Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH/CHE(N)/SEM-3/CHE-301/2012-13

2012

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) Navier-Stokes equation deals with the law of conservation of

a) mass b) energy

c) momentum d) both (a) and (b).

ii) Which of the following equation is applicable for the flow of fluid through a packed bed for large Reynold's number ?

a) Fanning's equation

b) Kozeny Carman equation.

iii) At stagnation point

a) velocity equals to zero

b) pressure drop equals to zero

c) density equals to zero

d) viscosity equals to zero.

iv) Coefficient of discharge of orifice meter is ..... that of venturi meter.

a) less b) more

c) both (a) and (b) d) none of these.

v) Flow number N_Q is defined as

a) $\frac{nD_a^3}{q}$ b) $\frac{q}{nD_a^3}$

c) $\frac{Pg_c}{n^3 D_a^5 \rho}$ d) $\frac{n^3 D_a^5 \rho}{Pg_c}$.

vi) Bernoulli's Theorem deals with the conservation of

a) mass b) force

c) momentum d) energy.

vii) Rotameter is known as

a) Pressure meter b) Velocity meter

c) Area meter d) none of these.

viii) A fluid ($\frac{\mu}{\rho} = 0 \cdot 01\ \text{cm}^2/\text{s}$) is moving at critical flow condition ($N_{\text{Re}} = 2100$) through a pipe of diameter 3 cm. Velocity of flow (cm/s) is

a) 700 b) 7000

c) 0·7 d) 7·0.

ix) Toothpaste is an example of

a) Bingham plastic fluid b) Dilatants fluid

c) Pseudo plastic d) Newtonian fluid.

x) Priming is needed in a

a) Reciprocating pump b) Centrifugal pump

c) Gear pump d) Diaphragm pump.

xi) Which of the following valves permits fluid flow in one direction only ?

a) Gate valve b) Globe valve

c) Check valve d) All of these.

xii) The hydraulic radius of an annulus of inner and outer redii r_1 and r_2 respectively is

a) $4(r_0 - r_i)$ b) $(r_i + r_0)^{\frac{1}{2}}$

c) $\left(\frac{r_0 - r_i}{2}\right)$ d) $\left(\frac{r_i + r_0}{2}\right)$.

GROUP – B

(Short Answer Type Questions)

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

2. What do you understand by 'kinetic energy correction factor' ? Find out its value for a Newtonian fluid flowing through a circular long straight tube in laminar condition. 2 + 3

3. a) The velocity distribution for a three-dimensional flow is given by $u = -x, v = 2y$ and $w = 3 - z$. Find the equation of the streamline passing through (2, 2, 1).

   b) Water is flowing at 25° C (density 998 kg/m^3) through a pipe of 5 cm diameter at a velocity of 0·033 m/s and Re.no = 1700. Calculate the pressure drop per unit length. 3 + 2

4. Determine the distance from the pipe wall at which the local velocity is equal to the average velocity for turbulent flow in pipes.

5. Scalar form of Navier-Stokes equation for x direction is given by

$$\rho\left[\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z}\right] = -\frac{\partial p}{\partial x} + \rho g x + \mu\left[\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right]$$

   Where u, v, and w are scalar components of velocity field along x, y and z direction respectively. Starting from this equation derive the expression of velocity field, volumetric flow rate and average velocity.

6. Particles of sphalerite (S.G. 4·00) are settling under the force of gravity in a fluid at 20°C having S.G. 1·594. The diameter of sphalerite is 0·10 mm. The volume fraction of sphalerite in the fluid is 0·20. What is the terminal velocity of sphalerite. Given μ_{fluid} = 1·03 cp (at 20°C).

GROUP – C

(Long Answer Type Questions)

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

7. a) Water at 20°C is pumped at a constant rate of 9 m^3/h from a large reservoir resting on the floor to the open top of an experimental absorption tower. The point of discharge is 5 m above the floor, and friction losses in the 50 mm pipe from the reservoir to the tower amount to 2·5 J/kg. At what height in the reservoir must the water level be kept if the pump can deliver only 0·1 kW ?

   b) Write down the difference between Dilatant and Thixotropic fluids. 12 + 3

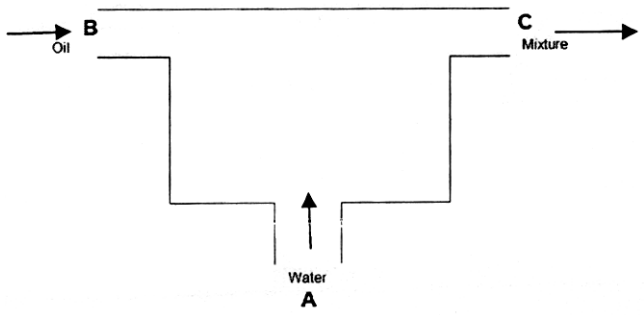
8. a) What are the major assumptions used in the derivation of Bernoulli's equation ?

   b) What are the corrections needed in Bernoulli's equation when this equation is applied in the practical field ?

   c) Water with a density of 998 kg/m^3 is flowing at a steady mass flow rate through a uniform diameter pipe. The entrance pressure of the fluid is 68·9 kN/m^2 absolute in the pipe, which connects to a pump that actually supplies 155·4 J/kg of fluid flowing in the pipe. The exit

pipe from the pump is the same diameter as the inlet pipe. The exit section of the pipe is 3·05 m higher than the entrance and the exit pressure is 137·8 kN/m^2 absolute. The Reynolds No. in the pipe is above 4000 in the system. Calculate the frictional loss in the pipe system. 3 + 6 + 6

9. a) Water is forced into the device shown in figure below at the rate of 0·15 m^3/sec through pipe *A*, while oil of specific gravity 0·8 is forced in at the rate of 0·05 m^3/sec through pipe *B*. If the liquids are incompressible and form a homogeneous mixture of oil globules in water, what is the average velocity and density of the mixture leaving through pipe *C* having a diameter of 0·0564 m ?



b) Water at 20°C enters into lead pipe, having diameter (*D* = 10 cm) length *L* = 8 m and flow rate *Q* = 0·001 m^3/s. Calculate entrance length. Does the flow become fully developed ?

c) What is the significance of Reynolds number ? Write two example of binghamplastic fluid. 5 + 6 + 4

10. a) Find the drag force exerted on a flat plate of size 2 m × 2 m when the plate is moving at a speed of 4 m/s normal to its plane in (i) water, (ii) air of density 1·24 kg/m^3. Coefficient of drag is given as 1·15.

    b) A pitot static tube is used to measure the velocity of water in a pipe. The stagnation pressure head is 6 m and static pressure head is 5 m. Calculate the velocity of flow assuming the coefficient of tube equal to 0·98.

    c) Explain the advantages and disadvantages of each of the following : (i) venturi meter, (ii) orifice meter.

    d) Why is coefficient of discharge of a orifice meter much smaller than that of venturi meter. 4 + 4 + 4 + 3

11. a) What is fluidization ? Write down the applications of fluidization.

    b) What do you mean by NPSH ? To avoid cavitation what should be the NPSH ?

    c) A 0·5 m high bed made up of a 1 mm glass spheres (density = 2500 kg/m^3) is to be fluidized by water (density = 1000 kg/m^3). If at the point of incipient fluidization, the bed voidage is 40% then what is the pressure drop across bed ?

    d) "The pressure drop across a fluidized bed always remains constant." Explain the statement with proper reason. 3 + 4 + 5 + 3

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