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

Total Number of Pages : 03

B.Tech.
PCE5I101

5th Semester Regular Examination 2017-18
Transport Phenomena
BRANCH : CHEM
Time : 3 Hours
Max Marks : 100
Question Code : B230
Answer Question No.1 and 2 which are compulsory and any four 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.

Q1. Answer the following questions : **(2x10)**

(a) In Fourier's law, the proportionality constant is called the
- i. Stefan-Boltzman constant
- ii. Thermal diffusivity
- iii. Heat transfer co-efficient
- iv. Thermal conductivity

(b) Prandtl number is the reciprocal of
- i. Mass diffusivity x Momentum diffusivity
- ii. Thermal diffusivity x Momentum diffusivity
- iii. Thermal diffusivity/Momentum diffusivity
- iv. Thermal diffusivity x Mass diffusivity

(c) In natural convection heat transfer, the correlating parameter is
- i. Grashoff number
- ii. Eckert number
- iii. Graetz number
- iv. Bond number

(d) The rate of heat transfer is a product of overall heat transfer co-efficient, the difference in temperature, and the
- i. Nusselt number
- ii. heat transfer area
- iii. heating volume
- iv. none of these

(e) The velocity profile for laminar flow through a pipe is
- i. logarithmic
- ii. parabolic
- iii. linear
- iv. hyperbolic

(f) The ratio of average fluid velocity to the maximum velocity in case of laminar flow of a Newtonian fluid in a circular pipe is
- i. 1
- ii. 2
- iii. 0.66
- iv. 0.5

(g) For a particle settling in water at its terminal settling velocity, which of the following is true?
- i. Drag = weight
- ii. Drag = buoyancy + weight
- iii. Buoyancy = weight + drag
- iv. Weight = buoyancy + drag

(h) Where does the maximum stress occur in case of laminar flow of incompressible fluid in a closed conduit of diameter 'd'?

i. At d/4 from the wall
ii. At the wall
iii. At the centre
iv. At d/8 from the wall

(i) The movement of molecules from an area of high concentration to an area of low concentrationis known as

i. Osmosis
ii. Isotonic
iii. Diffusion
iv. Solution

(j) As molecules diffuse, they create this, which is a difference in concentrations across space.

i. Concentration gradient
ii. Diffusion
iii. Semi-permeable
iv. Osmosis

Q2. Answer the following questions : **(2x10)**

(a) Define momentum, thermal, and mass diffusivities.
(b) Define combined momentum flux.
(c) State Newton's Law of Viscosity with mathematical expression.
(d) What is friction factor?
(e) How thermal conductivity depends on temperature in case of low density gases and liquids ?
(f) Define mass transfer co-efficient.
(g) Write the formula for overall heat transfer coefficient for a composite wall consisting of four different layers with different thermal conductivities with different thicknesses.
(h) How diffusivity of liquids is varied with temperature?
(i) State Fick's Law of binary (molecular) diffusion.
(j) Write the unit and dimensions of momentum, thermal, and mass diffusivities.

Q3. **(a)** Explain the classification of fluids. **(4)**
(b) Define Stoke's law and its range of applicability. **(3)**
(c) Derive an expression for average velocity profile of Newtonian fluid flow between two vertical walls separated by a distance 2B, taking origin at midpoint of 2B distance. **(8)**

Q4. **(a)** What pressure gradient is required to cause di-ethylaniline ($C_6H_5N(C_2H_5)_2$), to flow in a horizontal, smooth, circular tube of inside diameter D=3cm at a mass rate of 1028 gm/sec at 20^0C? At this condition, density of di-ethylaniline is 0.935 gm/cm^3 and viscosity is 1.95cP. Friction factor is 0.0063. **(5)**
(b) Derive an expression for maximum velocity when a Newtonian fluid is flowing through a pipe of radius R vertically downward. Draw the velocity profile. **(10)**

Q5. **(a)** A heated sphere of radius R is suspended in a large motionless body of fluid. It is desire to study the heat conduction in the fluid surrounding the sphere in the absence of convection.Set upthe differential equation describing the temperature T in the surrounding fluid as a function of r, the distance from the centre of the sphere. The thermal conductivity of K of the fluid is considered constant.Integrate the differential equation and use these boundary conditions to determine the integration constants: at r=R, T= $T_R$and r = ∞, T=T_∞.
From the temperature profile, obtain an expression for the heat flux at the surface. Equate this result to the heat flux given by 'Newton's Law of Cooling' **(10)**

and show that Nusselt number, $Nu = \frac{hD}{K} = 2$, in which D is the sphere diameter.

(b) Explain Free and Forced convection. **(5)**

Q6. **(a)** Derive an expression for determining the mass flux of a liquid, diffusing through a stagnant gas film where the gas is non-diffusing. **(10)**

(b) What are the boundary conditions used for solving shell mass balance equation? **(5)**

Q7. 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, $Sn = S_{no} \times r^2$, where S_{n0} is known constants, and r is the radial coordinate measured from the axis of the cylindrical fuel rod. R_F and R_C are the radius 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. **(15)**

Q8. 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 **(15)**

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

When $r_2 \rightarrow \infty$ what will be the expression for N_{Ar1} ?

Q9. **(a)** Discuss in brief about the Equation of continuity. **(5)**

(b) Explain creeping flow around the sphere. **(5)**

(c) Discuss steady state equimolar counter diffusion. **(5)**