Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(CE)/SEM-3/CE-302/2009-10

2009

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) The resultant hydrostatic force acts through a point known as

      a) centre of gravity b) centre of buoyancy

      c) centre of pressure d) none of these.

   ii) The condition of stable equilibrium for a floating body is

      a) the metacentre M coincides with the centre of gravity G

      b) the metacentre M is below the centre of gravity G

      c) the metacentre M is above the centre of gravity G

      d) the centre of buoyancy B is above the centre of gravity G.

iii) The necessary condition for the flow to be steady is that
   a) the velocity does not change from place to place
   b) the velocity is constant at a point with respect to time
   c) the velocity changes at a point with respect to time
   d) none of these.

iv) The flow in pipe is laminar if
   a) Reynolds number is equal to 2500
   b) Reynolds number is equal to 4000
   c) Reynolds number is more than 2500
   d) none of these.

v) The value of friction factors for smooth pipes for Reynolds number equal to 10^6 is approximately
   a) 0·0001 b) 0·001
   c) 0·01 d) 0·1

vi) Hydraulic jump is used for
   a) increasing the depth of flow
   b) reducing the energy of flow
   c) decreasing the velocity of flow
   d) reducing turbulence.

vii) Flow has Froude number less than one
   a) if normal depth is less than critical depth
   b) if normal depth is more than critical depth
   c) if normal depth is equal to critical depth.

viii) An impulse turbine
   a) always operates submerged
   b) makes use of a draft tube
   c) is most suited for low-head installations
   d) operates by initial complete conversion to kinetic energy.

ix) Francis turbine is

a) an impulse turbine

b) a reaction turbine

c) a tangential flow turbine

d) an axial flow turbine.

x) The specific speed of a pump is defined as the speed of a unit

a) of unit size with unit discharge at unit head

b) of such a size that it requires unit power at unit head

c) of such a size that it delivers unit discharge at unit head

d) of such a size that it delivers unit discharge at unit power.

xi) Unit power of a turbine is given by

a) $P/H^{1/2}$ b) $P/H^{3/2}$

c) $P/H^{3/4}$ d) $P/H^{5/2}$.

xii) Which mouthpiece has a maximum coefficient of discharge ?

a) External mouthpiece

b) Internal mouthpiece

c) Convergent divergent mouthpiece

d) None of these.

xiii) The discharge through triangular notch is given by

a) $Q = (2/3)^* C_d ^* (\tan \theta/2)^* (2 gH)^{1/2}$

b) $Q = (2/3)^* C_d ^* (\tan \theta/2)^* (2 gH)^{3/2}$

c) $Q = (2/15)^* C_d ^* (\tan \theta/2)^* (2 gH)^{5/2}$

d) none of these.

xiv) The loss of head due to sudden expansion on a pipe is given by

a) $h_L = \left(V_1^2 - V_2^2 \right) / 2g$

b) $h_L = \left(0{\cdot}5\, V_1^2 \right) / 2g$

c) $h_L = \left(V_1 - V_2 \right)^2 / 2g$

d) none of these.

GROUP – B
(Short Answer Type Questions)

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

2. a) Write a short note on vena-contracta.

   b) Define potential energy, kinetic energy and pressure energy. 2 + 3

3. a) Water flows through a pipe of 200 mm in diameter and 60 m long with a velocity of 2·5 m/s. Find the head lost due to friction using Darcy's formula. Assume $f = 0{\cdot}005$.

   b) Define metacentre and metacentric height. 3 + 2

4. State and explain the equilibrium of a floating body.

5. Discuss what will be the effect on the flow through a rectangular channel in transition with raised bottom or hump.

6. a) What do you understand by total pressure and centre of pressure ?

   b) The head of water over the centre of an orifice of diameter 20 mm is 1m. The actual discharge through the orifice is 0·85 litres/sec. Find the coefficient of discharge. 2 + 3

7. a) What is the difference between centre of gravity and centre of buoyancy ?

   b) What is the difference between types of orifice and types of mouthpiece ? $2\frac{1}{2} + 2\frac{1}{2}$

8. a) Determine the terms notch, weir, nappe and crest ?

   b) Derive the expression $C_d = C_v * C_c$? $2\frac{1}{2} + 2\frac{1}{2}$

GROUP – C

(Long Answer Type Questions)

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

9. a) What are the conditions of stability of submerged body and floating body ?

   b) A vertical sluice gate is used to cover an opening in a dam. The opening is 2 m wide and 1·2 m high on the upstream of the gate, the liquid of specific gravity 1·45 lies up to a height of 1·5 m above the top of the gate, whereas on the downstream side of the water is available up to a height touching the top of the gate. Find the resultant force acting on the gate and position of centre of pressure. Aassume that the gate is hinged at bottom. 5 + 10

10. a) Calculate the discharge through a pipe of diameter 300 mm when the difference of pressure head between two ends of a pipe 450 mm apart is 6·5 m of water. Take coefficient of friction = 0·009.

b) An internal mouthpiece of 75 mm diameter is discharging water under a constant head of 4·5 m. Find the discharge through mouthpiece, when

i) the mouthpiece is running free and

ii) the mouthpiece is running full.

c) Find the discharge through a trapezoidal notch which is 1 m wide at the top and 0·4 m at the bottom and is 30 cm in height. The head of water on the notch is 20 cm. Assume C_d for rectangular portion = 0·62 while for triangular portion = 0·60. 5 + 5 + 5

11. a) Prove that for most economical rectangular section

i) Depth of flow = Half bottom width.

ii) Hydraulic radius = Half the depth of flow.

b) An earthen channel with a base width 2 m and side slope 1 horizontal to 2 vertical carries water with a depth of 1 m. The bed slope is 1 in 625. Manning's constant n = 0·03.

Calculate :

i) Discharge

ii) Average shear stress at the channel boundary. 5 + 10

12. a) Explain the following :

i) Geometric similarity

ii) Kinematic similarity

iii) Dynamic similarity.

b) Water is flowing through a pipe of diameter 30 cm at a velocity of 4 m/s. Find the velocity of oil flowing in another pipe of diameter 10 cm, if the condition of dynamic similarity is satisfied between the two pipes. The viscosities of water and oil are given as 0·01 poise and 0·025 poise respectively. The specific gravity of oil = 0·80. (3 × 2) + 9

13. a) The head of water over an orifice of diameter 40 mm is 10 m. Find the actual discharge and actual velocity of the jet at vena-contracta. Take C_d = 0·6 and C_v = 0·98.

b) A right-angled V-notch is used for measuring a discharge of 30 litres/sec. An error of 2 mm was made in measuring the head over the notch. Calculate the percentage error in the discharge. Take C_d = 0·62.

8 + 7

14. a) State and explain the conditions of equilibrium of

i) Floating body

ii) Submerged body

with suitable sketches.

b) An earthen channel with a base width 2 m and side slope 1 horizontal to 2 vertical carries water with a depth of 1 m. The bed slope is 1 in 625. Calculate the discharge if n = 0·03. Also calculate the average shear stress at the channel boundary. (4 + 4) + 7

15. a) In a rectangular channel 3·5 m wide laid at a slope of 0·0036, uniform flow occurs at a depth of 2 m. Find how high the hump can be raised without causing afflux ? If the upstream depth of flow is to be raised by 2·5 m, what should be the height of the hump ? Take Manning's n equal to 0·015.

b) What is dimensional homogeneity ? Explain this principle with the help of examples. What is the difference between dimensionally homogeneous equation and dimensionally non-homogeneous equation ? Give examples. 7 + (2 + 3 + 3)