

19 NOV 2025 TE CHEMICAL (SEM-V) C SCHEME TP QP CODE :10095933

**(3 Hours)****Marks :80****Instructions:**

- (1) Question No. 1 is compulsory.**
- (2) Attempt any three questions from remaining five questions.**
- (3) Assume suitable data if necessary.**
- (4) Figure to the right indicates marks**

**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) The distance between two plate is 0.5 cm and  $\Delta V_x = 10$  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)**
- b) Derive an expression for momentum flux and velocity distribution for flow of falling film over an inclined plate. **(10)**

**Q. 3**

- a) Find the radius of capillary tube which is used to measure the rate of flow of viscous fluid flow through the tube. **(10)**

Given:

Length of capillary = 50.02 cm

Kinematic viscosity of fluid =  $4.03 \times 10^{-5}$  m<sup>2</sup> sec<sup>-1</sup>Density of Fluid =  $0.9552 \times 10^3$  Kg/m<sup>3</sup>Pressure drop across capillary tube =  $4.829 \times 10^3$  N/m<sup>2</sup>Mass rate of flow through tube =  $2.997 \times 10^{-3}$  Kg/sec

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

**Q. 4**

a) 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  $10^{\circ}\text{C}$ , if the surface temperature of the wire is  $20^{\circ}\text{C}$ .

i) Lorenz number for copper =  $2.23 \times 10^{-8} \text{ volt}^2 \text{ K}^{-2}$ . **(10)**

b) Heavy oil is passed through a pipe of  $5.08 \times 10^{-2} \text{ m}$  diameter. The pressure drop over the pipe is  $68.958 \text{ KN/m}^2$ . The viscosity of oil is 200 cp and density is  $800 \text{ kg/m}^3$ . 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)**

**Q. 5**

a) A value of  $D_{AB} = 0.151 \text{ cm}^2/\text{sec}$  has been found for the system  $\text{CO}_2$ -air at 293K and 1atm. Calculate  $D_{AB}$  at 1500K by the following methods.

i) Slattery Equations,

ii) Chapman Enskog Equation

Data: For non-polar gas pairs,  $b = 1.823$ ,  $(\Omega_{DAB})_{1500} = 0.734$ ,  $(\Omega_{DAB})_{293} = 1.047$

**(10)**

b) Derive an expression for Diffusion with homogenous chemical reaction. **(10)**

**Q. 6**

(a) Derive an expression for flow through the circular tube. **(10)**

(b) Write

i) General momentum balance equation,

ii) General procedure for setting up and solving viscous flow problems, and

iii) Boundary conditions. **(10)**