M. Tech. –I (Chemical Engineering) (CBCS – 2015 Course) :
SUMMER - 2019
SUBJECT: ADVANCED MOMENTUM AND HEAT TRANSFER

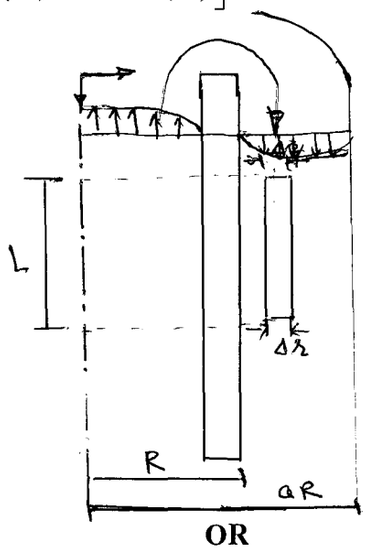
Day : Saturday
Date : 18/05/2019
S-2019-3394
Time: 11.00 AM TO 02.00 PM
Max. Marks: 60.

N.B.:
1) All questions are **COMPULSORY.**
2) Figures to the **RIGHT** indicate full marks.
3) Answer to both the sections should be written in **SAME** Answer book.
4) Draw neat diagrams **WHEREVER** necessary.
5) Assume suitable data, if necessary.

SECTION-I

Q.1 In gas absorption experiment a viscous fluid flows upward through a small circular tube and then downward in laminar flow on the outside. Set up a momentum balance over a shell of thickness Δr in the film. Show that the velocity distribution in the falling film is: **(10)**

$$v_z = \frac{\rho g R^2}{4\mu}\left[1-\left(\frac{r}{R}\right)^2 + 2a^2 \ln\left(\frac{r}{R}\right)\right]$$



OR

a) Describe the shear stress- shear rate diagram for time independent and time dependent non-Newtonian fluids. **(05)**

b) Discuss the theory of viscosity of gases at low density and show that - **(05)**

$$\mu = \frac{2}{3\pi^{3/2}}\frac{\sqrt{mkT}}{d^2}.$$

Q.2 **a)** Discuss eddy viscosity of Boussinesq for a turbulent shear flow. **(05)**

b) Describe the Prandtl's equation for momentum transfer in turbulent flow. **(05)**

OR

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

$$\frac{\partial}{\partial t}(\rho v) = -[\nabla \cdot \rho v v] - \nabla P - \nabla \tau + \rho g$$

Q.3 Define friction factor for the packed column and derive - **(10)**

a) Blake – Kozeny equation

b) Burke – Plummer equation

c) Ergun equation

OR

P.T.O.

a) Describe the methods for estimation of the viscous loss or friction loss, which appears in the macroscopic mechanical energy balances. **(05)**

b) State the macroscopic mechanical energy balance for steady and unsteady state. **(05)**

Q.4 Consider a rectangular composite slab made up of three materials of different thicknesses and different thermal conductivities. Develop an expression for overall heat transfer coefficient for heat conduction through such composite wall, located between two fluid streams at temperature T_a and T_b. **(10)**

OR

For heat conduction in rectangular cooling fin show that effectiveness of a fin is - **(10)**

$$\eta = \frac{\tanh N}{N}$$

Clearly state the assumptions used.

Q.5 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)**

OR

Describe in detail time smoothed equations of change for incompressible non-isothermal flow. **(10)**

Q.6 Define heat transfer coefficients for interphase transport in non-isothermal system and describe the heat transfer coefficients for forced convection through packed beds. **(10)**

OR

Explain in detail the Reynolds and Chilton–Colburn analogy between momentum and heat transfer. **(10)**

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