B.Tech. Eighth Semester (Chemical Engineering) (CBS)



# 11674 : Transport Phenomena : 8 CH 01

P. Pages : 2

Time : Three Hours

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**AW - 3492**

Max. Marks : 80

Notes : 1. Answer **three** question from Section A and **three** question from Section B.
2. Assume suitable data wherever necessary.
3. Illustrate your answer necessary with the help of neat sketches.
4. Use of slide rule logarithmic tables, Steam tables, Mollier's Chart, Drawing instrument, Thermodynamic table for moist air, Psychrometric Charts and Refrigeration charts is permitted.

## SECTION – A

**1.** a) The distance between two parallel plates is 9.14mm. The lower plate is being pulled at an relative velocity of 366 mm/s. The fluid held between plates is Soyabean oil of viscosity 0.04 pa's at 303 k. Calculate shear stress and shear rate. If glycerol of viscosity 1.069 kg/m.s at 203 K is used instead of Soyabean oil what relative velocity is needed to hold same shear stress? **7**

b) Discuss the various types of Non-Newtonian fluids with examples. **7**

**OR**

**2.** a) Calculate average velocity in terms of max. velocity for velocity profile **7**

$$u_x = u_x \max\left(1 - \frac{r^2}{R^2}\right).$$

b) Derive an Expression for pressure drop for laminar flow in circular pipe. **7**

**3.** a) Starting with Newton's second law of motion develop integral momentum balance equation for linear momentum. **6**

b) A tank having inside diameter 4m & a water level of 2m is to be flow through orifice of 6cm. How long will it take to remove half the contents of the tank & to empty it completely? **7**

**OR**

**4.** a) A tank containing 100kg of 60% brine is filled with 10% salt solution at the rate of 10 kg/min. Solution is removed from the tank at the rate of 15 kg/min. Assuming complete mixing. Find the Kg. of salt in the tank after 10 min. **7**

b) Derive Energy equation using over all energy balance. **6**

**5.** a) **6**

For incompressible fluid at steady state show that $\vec{\Delta u} = 0$ or

$$\frac{\partial ux}{\partial x} + \frac{\partial uy}{\partial y} + \frac{\partial uz}{\partial z} = 0$$

b) Derive Navier - Stokes equation in rectangular co-ordinates. **7**

**OR**

**6.** a) An oil having density 900 kg/m$^3$& viscosity of 0.105 kg/m.s flows in the channel formed by the two horizontal stationary plates spaced 0.014m apart. If the avg. velocity is 1.3 m/s, determine. **10**

i) The velocity profile.

ii) Max. velocity.
iii) Shear stress at a distance of 0.005m from one of the plates.
iv) Head loss in a distance of 15m along the length of plate.

b) Explain Dimensional analysis of Navier stokes equation. **3**

## SECTION – B

**7.** a) Derive Laplace equation for heat transfer in solids, state clearly the approach you have made. **10**

b) Write the various cases for flow around submerged objects while dealing with chemical engineering operations. **4**

**OR**

**8.** a) Derive von Karman Integral momentum equation & its applications. **8**

b) Film thickness of boundary, layer is given by **6**

$$\delta = 5\sqrt{\frac{\mu x}{u_o \cdot p}}$$

Find the expression for drag force (FD)

**9.** a) Discuss in detail Enhancement factor and mass Transfer regimes. **7**

b) Derive Prandtl's one by seven power law - $\frac{ux}{ux_{max}} = \left(\frac{y}{R}\right)^{1/7}$ **6**

**OR**

**10.** a) Derive an equation for Prandtl Taylor analogy for heat & momentum transfer. **7**

b) A wet & dry bulb thermometer is kept in atmosphere if WBT is 18°C. Find DBT by Chilton–Colburn analogy **3**
Given:

$\rho_o = 2.1 kN/m^2$ , $\lambda = 245g\ kJ/kg$

$c_p = 1 kJ/kg.k$ , $\rho\ air = 1.2 kg/m^3$

$pr = 0.72$ , $SC = 0.61$

c) Discuss Prandtl mixing length. **3**

**11.** a) Derive an expression for mass flux by Danckwert's surface renewal theory & explain. **10**

b) Explain the term Hatta number. **3**

**OR**

**12.** a) Find mass transfer coefficient by Prandtl – Taylor analogy given that Reynolds No. is $1.6 \times 10^4$, Kinematic viscosity $15.53 \times 10^{-6}$ $m^2$/sec, diffusivity $7 \times 10^{-6}$ $m^2$/sec and velocity of flow is 10 m/s. **6**

b) Show that Sherwood number for a solid sphere dissolving into in finite stagnant medium is 2. **7**

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