June 11, 2024 02:30 pm - 05:30 pm 1T00535 - T.E.(Chemical Engineering)(SEM-V)
(Choice Base Credit Grading System) (R- 19) (C Scheme) / 31724 - Transport Phenomena
QP CODE: 10056229

Time: 3 Hours **Marks: 80**

N. B.: (1) Question No. 1 is compulsory.

(2) Attempt any three questions from remaining five questions.

(3) Assume suitable data if necessary.

Q. 1 Answer any five questions **(20)**

a) Explain Fourier's law? Write its 3D form.

b) Explain rules for writing shell mass balances.

c) Explain Gradient and Divergence.

d) Explain the factors affecting rate of diffusion.

e) Derive Newton's law of viscosity

f) Explain the three basic dimensionless numbers.

Q. 2

(a) Derive an expression for momentum flux and velocity distribution for flow of falling film over an inclined plate. **(10)**

(b) The distance between two plate is 0.5 cm and ΔV_x = 10 cm/sec, the fluid is ethyl alcohol at 273 K having a viscosity of 0.0177 gm/cm s. Calculate the shear stress and velocity gradient. **(10)**

Q. 3

(a) Estimate the viscosity of N_2 at 50°C and 854 atm, given M = 28 gm/gmole, P_c = 33.5atm, and T_c =126.2 K. **(10)**

(a) Derive an expression for heat conduction in composite wall. **(10)**

Q. 4

(a) For an electrically heated cylindrical wire, show that the temperature distribution is

$$T - T_0 = \frac{S_e R^2}{4K}\left[1 - \left(\frac{r}{R}\right)^2\right] \quad \text{and} \quad T_{max} - T_0 = \frac{S_e R^2}{4K}$$ **(10)**

(b) A copper wire has a radius of 2 mm and a length of 5 m. For what voltage drop would the temperature rise at the wire axis be 10 °C, if the surface temperature of the wire is 20 °C. Lorenz number for copper = 2.23×10^{-8} volt^2 K^{-2}. **(10)**

Q. 5

(a) Predict D_{AB} for methane-ethane system at 313 K and 101.325 KPa by the following two methods.

i) The Slatterry equation

ii) The Chapman-Enskog theoretical equation

Given: $\Omega_{DAB} = 1.45$ $a = 2.745 \times 10^{-4}$ $b = 1.823$

Methane: Tc = 190.7 K Pc = 45.8 atm

Ethane: Tc = 282.4 K Pc = 50 atm **(10)**

(b) Derive an expression for diffusion with heterogeneous chemical reaction. **(10)**

Q. 6

(a) Heavy oil is passed through a pipe of 5.08×10^{-2}m diameter. The pressure drop over the pipe is 68.958 KN/m^2. The viscosity of oil is 200 cp and density is 800 kg/m^3. The length of the pipe is 3.048m.

i) Calculate the volumetric flow rate of oil in lit/min.

ii) Calculate and plot momentum flux profile across the pipe. **(10)**

(b) Derive an expression for Diffusion through a stagnant gas film **(10)**
