VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA
DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING
SESSION 2016 - 17 (ODD SEMESTER)

Total Pages—5

(Set-T_1)

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

Full Marks : 70

Time : 3 hours

Answer six questions including Q. No. 1 which is compulsory

The figures in the right-hand margin indicate marks

Symbols carry usual meaning

1. Answer *all* questions : 2 × 10

(*a*) What are the different modes of mass transfer ? Briefly explain each of them.

(*b*) What is the significance of different Biot's number ?

(*c*) Mention the difference between free and forced convection of heat transfer.

(Turn Over)

(*d*) State Fick's second law of diffusion with proper mathematical expression.

(*e*) Write down the kinetic steps involved in the following reaction :

$$[Mn] + (Fe^{2+}) = (Fe) + [Mn^{2+}]$$

Also, mention the rate controlling step among the kinetic steps.

(*f*) Explain the Langmuir adsorption isotherm model with requisite mathematical expressions.

(*g*) Differentiate between Newtonian and Non-Newtonian fluid.

(*h*) Why momentum transfer is a very important phenomenon from Metallurgy point of view ?

(*i*) Define thermal resistance. How it is related to the energy parameter ?

(*j*) Write down the differential heat balance equation for unsteady heat transfer.

2. (*a*) With a proper example derive the mathematical expression for Topo-chemical model. 5

(*b*) How mass transfer differs from heat transfer in case of a hollow cylinder ? Explain using mathematical expression. 5

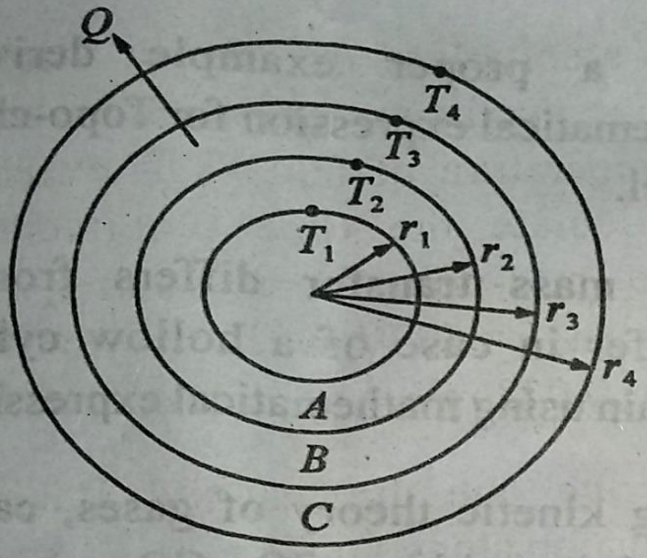
3. (*a*) Using kinetic theory of gases, calculate diffusivity in binary $CO-CO_2$ gas mixture at 1900 K and 1 atm total pressure. Given values : 5

$$\upsilon_{CO-CO} = 3{\cdot}59,\ \upsilon_{CO_2-CO_2} = 3{\cdot}996,\ \Omega_{CO-CO_2} = 0{\cdot}7214$$

(*b*) Derive the Heisen Poiseuille equation of momentum transfer. 5

4. (*a*) Derive the maximum velocity expression for the fluid flow between two stationary plates. 5

(*b*) Derive the overall heat transfer coefficient for the composite sphere as shown below : 5



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5. (*a*) Apply Rayleigh's method to the dimensional analysis of the heat transfer coefficient(h) for the case of fluid flow through a pipe. 5

(*b*) A furnace is lined with an outer steel shell of 1 cm thick and a refractory lining of 5 cm thick. Calculate the overall heat transfer coefficient and the heat flux, if the furnace temperature is 1000 °C and the outside air temperature is 40 °C. The heat transfer coefficients of the flowing gases on the hot side and on the cold side are 5×10^{-3} and 4×10^{-4} cal s^{-1} cm^{-2} K^{-1}, respectively. Assume thermal conductivity of the steel and the refractory as 60 and 2 W m^{-1} K^{-1}, respectively. 5

6. (*a*) A steel plate of 20 mm thickness and 1 m^2 surface area is quenched from a temperature of 800 °C in water at 30 °C. Calculate the time required to obtain the mid-point temperature of 400 °C. Given, $h = 60\ W\ m^{-2}K^{-1}$, $k = 30\ W\ m^{-2}\ K^{-1}$, $\alpha = 0{\cdot}023\ m^2h^{-1}$. 5

(*b*) Derive one dimensional Navier-Stoke's equation along x-axis. 5

7. (*a*) Explain Lumped capacitance method for transient conduction of heat. 5

(*b*) Briefly explain the significance of transport phenomena in Metallurgy. 5

8. Write short notes on any *two* : 5×2

(*i*) Nucleation and growth phenomenon

(*ii*) Interfacial reaction

(*iii*) Lembert's law

(*iv*) Fick's laws of diffusion.
