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Paper Code : CHE-301

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) A fluid is flowing through a pipe diameter d, if diameter is increased two times Reynolds number will be

a) increased by 40% b) decreased 25%

c) unchanged d) decreased by 50%.

ii) A 1/3 decrease in the pipe diameter will result in change in average velocity by

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

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

iii) Which of the following valves permit flow of slurry material ?

a) gate valve b) globe valve

c) plunger d) diaphragm.

iv) 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.

v) A Newtonian fluid (density = ρ, viscosity = μ) is flowing in a smooth pipe with velocity v in a tube of dia D. they 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) $\mu v / L$.

vi) For a properly designed orifice meter. The orifice coefficient can be

a) 0·60 b) 1·05

c) 0·8 d) 0·98.

vii) Net positive suction head of a centrifugal pump must be

a) > vapour pressure of the liquid

b) < vapour pressure of the liquid

c) = vapour pressure of the liquid

d) < barometric pressure.

viii) Terminal velocity is

a) Fluctuating velocity

b) A constant velocity with no acceleration

c) Attained after moving one half of total distance

d) None of these.

ix) Navier Stoke's equation is derived on the basis of

a) Only momentum balance in laminar zone

b) Only momentum balance in turbulent zone

c) Mass balance, momentum balance, stress tensors in laminar zone

d) Mass balance, momentum balance, stress tensors in turbulent zone.

x) In a centrifugal pump cavitation is reduced by

a) increasing the flow velocity

b) reducing the discharge

c) throttling the discharge

d) reducing suction head.

xi) Fluidized beds are formed when

a) fluid fiction is zero

b) gravity force is less than fluid friction

c) pressure force is equal to gravity force

d) sum of fluid force & pressure is equal & opposite to gravity force.

xii) Euler number is the ratio of

a) inertia force to gravity force

b) inertia force to viscous force

c) pressure force to inertia force

d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

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. 2 + 2 + 1

3. Write the importance of momentum correction factor and find out an expression for momentum correction factor β. 2 + 3

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. For turbulent flow in a smooth circular tube of radius R, the velocity profile varies according to $V = V_{max}\{(R-r)/r\}^{1/7}$ at Reynolds number about 10^5, where r = radial distance from centre. Prove that the ratio of average velocity to maximum velocity is given by (49/60).

6. Write down the differences between streamline and streak line. The velocity distribution for a three dimensional flow is given by $u = -x$, $v = 2y$ and $z = 3 - z$. Find the equation of the stream line passing through (3, 2, 1).

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

a) A U-tube manometer with mercury reads 30 cm. Water is 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) Write the modified Bernouli'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 10 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 2500 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 50000 L/hr and pump is 80% efficient, then what should be the hourly pumping cost if electricity costs Rs. 5 per k.watt-hr ? 4 + 3 + 8

8. a) What do you mean by minimum fluidization velocity ? Starting from Ergum equation drive the expression for minimum fluidization velocity. Also Explain the importance of Ergum equation to find out pressure drop in a packed bed.

b) Drops of oil 15 micron in dia ore 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 be chamber be to allow 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) Water 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) "The permanent pressure loss in a venturi meter is relatively small than that in a Orifice meter". Elaborate the statement.

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. 2 + 6 + 7

11. a) Explain the terms "NPSH" and "Cavitation". How Cavitation may be avoided in a centrifugal pump ?

2 + 2 + 1

b) Write down the relations between pump head, capacity and rpm for centrifugal pump and show their characteristic curves. 6

c) Air at 38° C and 100 kpa absolute pressure flows at a velocity of 20 m/s past a sphere having diameter of 40 mm. Calculate N_{Rep} and the force on the sphere if density of air is 1·13 kg/m^3 and viscosity is 1·9 × 10^{-5} Poise, C_d = 0·47. 4