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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:

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

SECTION-A

Write briefly:

- Write down the units for rate of momentum flux.
- 2. Define Reynolds's number and Prandtl number.
- Differentiate between forced convection and free convection.
- Define streamline and what is the equation of streamline in two dimension flow.
- Verify that 'momentum per unit area per unit time' has the same dimensions as 'force per unit area'.
- What is Biot number? What do we conclude from Biot number is very small (< 0.1)?
- 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.
- Define Fourier's law of heat conduction.
- 10. What is Brinkman number?

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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 2.5m². 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 μ = 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 m² / sec. Determine the rate at which naphthalene evaporates.
- 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 cm²/sec.
- The velocity component for a flow field are as follows: v_x = a(x² y²) 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 × 10³ W/m³. 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.

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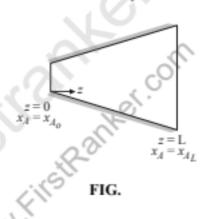
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 Velocity components in a two dimensional (x,y), for incompressible flow field are expressed as:

$$v_x = \frac{y^3}{3} + 2x - x^2y$$
 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.



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.

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