B.Tech. Eighth Semester (Chemical Engineering) (CGS) Summer 2022

11674 : Transport Phenomena

8 CH 01

AY - 3563

P. Pages : 2

Time : Three Hours Forty Five Minutes

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) A tank is filled with 500 kg of 10% by wt. salt solution. A stream of 20% salt solution enters the tank at 10 kg/hr and same solution leaves the tank at 5 kg/hr. If the tank is well stirred find out how long will it take the strength of solution in tank to reach 15% ? **9**

   b) What is average velocity ? Find average velocity for laminar flow. **5**

OR

2. a) Discuss the time derivatives explain with suitable examples. **8**

   b) Show that for turbulent flow $(U_x)_{av} = 0.817(U_x)_{max}$. **6**

3. a) Derive energy equation using overall energy balance. **8**

   b) Explain the difference between overall and differential transport analysis. **5**

OR

4. a) Prove that converging nozzle body is always under tension and body force acting on it when a fluid flows through it is given by - **7**

$$f_{XB} = -\frac{(ubl)^2 \rho A_1}{2}\left[1 - \frac{A_1}{A_2}\right]^2$$

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

5. a) Derive Navier-Stokes equation using generalised differential momentum. **9**

   b) Water flows through 5 cm diameter wetted well column & produces a film of 0.5 cm thickness find the volumetric flow rate and avg. velocity. **4**

OR

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6. a) Derive an expression for velocity distribution in the film inside tube for flow in wetted wall column. 7

b) Show that $N_4 = 2$ for heat transfer from a hot sphere placed in a quiescent infinite fluid 6

SECTION - B

7. a) Discuss and derive Von-Karman integral momentum equation. 8

b) Write the various cases for flow around submerged objects, while dealing with chemical engineering operation. 6

OR

8. a) Explain the term : 8
i) Creeping flow
ii) Boundary layer thickness
iii) Form drag
iv) Wall drag

b) Discuss the problem of heat transfer in fully developed flow. Prove that for constant heat flux and flat velocity profile the Nusselt number is 8. 6

9. a) Derive university velocity distribution law for turbulent region for flow through pipe. 7
Show that – $u^t = 5.5 + 2.5 \text{luy}^t$.

b) Explain the term Isotropy of turbulence and Prandtl mixing length in brief. 6

OR

10. a) Discuss the salient features of Prandtl Taylor analogy between heat & momentum transfer. 7

b) Air is blowing over a freezer plate of 1.5 m with a velocity of 0.5 m/s. The surface is maintained at 10°C & average temperature of surrounding is 30°C. Find heat transfer from freezer plate (Pr = 0.71) 6

11. a) Discuss two film theory and drive equation for rate of mass transfer. 5

b) For simultaneous heat & mass transfer for air / water system following data is known. Find out the dry bulb temperature. Data 8
$\rho^o = 2.1 \text{ kN/m}^2$, $\lambda = 2459 \text{ kJ/kg}$, $\rho_{air} = 1.2 \text{ kg/m}^3$, pr = 0.72, $S_c = 0.61$, C_p = 1kJ kg k
wet bulb temperature is 18°C.

OR

12. a) Derive a relation for shear wood number for drop rising in a continuous medium and transferring a solute. 7

b) Explain the term in brief : 6
i) Hatta Number
ii) Enhancement factor

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