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

Total No. of Questions : 09

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

1. Write briefly :

a) Write down the units for rate of momentum flux.

b) Define Fick's law of diffusion.

c) Differentiate between forced convection and free convection.

d) Define streamline and what is the equation of streamline in two dimension flow.

e) Define Navier Stokes equation.

f) What is Biot number? What do we conclude from Biot number is very small (< 0.1)?

g) 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.

h) What are Non Newtonian Fluids? Explain with example.

i) What is Hagen Poiseullie's equation?

j) What is Brinkman number?

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SECTION-B

2. Consider a horizontal pipe through which an incompressible Newtonian fluid is flowing in one dimensional, steady state, laminar flow. Flow is fully developed: apply the momentum shell balance to develop the following velocity profile.

$$v_x = \frac{P_O - P_L}{4\mu L} R^2 \left[1 - \left(\frac{r}{R} \right)^2 \right]$$

3. 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.

4. Consider a hollow sphere, through which heat conduction in one dimension is flowing. Show that temperature varies hyperbolically with the radius.

5. The potential function for a two dimensional, irrotational. incompressible flow field is given as $\Phi = x^2 - 2y - y^2$. Find the stream function ψ and velocity components v_x and v_y.

6. Heat is generated in a rectangular heating element of dimensions lm × 0.5m × 0.1m of thermal conductivity 60 W/m K at rate of 15×10^3 W/m^3. Calculate maximum temperature in the wall if the surface temperatures are 100°C. Also calculate the heat flux at the surface.

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SECTION-C

7. Heat is flowing through an annular wall of inside radius r_0 and outside radius r_1. The thermal conductivity varies linearly with temperature from k_0 at T_0 to k_1 at T_1. Develop an expression for the heat flow through the wall.

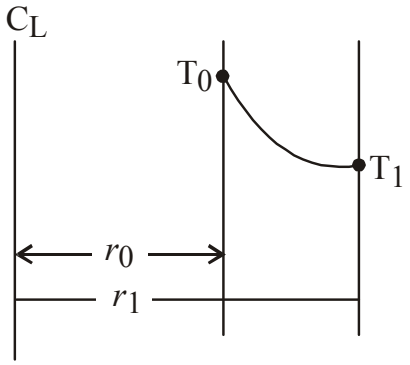

Fig.1

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8. 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 (a) Constant diffusivity and (b) Constant diffusivity and constant area

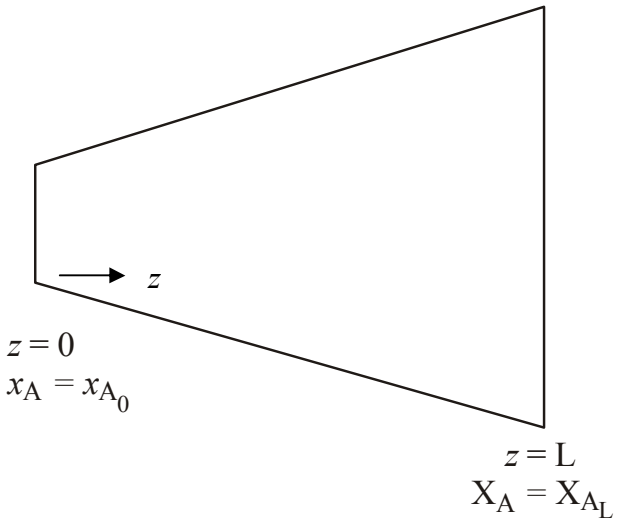

Fig.2

9. 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 w, find :

   a) the velocity and shear stress distributions and

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

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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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