) Define Fourier's Law of heat conduction
(f) Specify the interface boundary condition in a system for solving heat transport problems.
(g) State Eucken formula for thermal conductivity.
(h) Write Fick's Law of diffusion with constant concentration.
(i) How diffusivity varies with temperature in case of gas &liquid?
(j) Write shell mass balance equation.

2. **(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. **06**

(b) Estimate the viscosity of liquid benzene at 20^0C. (T_b = 80.1^0C and specific molar volume=89.0 cm^3/g-mole). **04**

3. **(a)** Derive an expression for shear stress profile, when a Newtonian fluid is flowing inside a pipe of radius *R*. **04**

(b) 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:	60.0 cm
Kinematic viscosity of liquid:	4.0×10^{-5} m^2/s
Density of liquid:	1000 kg/m^3
Pressure drop in the horizontal tube:	5×10^5 Pa
Mass rate of flow through tube:	3×10^{-3} kg/sec

06

4. **(a)** A heated sphere of radius R is suspended in a large container of motionless body of fluid.Show that, $Nu = \frac{hD}{K} = 2$. **06**

(b) Write combined heat flux equation and explain each term. **04**

5. **(a)** Write three heat source name used in heat transport analysis. **03**

(b) The heat generated per unit volume in a parallel plate is given by: $S_V = \mu\left(\frac{v}{b}\right)^2, \frac{w}{m^3}$ where, v is the upper plate velocity; b is thedistance between two plates. Taking origin at the lower plate with boundary condition x = 0, T =T_0, and x = b, q_x= 0, show that: $T - T_0 = \frac{\mu v^2}{k}\left[\frac{x}{b} - \frac{1}{2}\left(\frac{x}{b}\right)^2\right]$. **07**

6. A viscous fluid with temperature independent physical properties is in fully developed laminar flow through a vertical tube of radius R. At z=0, the fully developed flow is achieved. For z<0 the fluid temperature is uniform at T=T_1. For z>0, heat is added radially at a constant, uniform flux q_0, at the tube surface. Make a shell energy balance to obtain the differential equation for T(r,z) in the zone z>0.
Develop the non-dimensional differential equation in terms of the following variables
$\Theta=(T-T_1)/(q_0R/K)$, £=r/R, $\phi=Kz/(\rho C_p v_{max} R^2)$ **10**

7. **(a)** Define Prandtl, Schmidt, and Lewis numbers. **03**

(b) A hollow solid sphere has its inner (r = R_1) and outer (r = R_2)surfaces maintained at concentrations C_{A1} and C_{A2}respectively**.** Obtain the expression for concentration profile in the solid at steady-state condition. **07**

8. Write short notes on any **TWO**: **5 x 2**

(a) Equation of motion
(b) Convection heat transfer
(c) Types of diffusion
(d) Importance of transport phenomena
