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Total No. of Pages : 03

Total No. of Questions : 09

B.Tech. (BT) (2012 to 2017) (Sem.–3)

TRANSPORT PHENOMENON

Subject Code : BTBT-305

M.Code : 55075

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) What is the driving force for heat and momentum transport?

b) Define Newtonian and non-Newtonian fluids.

c) What are the units of mass diffusivity?

d) Define Reynolds number.

e) Write Newton's law of viscosity.

f) How does the viscosity of gases vary with temperature?

g) What are the various mechanisms of transport?

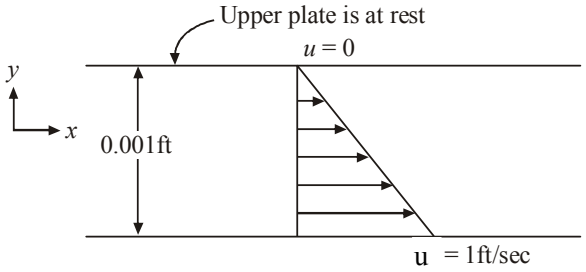
h) Write down the units for rate of heat flux.

i) What is the general transport equation for momentum, heat and mass transport?

j) What is Biot number? What is its significance?

SECTION-B

2. Consider a system having two parallel plates in figure 1. Compute the steady state momentum flux τ_{yx} in lb_f / ft^2 when the lower plate velocity is 1.5 ft/s in the positive x direction, the plate separation is 0.01 ft and the fluid viscosity is 10cp.



FULLY DEVELOPED LAMINAR FLOW

Fig. 1

3. The potential for a flow around a cylinder of radius $\underline{a}$ is given by $\phi = ux\left[1+\frac{a^2}{x^2+y^2}\right]$ where x and y are the rectangular coordinates with the origin at the middle. Derive an expression for stream function ψ.

4. 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.

5. Consider an incompressible liquid in a cylindrical vessel which has been undergoing constant angular motion for a time interval which is of such a duration that the liquid has assumed a fixed orientation in the vessel. Show that at steady-state, the free surface forms a paraboloidal surface given by $Z - Z_0 = (\omega^2 / 2g)\, r^2$. Assume that the viscosity of the fluid is constant.

6. Derive the equation of continuity for a binary mixture for the following case: Case: equation describes the concentration profiles in a binary diffusing system.

$$\frac{\partial c_A}{\partial t} + \left(\nabla . c_A v^*\right) = \left(\nabla . c \mathcal{D}_{AB} \nabla x_A\right) + R_A$$

SECTION-C

7. In a gas diffusion experiment chloropicrin (CCI_3NO_2) is kept in a cylindrical test tube. A gas is passed through the open end of the tube. What is the rate of evaporation (in $g.hr^1$) in air at 25°C? Total pressure = 770 mm; Hg Diffusivity = 0.088 cm^2 Sec^{-1}; Vapor pressure = 23.81 mm; Hg Distance from liq. Level to top of tube = 11.14 cm

   Density of chloropicrin = 1.65 g cm^{-3}; Surface area of liq. exposed to air = 2.29cm^2.

8. A 15 cm long copper fin of diameter 3 mm is attached to a vertical wall at 500 K and is projected in a room where air is at 300 K. The heat transfer coefficient at the fin surface is 700 W/m^2 K and conductivity of fin material is 450 W/m K. Calculate :

   a) Heat loss from fin b) Fin efficiency c) Fin effectiveness.

9. Two large tanks are connected by a truncated conical duct as shown in Figure 2. The variation in the diameter as a function of position is represented by $D(z) = 0.006 + 0.02z$. Gas compositions in the tanks are given in terms of mole percentages. The pressure and temperature throughout the system are 1 atm and 25°C, respectively, and $D_{AB} = 3 \times 10^{-5}$ m^2/s.

   a) Determine the initial molar flow rate of species A between the vessels.

   b) What would be the initial molar flow rate of species A if the conical duct were replaced with a circular tube of 8 mm diameter?

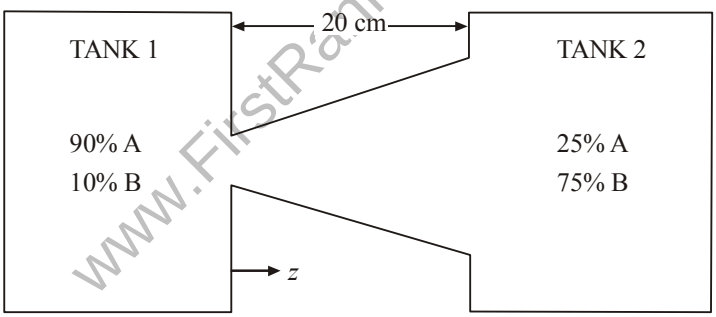


Fig. 2

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