VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA
DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING
SESSION 2015 - 16 (ODD SEMESTER)

Total Pages—5

(Set-Q_1)

B.Tech-5th (M & M)
Transport Phenomena

Full Marks : 70

Time : 3 hours

Q. No. 1 is compulsory and answer any **five** from the rest of the questions

The figures in the right-hand margin indicate marks

1. Answer the following (any *ten*) : 2 × 10

(*a*) Explain Reynolds number (Re) in brief and write its significance.

(*b*) CO gas at 200 °C flows over a steel plate maintained at 50 °C. The convection heat transfer coefficient is 75 $W/m^2.K$. Calculate the neat gain rate by the plate through an area of 5 m^2.

(*c*) State and explain Newton's law of viscosity.

(*d*) Explain friction factor.

(Turn Over)

(e) Distinguish between tree and forced convection mechanism of heat transfer with suitable example.

(f) Define a black surface.

(g) What is the difference between Nusselt Number and Biot Number ?

(h) Define view factor.

(i) Define emmissivity and write the range of its value.

(j) State and explain Stefan Boltzmann Law.

(k) Prove that one diffusivity is needed to describe the diffusional behavior of a binary mixture, i.e $D_{AB} = D_{BA}$.

(l) State Fick's first law of diffussion and write its limitation.

(m) Write down the difference between homogeneous and heterogeneous reaction.

(n) Explain types of fluid flow.

(*c*) Write down the characteristics of interfacial reaction.

2. Derive Hagen-Poiseulle equation for Laminar, incompressible, steady flow through a straight, circular, horizontal pipe. 10

3. A steel tube ($K = 45$ W/m.K) of outside diameter 7·6 cm and thickness 1·3 cm, is covered from outside with an insulating material ($K = 0{\cdot}2$ W/m.K) of thickness 2 cm. A hot gas at 330 °C, with convention heat transfer coefficients of 200 W/m².k, is flowing inside the tube. The outer surface of the insulation is exposed to ambient air at 30 °C, with convection heat transfer coefficients of 50 W/m².k. Calculate :

(*a*) Heat loss to air from the 5 m long tube

(*b*) Temperature drop (ΔT) across steel tube and insulating layer. 10

4. What is a lump system ? Derive the expression of unsteady state heat transfer by lumped system analysis. Write the validity criteria of lumped capacitance method. 10

5. Define intensity of radiation for a black body and derive the relation between emissive power and radiation intensity. 10

6. (a) Derive the expression for species diffusion resistance (R) for one dimentional diffusion of species A, through a planes medium of B. Boundary condition : At. $X = 0$, $X = X_{A,S_1}$ and At. $X = L$, $X = X_{A,S_2}$. 5

(b) Consider the diffusion of hydrogen (species A) in water (speces B) at $T = 293$ K.

(*i*) Compare the value of mass diffusivity and thermal diffusivity at 293 K.

(*ii*) Calculate Lewis No.

(*iii*) Calculate the species flux on molar basis if the concentration gradient at a particular location is $dC_A/dx = 1$ K mol/m^3.m. The mole fraction of the hydrogen X_A, is much less than unity.

Given : $D_{AB,298\,K} = 0{\cdot}63 \times 10^{-8}$ m^2/s, $C_p = 4182$ J/kg k, $K = 0{\cdot}603$ W/m.K, $\rho = 998$ K/m^3 5

7. Write short notes on : 5 + 5

(i) Electrochemical mechanism of slag-metal interfacial reaction

(ii) Nucleation, growth and bubble formation phenomenon of co-bubbles.

8. Explain : 3 + 3 + 4

(a) Knudsen flow

(b) Kirchhoff's law of radiation

(c) Heat transfer between two black walls in an enclosure.
