M. Tech. First Semester (Chemical Engineering) (CBS)

13001 : Transport Phenomena

1 CE 1

P. Pages : 2 AV - 3383

Time : Three Hours Max. Marks : 80

Notes :
1. Answer **six** questions.
2. Question No. **one** is compulsory.
3. Assume suitable data wherever necessary.
4. Diagrams and chemicals equations should be given wherever necessary.
5. Illustrate your answer necessary with the help of neat sketches.
6. Use of pen Blue/Black ink/refill only for writing the answer book.

1. Show that F = m. a represents the rate of change of momentum of a fluid under the influence of an external force. Derive equation for overall momentum balance in X and Y direction. **15**

2. The pump of a water distribution system is powered by a 15 kW electric motor whose efficiency is 90% The volumetric flow rate through the pump is 50 ℓ/s. The suction and discharge lines are of uniform size. If the absolute pressure at inlet and out let are 100 kPa and 300 kPa respectively, determine the mechanical efficiency of the pump and the rise in the temperature as the water flows through the pump due to mechanical inefficiencies Derive the equation used. **13**

3. Calculate the average velocity and thickness of water layer flowing down through a vertical plate of width 1 meter. The volumetric flow rate is $21.6 \ m^3/hr$. Assume a velocity profile. **13**

$$u_\gamma = \frac{\rho g}{H}\left\{L_x - \frac{x^2}{2}\right\}$$

Where 'L' is the thickness of water Layer. '$H\gamma$' downward velocity at distance 'x' from the wall. $\rho = 1000 \ kg/m^3$, $H = 1 \times 10^{-3} \ kg/m.s$.

4. Calculate the maximum velocity in terms of average velocity for the velocity profile given below; **13**

i) $U = U_{max}\left\{1-\left(\frac{r}{R}\right)^2\right\}$

ii) $U = U_{max}\left\{1-\left(\frac{r}{R}\right)\right\}^{1/7}$

5. For a fluid of constant density show that $(V.u) = 0$. Explain the difference between Euler's and Lagrangian approach used in differential mass balance. **13**

6. a) The parallel plates are separated from each other by 5mm and filled with crude oil of sp. gr. 0.9. A force of 2N is needed to pull the upper plate at a constant. velocity 0.8 m/s. Lower plate is stationary. If the area of upper plate is $0.09m^2$. Determine the dynamic viscosity in poise and kinematic viscosity in stokes. **7**

b) In a three dimensional incompressible fluid flow, the velocity component in x and y directions are $U_x = x^2 + y^2z^3$ and $U_y = -(xy + yz + xz)$ use continuity equation to evaluate an expression for the velocity component U_z in the Z-direction. **6**

7. Distinguish between homogeneous and isotropic material. Prove that for an isotropic material under steady state condition $\Delta^2 t = 0$ and for a one dimensional situation with no heat generation $\frac{\partial^2 t}{\partial x^2} = 0$. **13**

8. Calculate the boundary layer thickness and the average drag coefficient for the flow of water at a velocity of 0.8 m/sec at a distance of 0.5 m. The velocity distribution may be assumed as, **13**

$$\frac{u_x}{u_0} = \left(\frac{Y}{\delta}\right) - \left(\frac{Y}{\delta}\right)^2$$

Explain the concept of universal velocity profile.

9. Explain the theories of mass transfer also mention its assumption and significance. **13**

10. What is mean by Analogy? Discuss the following analogy with their salient features, **13**

i) Raynold analogy.

ii) Prandtl analogy.

iii) Chilton Colburn Analogy.

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