M. TECH. –I (CHEMICAL ENGINEERING) (CBCS – 2015 COURSE) : SUMMER - 2018

SUBJECT: ADVANCED MOMENTUM AND HEAT TRANSFER

Day :	Wednesday	S-2018-2991	Time:	11.00 AM TO 02.00 PM
Date :	30/05/2018		Max. Marks: 60.	

N.B.:

1) All questions are **COMPULSORY.**
2) Figures to the **RIGHT** indicate full marks.
3) Both the sections should be written in **SEPARATE** answer books.
4) Draw neat diagrams **WHEREVER** necessary.
5) Assume suitable data, if necessary.

SECTION-I

Q.1 Consider a flow of two adjacent immiscible fluids. These fluids are flowing in the z-direction in a horizontal thin slit of length L and width W under the influence of horizontal pressure gradient $(P_0 - P_L)/L$. The fluid flow rates are adjusted so that the slit is half filled with fluid I (more dense) and half filled with fluid II (less dense phase). Set up a differential momentum balance and obtain the expressions for momentum flux and velocity distribution. **(10)**

OR

A Newtonian fluid is in laminar flow in a narrow slit formed by two parallel walls a distance 2B apart. It is understood that B << W, so that edge effects are unimportant. Make a differential momentum balance and obtain the following expressions: **(10)**

$$\tau_{xz} = \left[\frac{P_0 - P_L}{L}\right]x$$

$$v_z = \frac{(P_0 - P_L)B^2}{2\mu L}\left[1 - \left(\frac{x}{B}\right)^2\right]$$

Q.2 Predict the vortex depth in an agitated vessel. Consider two takes with mechanical agitators. Large tank can be marked as 1 and small tank as 2. Derive the following expression. **(10)**

$$\gamma_2 = \gamma_1\left[\frac{D_2}{D_1}\right]^{1.5}$$

where,

D_1 and D_2 – diameter of the two tanks.

γ_1 and γ_2– Kinematic viscosity of two liquids.

OR

Derive the equation of motion: **(10)**

$$\rho\frac{Dv}{Dt} = -\nabla P - (\nabla \cdot \tau) + \rho g$$

Q.3 Show that for laminar flow in a thin slit of width 2B the friction factor is **(10)**

$$f = \frac{12}{\text{Re}} \textit{ if } \text{Re} = \frac{2B\langle v\rangle\delta}{\mu} \text{ and}$$

$$v_z = \frac{(P_0 - P_L)}{2\mu L}B^2\left[1 - \left(\frac{x}{B}\right)^2\right]$$

OR

Define friction factor for the packed column and derive - **(10)**

a) Blake – Kozeny equation
b) Burke – Plummer equation
c) Ergun equation

Q.4 **a)** Explain the temperature and pressure dependence on thermal conductivity of liquids and solids. **(05)**

b) A plastic panel of area 1 ft^2 and thickness 0.252 inch was found to conduct heat at a rate of 3 watts at a steady state temperature of T_0=24°C and T_1=26 °C on two main surfaces. Determine the thermal conductivity. **(05)**

OR

For free convection between two vertical plates at two different temperatures, obtain an expression for velocity distribution as **(10)**

$$v_z = \frac{(\rho g \beta \Delta T) B^2}{12\mu}\left[\left(\frac{y}{B}\right)^3 - \left(\frac{y}{B}\right)\right].$$

Q.5 **a)** Discuss the time smoothed temperature profile near a wall. Describe various regions based on the temperature profile. **(05)**

b) State the equation of motion for forced and free convection. **(05)**

OR

A solid slab occupying the space between y = -b and y = +b is initially at temperature T_0. At time t = 0 the surfaces at y = ± b are suddenly raised to temperature T_1 and maintained at that temperature. Find T(y, t) for heating of this finite slab. **(10)**

Q.6 Define heat transfer coefficient, the Nusselt number, the Stanton number and the Chilton – Colburn factor jH. Discuss in detail any one analogy for heat and momentum transfer. **(10)**

OR

What is the importance of analogies in transport phenomena? Explain in detail the Reynolds and Chilton–Colburn analogy between momentum and heat transfer. **(10)**

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