Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (CHE-OLD)/SEM-4/CHE-405/2013

2013
FLUID MECHANICS

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) At a given mass flow rate doubling the pipe diameter

      a) reduces N_{Re} by $\frac{1}{2}$

      b) doubles N_{Re}

      c) None of these.

   ii) Stokes law is based on

      a) Newtonian fluid

      b) Non-Newtonian fluid

      c) None of these.

iii) For a properly designed Orifice meter, the Orifice coefficient can be

a) 0·60 b) 1·05

c) 0·8 d) 0·98.

iv) If the ratio of the diameters of the two spheres is 1·5, the ratio of Stokes drug on the two sphere should be

a) 1·5 b) 4·5

c) $\frac{1}{4 \cdot 5}$ d) none of these.

v) A 1/3 decrease in the pipe dia will result in change in average velocity by

a) 4/5 time decrease b) 3/2 times increase

c) 5/4 times increase d) none of these.

vi) Which of the following valves permits flow of slurry material ?

a) Gate valve

b) Globe valve

c) Plunger

d) All of these

e) Diaphragm.

vii) The sphericity of a cubical particle having length 3 mm is equal to

a) 3·0 b) 1·0

c) 1·274 d) none of these.

viii) A Newtonian fluid (density = ρ, viscosity = μ) is flowing in a smooth pipe with velocity v in a tube of dia D. Then pressure drop across the length L will be proportional to

a) $L\ \rho v^2 / D$ b) $D\ \rho v^2 / L$

c) $L\ \mu v / D^2$ d) $\mu v / L$.

ix) For an ideal fluid flow the Reynolds no. is

a) 2100 b) 100

c) 0 d) infinity.

x) Fluidized bed are formed when

a) fluid friction is zero

b) gravity force is less than fluid friction

c) pressure force is equal to gravity force

d) sum of the fluid friction and pressure forces is equal an opposite to gravity forces.

xi) For the laminar flow of a fluid in a circular pipe of radius R, the Hagen-Poiseuille equation predicts the volumetric flow rate to be proportional to

a) R b) R^2

c) R^4 d) $R^{0.5}$.

xii) Equivalent diameter of a annulus pipe having outer and inner radii 5 m and 3 m is given by

a) 10 m b) 4 m

c) 6 m d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. What do you mean by transition length ? Define the term "Boundary layer" and draw a diagram to describe the development of boundary layer on a flat plate.

3. Write the importance of kinetic energy correction factor for modification of Bernoulli's equation and find out an expression for kinetic energy correction factor α.

4. Derive Hagen-Poiseuille equation starting from average velocity distribution for laminar flow and find out the relation between friction factor and Reynolds No.

5. Find out the general expression for average velocity of dilatant or pseudoplastic fluid under laminar flow.

6. Prove that for laminar flow the average velocity is exactly one-half of maximum velocity for the same system.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) A *U*-tube manometer with mercury reads 12 cm water in the pipeline. Express the pressure in N/m^2. Density of mercury = 13600 Kg/m^3; density of water is = 1000 kg/m^3.

b) Give an idea of boundary layer in a straight tube. Write the Bernoulli's equation with friction and explain the significance of its each term.

c) A town delivers its water supply from a river pumping it with a standard pipe. The inlet to the pump is 5 m above the river and the water level in the pipe kept constant at 100 m above the pump discharge. The frictional loss is 3600 gmf cm/gm of water through the 1500 m of 25 cm *I. D* pipe which includes the total equivalent length of all piping from river to water tower. If the pump capacity is 40000 L/hr. and pump is 80% efficient, then what should be the hourly pumping cost if electricity costs Rs. 2 per k-watt-hr ? 4 + 3 + 8

8. a) Define terminal velocity. Show that the expression for terminal velocity of a falling particle in a gravitational field is

$$U_t = \left[2g \left(\rho_p - \rho \right) m \; A_p \rho_p \, . C_D \, . \rho \right]^{0.5}$$

Where A_p = projected area of the particle, C_p = drag coefficient and ρ_p and ρ are the density of medium and particles respectively.

b) Drops of oil 15 micron in dia are to be settled from their mixture with air. The *sp.* gravity of the oil is 0·9 and the air is at 21°C and 1 atm pressure. A settling time of 1 min is available. How high should chamber be allowed to settling of the particle ?

(Viscosity at 21°C = 0·018 cp) 7 + 8

9. a) Find out an expression for a friction loss coefficient for sudden expanded cross-section.

b) Water flows through a 200 mm dia pipe with an average velocity of 3·6 m/sec. There is a certain enlargement to a 400 mm dia pipe.

i) What is the power loss due to the certain enlargement ?

ii) What will be power loss if water flows into opposite direction with the same average velocity in the smaller pipe ? 7 + 8

10. a) What do you mean by minimum fluidization velocity ? Explain the importance of Ergum equation to find out pressure drop in a packed bed.

b) A vessel 3 m in dia contains 23700 kg of spherical sand particles of 14·7 mm size. The bed is to be fluidized by air at 400°C and 17 atm pressure. The viscosity of air at operating conditions is 0·00032 poise. If density of sand particle is 2690 kg/m^3. Calculate the minimum height of the fluidised bed if porosity at the minimum fluidization is 0·55. Pressure drop across the fluidization bed at minimum porosity conditions.

2 + 6 + 7

11. a) Give the difference between suction head and suction lift.

b) Deduce the expression for volumetric flow rate through orifice meter.

c) Flow of a liquid in a 75 mm diameter pipe is measured by an orifice. Maximum flow rate is limited to 10 litres in a second. The mercury manometer gives a reading of 35 cm at this flow rate. Estimate orifice size. Liquid density = 1200 kg/m^3.

OR

A venturimeter is to be installed in a 100 mm tine to measure the flow of water. The maximum rate is expected to be 75 m^3/hr at 20°C. The manometer used to measure the differential pressure is to be filled with mercury, and water is to fill the leads above the surfaces of the mercury. If the maximum manometer reading is to be 1·25 m and the venturi coefficient is 0·98, what throat diameter should be specified for venturi ? 3 + 5 + 7

12. a) "The permanent pressure loss in a venturi meter is relatively small than that in a orifice meter." Elaborate the statement.

b) Draw the characteristic curves of centrifugal pump.

c) Write the principles of rotameter.

d) "The pressure drop across the fluidized bed always remains constant." Explain the statement with proper reason.

e) Explain how cavitation may be controlled for a pump.

5 × 3