Duration: 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 Analogy between heat and mass transfer.

b) Explain rules for writing shell mass balances.

c) Explain theories of thermal conductivity of gases and liquids in brief.

d) Explain temperature and pressure dependence of thermal conductivity.

e) Explain approach to solve heat transfer problems.

Q. 2

(a) Derive the velocity profile for flow through a circular tube and find the momentum flux, average velocity and maximum velocity for flow through a circular tube. **(10)**

(b) Heat is being generated uniformly by a chemical reaction in long cylinder of radius 91.44 mm. The generation rate is constant at 46.6 W/m^3. The walls of the cylinder are cooled so that wall temperature is held constant at 311K. The thermal conductivity is 0.865 W/m K. Calculate the centreline temperature. **(10)**

Q. 3

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

(b) Estimate D_{AB} for the non-polar system argon-oxygen at 293.2°K and 1 atm total pressure. Data given: a= 2.745×10^{-4}, b= 1.823

Gas	M	Tc (°K)	Pc (atm)
A (Argon)	33.94	145.2	41.0
B (Oxygen)	29.00	149.4	43.7

(10)

Q. 4

(a) Estimate the momentum flux for a system with lower plate having velocity of 1m/s. Distance between the two plates is 1 mm and viscosity is 1 cp. **(10)**

(b) Derive an expression for conduction in electrical heat source. **(10)**

Q. 5

(a) Derive an expression for Diffusion with heterogeneous chemical reaction. **(10)**

(b) An oil is flowing in laminar region in a 1.27 x 10^{-2} m diameter tube at the rate of 22.72 lit/min. The oil viscosity is 300 cp and its density is 960.9 Kg/m^3.

Calculate:

i) Pressure drop per metre of pipe length.

ii) The wall stress, N/m^2

iii) The velocity at the centre of the tube. **(10)**

Q. 6

(a) 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)**

(b) Explain the analogy between momentum, heat and mass transport. **(05)**

(c) Explain the shear stress versus shear strain graph for Newtonian and Non-Newtonian fluids. **(05)**

****