(3 Hours) **(80 Marks)**

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) What is thermal conductivity? Write 3D form of Fourier's law of conduction.
b) Write Navier-Stokes equation & Euler's equation.
c) Explain diffusion.
d) Explain Analogy between heat and mass transfer.
e) Explain the terms: forced and free convection.

Q. 2

(a) A viscous fluid is in laminar flow in a slit formed by two parallel walls at a distance 2B apart. Derive a differential momentum balance and obtain an expression for distribution of momentum flux. What is the ratio of average to maximum velocity in the slit? (10)

(b) A copper wire 10 mm diameter and 4.6 m long has a voltage drop of 0.6 volts, find the maximum temperature in the wire if the ambient air temperature is 298.15 K and the heat transfer coefficient h is 32.37 W/m^2 K, Lorenz constant for copper = 223×10-8 $volt^2/K^2$, Thermal conductivity of copper at 298.15 K = 384.1 W/m K (10)

Q. 3

(a) Derive an expression for conduction in composite wall. (08)

(b) 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. (08)

(c) Explain the terms: convective and molecular transport of energy (04)

Q. 4

(a) Derive an expression for conduction in electrical heat source. (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? For copper, the Lorenz number is 2.23×10^{-8} $volt^2/K^2$. (10)

Q. 5

(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 3.048 m.

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)

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 0.15 kg m/s, calculate the stress on each plate and the fluid velocity at 0.5 inch intervals from plate to plate. (08)

(b) Write i) general momentum balance equation, ii) general procedure for setting up and solving viscous flow problems, and iii) boundary conditions. (06)

(c) Explain the terms: convective and molecular transport of energy. (06)

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