Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (CHE)/SEM-4/CHE-405/2011

2011
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 of diameter *d*. If diameter is increased two times, Reynolds number will be

   a) increased 40% b) decreased 25%

   c) unchanged d) decreased 50%.

   ii) In laminar flow of Newtonian fluid through circular tube average velocity is

   a) 2/3 of the maximum velocity

   b) 1/3 of the maximum velocity

   c) 1/2 of the maximum velocity

   d) none of these.

iii) Fixed discharge flow through a tapering pipe is

a) steady and uniform flow

b) steady and non-uniform flow

c) unsteady and uniform flow

d) unsteady and non-uniform flow.

iv) For laminar flow through 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) $R^{0.5}$.

v) A control volume implies

a) an isolated system

b) a closed system

c) a specific mass in a fluid flow

d) a fixed region in space.

vi) In which of the following measuring devices is Bernoulli's equation used ?

a) Venturimeter b) Orifice meter

c) Pitot tube d) All of these.

vii) The co-efficient of discharge of an orifice meter is ..... that of a venturimeter.

a) equal to b) much smaller than

c) much more than d) any of these.

viii) A Pitot tube is used for measuring

a) local velocity of flow

b) average velocity of flow

c) pressure drop of flow

d) total energy of flow

ix) In centrifugal pumps, cavitation is reduced by

a) increasing the flow velocity

b) reducing the discharge

c) throttling the discharge

d) reducing the suction head.

x) The drag force is given by

a) $C_d \rho u^2 A$ b) $C_d \rho^2 u^2 A$

c) $C_d \rho u^2 A^2$ d) $C_d \rho u^2/2A$.

xi) Assumptions made in derivation of Navier-Stokes equations are

a) continuum, Newtonian fluid and μ = constant, incompressible flow

b) steady flow, irrotational flow, incompressible flow

c) continuum, non-Newtonian fluid, incompressible flow

d) continuum, Newtonian fluid, Stokes' hypothesis and isotropy.

xii) On account of which of the following does boundary layer exist ?

a) Surface tension b) Gravitational effect

c) Viscosity of the fluid d) None of these.

GROUP – B

(Short Answer Type Questions)

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

2. What is Reynolds number ? Prove that it is the ratio of two forces.

3. What are the desirable properties of a good manometric fluid ? Give some examples of manometric fluid generally used. 3 + 2

4. a) Define hydraulic radius.

   b) Water entres from 2 cm diameter pipe to a 3 cm diameter pipe; the fluid has the Reynolds No. of 6000 at 2 cm diameter. What will be its Reynolds No. while flowing through 3 cm diameter pipe ? 1 + 4

5. What is the difference between Newtonian fluid and Non-Newtonian fluid ? Draw the shear stress *vs* shear rate curves for different Non-Newtonian fluids. 2 + 3

6. What do you understand by the terms 'Major energy loss' and 'minor energy loss' in pipes ? How will you determine the loss of head due to friction in pipes by Darcy formula ? 2 + 3

GROUP – C

(Long Answer Type Questions)

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

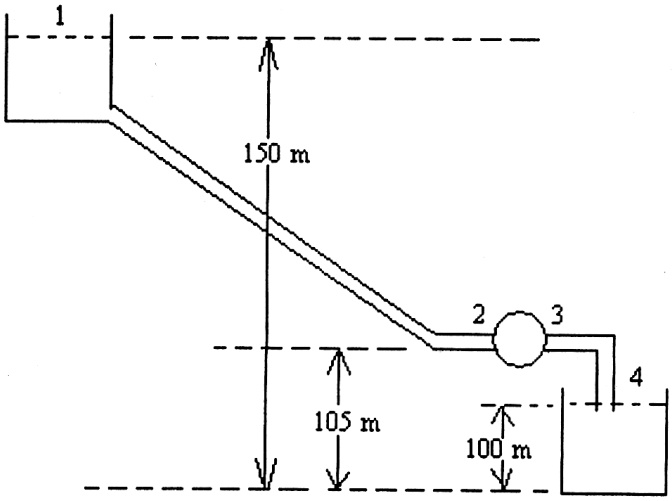
7. a) A pipe connects a reservoir to a turbine which discharges water to tail race through another pipe. The head loss between the reservoir and the turbine is 10 times the kinetic head in the pipe and that from the turbine to the tail race is 0·5 times the kinetic head in the pipe. The rate of flow is 1 m^3/s and the pipe diameter in both cases is 1 meter. Find the pressure at inlet and exit of the turbine.

Take :

Energy level of turbine = 105 m

Energy level of reservoir = 150 m

Energy level of tail water = 100 m



Also calculate the power generated by the turbine.

b) What is a power law equation ? Draw shear stress versus velocity gradient diagram for different types of fluids and explain for which fluid is the power law equation applicable. 10 + 5

8. a) Show that fanning friction factor, $f = 16/Re$ for laminar flow. Where, Re is Reynolds number.

   b) Orificemeter of diameter 20 mm is installed in pipeline of diameter 55 mm for measurement of flow rate of water. The pressure drop across the meter is 12 cm of Hg. Find the volumetric flow rate of water if constant of meter is 0·65.

   c) What is kinetic energy correction factor ? Prove that for laminar flow of Newtonian fluid, kinetic energy correction factor = 2·0. 6 + 4 + 5

9. a) What do you mean by minimum fluidization velocity ? Starting from Ergun equation, derive the expression of minimum fluidization velocity for a fluidized bed.

   b) For sudden expansion in a pipe flow, work out the optimum ratio between the diameter of the pipe before expansion and the diameter of the pipe after expansion so that pressure rise is maximum. 3 + 5 + 7

10. a) Derive the expression for the various efficiencies of a centrifugal pump :

      i) Manometric efficiency

      ii) Mechanical efficiency

      iii) Overall efficiency.

   b) Air at 37·8 °C and 101·3 kPa absolute pressures flows at a velocity of 23m/s past a Sphere having a diameter of 42 mm. Calculate N_{Rep} and the force on the sphere. Given $\rho_{air} = 1 \cdot 137 \text{ kg/m}^3$ and $\mu = 1 \cdot 9 \times 10^{-5}$ Pa – s, $C_d = 0 \cdot 47$.

   c) Give the difference between suction head and suction lift. 8 + 4 + 3

11. Write short notes on any *three* of the following : 3 × 5

a) Cavitation in centrifugal pump

b) Anemometer.

c) Time-dependent and Time-independent non-Newtonian fluids.

d) Different types of manometer.

e) Boundary layer.

f) Different types of pump.

12. a) What is priming ? How can it be overcome ?

b) A centrifugal pump with an efficiency of 65% is driven by an electric motor with an efficiency of 90%. The pump delivers 250 kg of water per minute against a total head of 25 m. What is the power required by the motor and what is the power delivered by the motor ? 3 + 2 + 10