Roll No. | | | | | | | | | | | | | **Total No. of Pages : 03**

Total No. of Questions : 18

B.Tech. (BT) (2018 Batch) (Sem.–3)

TRANSPORT PHENOMENON

Subject Code : BTBT-305-18

M.Code : 76949

Time : 3 Hrs. **Max. Marks : 60**

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION-A

Write briefly :

1. Write down the units for rate of momentum flux.
2. Define Reynolds's number and Prandtl number.
3. Differentiate between forced convection and free convection.
4. Define streamline and what is the equation of streamline in two dimension flow.
5. Verify that 'momentum per unit area per unit time' has the same dimensions as 'force per unit area'.
6. What is Biot number? What do we conclude from Biot number is very small (< 0.1)?
7. Relation between maximum velocity and local velocity, when a fluid flows under laminar, steady state, incompressible Newtonian fluid, in a tube and on an inclined flat surface.
8. What are Non Newtonian Fluids? Explain with example.
9. Define Fourier's law of heat conduction.
10. What is Brinkman number?

SECTION-B

11. A Newtonian fluid with a viscosity of 10 cP is placed between two large parallel plates. The distance between the plates is 4mm. The lower plate is pulled in the positive x-direction with a force of 0.5N, while the upper plate is pulled in the negative x-direction with a force of 2N. Each plate has an area of $2.5m^2$. If the velocity of the lower plate is 0.1 m/s, calculate :

    a) The steady-state momentum flux.

    b) The velocity of the upper plate.

    c) Parts (a) and (b) for a Newtonian fluid with $\mu = 1$ cP.

12. A solid sphere of naphthalene (A) with a radius of 2.5 mm is surrounded by still air (B) at 300 K and 1 atm. Take the surface temperature of the naphthalene as 300°K and its vapor pressure at this temperature as 0.104 mm Hg. The diffusivity of naphthalene in air at 318°K is 6.92×10^{-6} m^2 / sec. Determine the rate at which naphthalene evaporates.

13. Water at 25°C is flowing down a vertical wall with Re = 50. Calculate (a) the flow rate, in gallons per hour per foot of wall width, and (b) the film thickness in inches. Kinematic viscosity of water at 25°C is 1.10×10^{-2} cm^2/sec.

14. The velocity component for a flow field are as follows : $v_x = a(x^2 - y^2)$ and $v_y = -2axy$ Prove that it satisfy the continuity equation and determine the stream function.

15. Heat is generated in a rectangular heating element of dimensions 1m × 0.5m × 0.1m of thermal conductivity 75 W/m K at rate of 25×10^3 W/m^3. Calculate maximum temperature in the wall if the surface temperatures are 150°C. Also calculate the heat flux at the surface.

SECTION-C

16. Consider the steady-state tangential laminar flow of a constant density and viscosity fluid between two vertical concentric cylinders. If the outer cylinder is rotating with an angular velocity ω, find :

    a) The velocity and shear stress distributions

    b) The torque required to turn the outer shaft. Assume that the inner cylinder is at rest.

17. Velocity components in a two dimensional (x,y), for incompressible flow field are expressed as :

$$v_x = \frac{y^3}{3} + 2x - x^2 y \text{ and } v_y = xy^2 - 2y - \frac{x^3}{3}.$$

a) Determine the velocity vector and resultant acceleration at point (1,3).

b) Is the flow physically possible? If so, obtain an expression for the stream function.

c) Calculate the volumetric flow rate between streamlines passing through point (1, 3) and (2, 3).

d) Is the flow irrotational? If so, determine the corresponding velocity potential.

e) Show that both stream function and velocity potential satisfy Laplace equations.

18. Consider the transfer of species *A* by diffusion through a slightly tapered slab as shown in Figure. Mass transport can be considered one-dimensional in the *z*-direction. Determine the rate of molar transfer for the constant diffusivity and constant area.

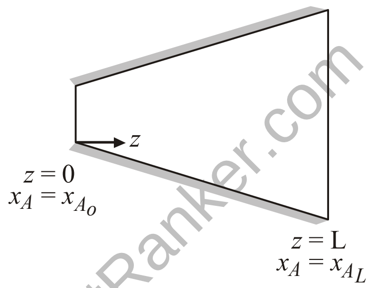

FIG.

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.