Q. P. Code: 27706

(3 HOURS) **(MAX. MARKS : 80)**

Note:

1. Question No. 1 is compulsory.
2. Attempt any three questions out of remaining five questions.
3. Assume suitable data wherever necessary.
4. Figures to right indicate full marks.

Q.1 Answer the following **(Any four)**

a. Compare two film theory with penetration theory. 5

b. Discuss temperature dependency of diffusivity. 5

c. Differentiate between shell and tube heat exchangers with double pipe heat exchangers. 5

d. Discuss Fick's law and Fourier's law. 5

e. Explain Stefan-Boltzman law and Kirchoff's law. 5

Q.2 a. Show that $Q_{with\ n\ shields} = \frac{1}{(n+1)} Q_{without\ shield}$ where Q is net heat exchange. 10

b. A dry steam at 373K condenses on the outside surface of a horizontal pipe of outside diameter 25mm. The pipe surface is maintained at 357K by circulating water through it. Determine the mean heat transfer coefficient, heat transfer per unit length of the pipe and the condensate rate per unit length of the pipe. 10

Data: Properties of condensate at film temperature 350K

Viscosity = 306 x 10^{-6} N.s/m^2

Thermal conductivity = 0.668w/m.K

Density = 974 kg/m^3

Latent heat of vapourization = 2225 kJ/kg

Q.3 a. Discuss tube pitch, clearance for shell and tube heat exchangers with neat sketch. 5

b. Explain oxygen uptake in cell cultures. 5

c. Diffusion of gases through polymers. 10

[P.T.O]

Q.4 a. In an experimental study of absorption of ammonia by water from an ammonia-water mixture in a wetted wall tower, the value of overall gas side mass transfer coefficient Ka was found to be 93.25x 10^{-2} kmol ammonia/ hr. m^3.atm. The operating pressure and temperature of the tower were 2 std. atm and 288K respectively. For dilute solution of ammonia in water at 288K the equilibrium partial pressure is given as P_{Ai} (atm) = 4 C_{Ai} (kmol/m^3). At the top of tower outlet gas contained NH_3 1% by volume and inlet liquid which this contacted was pure water. Assuming 85% of total resistance to mass transfer was by gas phase. Calculate k_G, k_L, K_L, P_{Ai} and C_{Ai}. 10

b. Explain Nusselt theory. 10

Q.5 a. A furnace is constructed with a 229 mm thick layer of fire brick, 115 mm thick layer of insulation brick and again a 229 mm thick layer of building brick. The inside temperature is 1223K and outer temperature of the wall is 323K. The thermal conductivities of the fire brick, insulating brick and building brick are 6.05, 0.581 and 2.33 W/m.K respectively. Find the heat loss per unit area and temperature at the interface. 10

b. Derive the molar flux equation for equimolar counter diffusion. 10

Q.6 Write a note on **any Four**

a. Optimum thickness of insulation 5

b. Concept of black body 5

c. Molecular diffusion 5

d. Conduction versus convection 5

e. Multiple effect evaporator 5
