(3 Hours) Total Marks: 80

N.B.: (1) Question 1 is compulsory.

(2) Attempt any three out of five remaining questions.

(3) Assume any suitable data if necessary and indicate it clearly.

1. **(a)** Explain different types of fluid. (05)
(b) Explain analogy between heat and mass transfer. (05)

(c) Write and explain Fourier's law of heat conduction. (05)

(d) Explain diffusion in detail. What factors cause diffusion to occur? (05)

2. **(a)** Derive the equation for heat conduction with an electrical heat source. (10)

(b) Derive the equation for heat flow through composite wall. (10)

3. Derive the expression for shear stress, point velocity, average velocity, maximum velocity and volumetric flow rate for flow of Newtonian fluid through the circular annulus. (20)

4. **(a)** Derive the expression for diffusion through stagnant gas film. (10)
(b) Derive the expression for diffusion through falling liquid film. (10)

5. **(a)** A heavy oil of viscosity 200 cp and density 800 kg/m^3, is passed through a pipe of 2 inch diameter. The pressure drop over the pipe of length 10 ft. is 68958 N/m^2. Calculate the volumetric flow rate of oil in lit/min. Also calculate and plot the momentum flux profile across the pipe. (10)

(b) An end of 1.3 cm diameter, 1 m long glass rod is maintained at normal boiling point of toluene at 110.6 ^{0}C. The other end is fixed to the block of ice. The thermal conduction along the rod is at steady state. Determine how much heat transferred to ice in watt. Also find the amount of ice that melts due to heat transferred to it in 30 min.

Data:

k for glass = 0.86 W/m.k

Heat of fusion of ice = 79.7 cal/gm.

Assume no heat loss from exposed surface of glass between toluene and ice block. (10)

6. Derive the expression for heat conduction with chemical heat source. (20)

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