2014

Fluid Mechanics

Time Alloted : 3 Hours *Full Marks : 70*

The figure 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 the following questions. 10x1=10

   i) The resultant hydrostatic force acts through force acts through a point known as

      a) centre of gravity
      b) centre of buoyancy
      c) centre of pressure
      d) none of the above

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

iii) The necessary condition for the flow to be uniform is that

a) the velocity is constant at a point with respect to time

b) the velocity is constant in the flow field to time

c) the velocity changes in the flow field with respect to time

d) none of the above.

iv) The dimension of kinematic viscosity is:

(a) $L^2 T^{-2}$

(b) $ML^2 T^{-1}$

(c) $L^2 T^{-1}$

(d) $ML^2 T^{-2}$

v) If the Froude number in open channel flow is less than 1.0, the flow is called

(a) critical flow

(b) streaming flow.

(c) shooting flow

(d) none of these.

vi) Specific energy of a flowing fluid per unit weight of an open channel is equal to

(a) $[\frac{p}{w}+\frac{v^2}{2g}]$ (b) $[\frac{p}{w}+h]$

(c) $[h+\frac{v^2}{2g}]$ (d) $[\frac{p}{w}+\frac{v^2}{2g}+h]$

where, p = pressure, w = unit weight, v = velocity of flow, h = head of the water level.

vii) **Reciprocating pump is suitable for**

(a) Low discharge and high head

(b) Low discharge & low head

(c) High discharge & low head

(d) High discharge & high head

viii) **If there are n physical quantities and m fundamental dimensions in a particular process, the number of non dimensional parameter is**

(a) m + n

(b) n - m

(c) m x n

(d) m / n

ix) **Discharge(Q), over a triangular notch or weir is given by**

(a) $\frac{2}{3}C_d.\sqrt{(2g)}\tan\frac{\theta}{2}.H^{\frac{3}{2}}$ (b) $\frac{2}{3}C_d.\sqrt{(2g)}\tan\frac{\theta}{2}.H^{\frac{5}{2}}$

(c) $\frac{1}{3}C_d.\sqrt{(2g)}\tan\frac{\theta}{2}.H^{\frac{5}{2}}$ (d) $\frac{8}{15}C_d.\sqrt{(2g)}\tan\frac{\theta}{2}.H^{\frac{5}{2}}$

x) **The acceleration of a fluid particle in the direction of x is given by**

(a) $A_x = u\frac{\partial u}{\partial x}+v\frac{\partial v}{\partial y}+w\frac{\partial w}{\partial z}+\frac{\partial u}{\partial t}$

(b) $A_x = u\frac{\partial u}{\partial x}+u\frac{\partial v}{\partial y}+u\frac{\partial w}{\partial z}+\frac{\partial u}{\partial t}$

(c) $A_x = u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z} + \frac{\partial u}{\partial t}$

(d) none of the above

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. 3x5=15

2. Prove that the work done in a reaction turbine is given as :

$$\frac{W}{g} = \left(V_{w_1} u_1 \pm V_{w_2} u_2\right)$$

Where V_{w_1} & V_{w_2} = velocities of whirl at inlet and outlet;

u_1 & u_2 = peripheral velocities at inlet outlet and W = weight of water.

(5)

3. Write down short notes on

a) Geometric similarity

b) kinematic similarity

c) Dynamic similarity.

(5)

4. Describe with neat sketches of characteristic curves of centrifugal pumps. (5)

5. How are notches and weirs classified ? (5)

6. What is specific energy? Draw the specific energy curve. Find out the value of Froude Number when critical flow occurs in a given channel.

(1+2+2=5)

GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. 3x15=45

7. a) Prove that the error in discharge due to the error in the measurement of head over a rectangular notch is given by

$$\frac{dQ}{Q} = \frac{3}{2}\frac{dH}{H}$$

Where Q = discharge through rectangular notch

And H = head over the rectangular notch.

b) Water is flowing in a rectangular channel of 1.2 m wide and 0.8 m deep. Find the discharge over a rectangular weir of crest length 70cm if the head of water over the crest of weir is 25cm and water from channel flows over the weir. Take C_d=0.60. Neglect end contractions but consider velocity of approach.

(7+8)

8. a) How are the repeating variables selected for dimensional analysis?

b) The resistance R, to the motion of a completely sub-merged body depends upon the length of the body L, velocity of flow V, density of the fluid ρ, dynamic viscosity of the liquid μ. Derive an expression for R by dimensional analysis.

(3 +12)

9. (a) A double jet Pelton wheel is required to generate 7500 kW when the available head at the base of the nozzle is 400 m. The jet is deflected through 165° and the relative velocity of jet is reduced by 15% in passing over the buckets. Determine:

(i) The diameter of each jet.

(ii) Total flow.

(iii) Force exerted by the jets on bucket in tangential direction. Assume generator efficiency of 95%, overall efficiency of 80%, K_v=0.97 and K_u=0.46

(b) Find the power required to drive a centrifugal pump which delivers 40 litres of water per second to a height of 20m through a 150 mm diameter and 100 m long pipeline. The overall efficiency of the pump is 70% and Darcy's f= 0.06 for pipeline. Assume inlet losses in suction pipe equal to 0.33 m.

(10+5)

10. (a) What do you understand by "total pressure" and "centre of pressure" in respect of hydrostatic forces on a surface?

(b) A cubical tank of side dimensions 1.5 m contains water in the lower part upto a height of 0.6 m from the bottom. The upper remaining part is filled with oil of specific gravity 0.9. Calculate for one vertical side of the tank (i) Total pressure (ii) Position of centre of pressure.

(4+11)

11. a) Derive the Darcy-Weisbach equation.

b) An oil of Specific gravity 0.9 and viscosity 0.06 poise is flowing through a pipe of diameter 200mm at the rate of 60 litre/sec. Find the head lost due to friction for a 500m length of pipe.

(10+5)