Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (CE)/SEM-3/CE-302/2010-11

2010-11
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 alternativ s for the following : 10 × 1 = 10

   i) A vertical rectangular plane surface is submerged in water such that its top and bottom surfaces are 1·5 m and 6·0 m respectively below the free surface. The position of centre of pressure below the free surface will be at the distance of

      a) 3·75 m

      b) 4·0 m

      c) 4·2 m

      d) 4·5 m.

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

a) the meta-centre (M) coincides with the centre of gravity (G)

b) the meta-centre (M) is below the centre of gravity (G)

c) the meta-centre (M) is above the centre of gravity (G)

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

iii) In the most general from of Bernou li's equation $\frac{p}{w}+\frac{v^2}{2g}+z=\text{constant}$, each term represen s

a) energy per unit mass

b) energy per unit weight

c) energy per unit volume

d) none of these.

iv) An error of 0·5% in the measurement of head in a V-notch causes an e ror of

a) 0·5% in the discharge b) 1·0% in the discharge

c) 1 25% in the discharge d) 1·5% in the discharge.

v) The unit of kinematic viscosity is

a $gm/cm\text{-}sec^2$ b) $dyne\text{-}sec/cm^2$

c) $gm/cm^2\text{-}sec$ d) cm^2/sec.

vi) Geometric similarity between model and prototype means

a) the similarity of discharge

b) the similarity of linear dimensions

c) the similarity of motion

d) the similarity of forces.

vii) If X is the distance from leading edge, then the boundary layer thickness in laminar flow varies as

a) $X^{1/2}$ b) $X^{4/5}$

c) $X^{3/5}$ d) $X^{1/7}$.

viii) 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 un t 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.

ix) Mach number is defined as the ratio of

a) inertia force to viscous force

b) inertia force to viscous force

c) viscous force to elastic force

d) inertia force to elastic force.

x) Pelton turbine is

a) impulse turbine

b) reaction turbine

c) tangential flow turbine

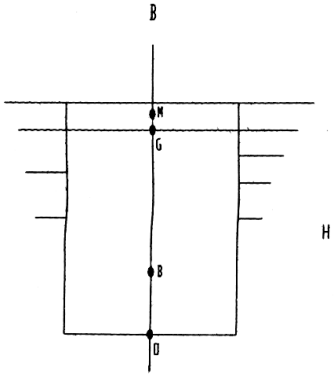
d) axial flow turbine.

GROUP – B

(Short Answer Type Questions)

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

2. A rectangular burge of width b and a submerged depth of h has its centre of gravity at the waterline. Find the metacentric height in terms of b/H, and hence show, that for stable equilibrium of burge $\frac{b}{H} \geq \sqrt{6}$.



3. A compound pipe system consists of 1800 m of 50 cm dia, 1200 m of 40 cm dia and 600 m of 30 cm dia pipes of the same material connected in series. What is the equivalent length of a 40 cm dia pipe of the same material ?

4. a) What is dimensional homogeneity ? 2

   b) Explain Rayleigh's method of dimensional analysis. 3

5. a) What do you understand by the terms 'major energy losses' and 'minor energy losses' in pipe ? 3

   b) Define the terms 'Hydraulic gradient line' and 'Total energy line'. 2

6. Derive a condition for maximum discharge through trapezoidal section.

GROUP – C

(Long Answer Type Questions)

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

7. a) The following are the design particulars of a large pelton turbine :

i) Head at the distributor = 630 m

ii) Discharge = 12·5 m^3/sec

iii) Power developed = 65 MW

iv) Speed of rotation = 500 r.p.m.

v) Runner diameter = 1 96 m

vi) Number of jet =

vii) Jet diame er = 0 192

viii) Angle through which the jet is deflected by the bucket = 165°

ix) Mechanical efficiency of the turbine = 96%

I. Determine the hydraulic power losses in the distributor-nozzle assembly and the buckets

II. If the loss in the buckets is given to be proportional to V_r^2 where V_r is the relative velocity at inlet, determine the best speed of rotation for this head and discharge.

b) Prove that the work done/sec/unit weight of water in a reaction turbine is given by as : $\frac{1}{g}\left(V_{w_1} u_1 \pm V_{w_2} u_2\right)$

where V_{w_1} & V_{w_2} = velocities of whirl at inlet & outlet

u_1 & u_2 = peripheral velocities at inlet & outlet. 8 + 7

8. a) What do you mean by similitude and what are the different types of similarities that must exist between a model and a prototype ?

b) Using Buckingham's π theorem, show that the velocity through a circular orifice is given by $V = \sqrt{2gH}\ \varphi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$, where H is the head causing flow, D is diameter of the orifice, μ is the co-efficient of viscosity, ρ is the mass density and g is the acceleration due to gravity.

9. a) For a vertical plane surface submerged in liquid, derive the express ons for

i) Total pressure

ii) Centre of pressure. 3 + 5

b) A rectangular plane surface 3 m wide and 4 m deep lies in water in such a way that its plane makes an angle of 30° with the free surface of water. Determine the total pressure force and position of centre of pressure, when the upper edge is 2 m below the free surface. 7

10. Water flows through a triangular right angled weir first and then over a rectangle weir of 1 m width. The discharge coefficients of the triangular and rectangular weirs are 0·6 and 0·7 respectively. If the depth of water over the weir is 360 mm, find the depth of water triangular over rectangular weir.

11. a) The velocity component in a two-dimensional flow field for an incompressible fluid is expressed as $u = \frac{y^3}{3} + 2x - x^2 y . v = xy^2 - 2y - \frac{x^3}{3}$

    i) Show that this function represents a possible case of an irrotatio al flow.

    ii) Obtain n expression for stream function ψ.

    iii) Obtain an expression for velocity potential ϕ.

    b) Derive the continuity equation : $\nabla . V = 0$ for three-dimensional flow. 8 + 7