

(Following Paper ID and Roll No. to be filled in your  
Answer Books)

Paper ID : 151404

Roll No. 

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**B. TECH.**

**Theory Examination (Semester-IV) 2015-16**

**TRANSPORT PHENOMENA**

*Time : 3 Hours*

*Max. Marks : 100*

**Note: Attempt all sections.**

**Section-A**

**1. Attempt all the parts. Write answer of each part in short.**  
**(2×10=20)**

- (a) What are the differential driving forces for momentum, heat and mass transports?
- (b) Write Fourier's law of heat conduction in 3-dimensional form.
- (c) Write Fick's law of diffusion in 3-dimensional form?
- (d) How does thermal conductivity of gas vary with temperature and pressure?
- (e) How does diffusivity of gas vary with temperature and pressure?

- (f) How does viscosity of liquid vary with temperature and pressure?
- (g) Write physical significance of Reynolds number.
- (h) What is thermal and mass diffusivities? Write their units also.
- (i) What is Newton's law of viscosity? Explain each term clearly.
- (j) Differentiate between absolute viscosity and kinematic viscosity.

### Section-B

## 2. Attempt any five questions from this section.

(10×5=50)

- (a) A horizontal annulus is 27 ft. long. The outside radius of inner cylinder is 0.49 inch, the inner radius of outer cylinder is 1.1 inch. A 60% of aqueous solution of sucrose is to be pumped through the annulus at 20 °C. At this temperature the fluid density is 80.3 lb /ft<sup>3</sup> and its viscosity is 136.8 lbm/ft hr. What is the volume rate of flow when the impressed pressure drop is 5.39 psi.
- (b) Derive continuity equation for a fluid in rectangular coordinate system. Also write suitable boundary conditions for momentum balance equation.

- (c) A copper wire has radius of 2 mm and length of 5 m. For what voltage drop would the temperature rise at the wire axis be  $10^{\circ}\text{C}$ , if the surface temperature of wire is  $20^{\circ}\text{C}$ ? For copper, the Lorentz No. is  $2.23 \times 10^{-8} \text{ Volt}^2/\text{K}^2$ .
- (d) Derive an expression for heat conduction through composite walls.
- (e) What do you understand by cooling fin, explain? Also discuss various types of cooling fins.
- (f) A catalytic reaction  $2A \rightarrow A_2$  is carried out in catalytic reaction. Show that

$$\left(1 - \frac{1}{2}x_A\right) = \left(1 - \frac{1}{2}x_{AO}\right)^{1-(z/\delta)}$$

Where  $\delta \rightarrow$  Effective gas film thickness

$x_{AO} \rightarrow$  Gas stream composition at beginning

- (g) The diffusivity of gas pair oxygen –carbon tetra chloride is determined by observing the steady state evaporation of  $\text{CCl}_4$  in to a tube containing  $\text{O}_2$ . The distance between the  $\text{CCl}_4$  liquid level and the top of the tube is 17.1 cm. the total pressure on the system is 755 mm Hg and the temperature is  $0^{\circ}\text{C}$  the vapor pressure of  $\text{CCl}_4$  at that

temperature is 33 mmHg. The cross sectional area of the diffusion tube is  $0.82 \text{ cm}^2$ . It is found that  $0.0208 \text{ cm}^3$  of  $\text{CCl}_4$  evaporate in 10 hour period after steady state has been attained. What is the diffusivity of the gas pair  $\text{CCl}_4\text{-O}_2$ ?

- (h) What is the difference between free convection and forced convection? Also write the physical significance of dimension less numbers which are used in these operations.

### Section-C

**Note: Attempt any two parts of the following. (15×2=30)**

3. Derive an expression for flow of a falling film on an inclined plane. Also find the maximum, average velocity and the volumetric flow rate.
2. Derive an expression of temperature distribution for heat conduction with an electrical heat source, Also find the expression for maximum, average temperature rise and heat flow at the surface.
3. Derive equation of motion in Cartesian coordinates and notify the various terms.