FLUID MECHANICS
(CIVL 2204)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Continuity equation can take in the form
(a) $A_1V_1 = A_2V_2$ (b) $\rho_1A_1V_1 = \rho_2A_2V_2$
(c) $\rho_1A_1 = \rho_2A_2$ (d) $P_1A_1V_1 = P_2A_2V_2$

(ii) Pitot tube is used to measure
(a) Pressure (b) Discharge
(c) Velocity (d) Density

(iii) The resultant hydrostatic force acts through a point known as
(a) Centre of gravity (b) Centre of buoyancy
(c) Centre of pressure (d) Centre of mass

(iv) For laminar flow in circular pipes the Darcy's friction factor f is equal to
(a) $16/R_e$ (b) $32/R_e$
(c) $64/R_e$ (d) $80/R_e$

(v) A body in neutral equilibrium will rotate about
(a) Centre of gravity and metacentre
(b) Centre of pressure and metacentre
(c) Centre of gravity and centre of buoyancy
(d) Centre of gravity, centre of buoyancy and metacentre

(vi) Which one of the following is non-dimensional parameter
(a) Chezy's coefficient (b) Darcy-Weisbach friction factor
(c) Froude's number (d) Mach number

(vii) Reynold's number is the ratio of inertia force to the:
(a) surface tension force (b) viscous force
(c) gravity force (d) elastic force

(viii) The specific speed for turbines has the dimensions:
(a) $F^{1/2}L^{-3/4}T^{-3/2}$ (b) T^{1}
(c) $F^{1/2}L^{-5/2}T^{-3/2}$ (d) $FL^{-3/4}T^{-3/2}$

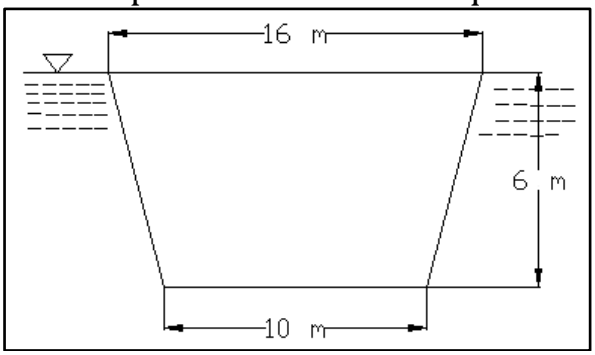
(ix) The water flows fully through a rectangular channel with dimensions 4m X 3m. What is the velocity of flow (m/s) through the channel, if the slope of energy line and Chezy's constant given 0.0006 and 90 respectively?
(a) 1.5 (b) 2.4
(c) 4.6 (d) 5.

(x) In centrifugal pump casing, the flow of water leaving the impeller is
(a) Radial (b) Centrifugal
(c) Rectilinear (d) Free vortex.

Group - B

2. (a) Illustrate the expression for total pressure and centre of pressure for a plane surface fully submerged in water.

(b) A caisson for closing the entrance to a dry dock is of trapezoidal form 16 m wide at the top and 10 m wide at the bottom and 6 m deep. Determine the total pressure and centre of pressure on the caisson if the water on the outside is just level with the top and dock is empty.Establish the expression for centroid and moment of inertia of trapezoidal section if required.

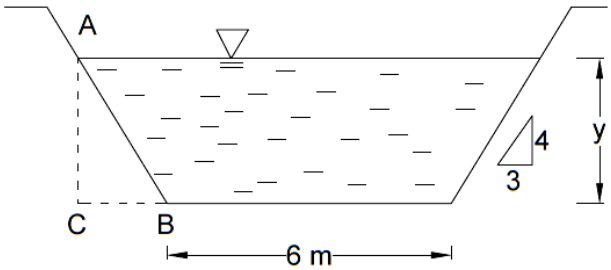


4 + 8 = 12

3. (a) Outline the complete classification of open flow channel.

(b) Illustrate the following terms:
(i) Non-uniform flow
(ii) Gradually varied flow.

(c) Determine the bed slope of a trapezoidal channel of bed width 6m., depth of water 3m, and side slope of 3 (Horizontal): 4 (vertical). The discharge through the channel is 30 m^3/s. Take Chezy's constant C=70. Here, y= depth of flow= 3 m.



2 + (3 + 3) + 4 = 12

Group - C

4. (a) Construct the expression for discharge through triangular notch.
   (b) A rectangular channel 2.0 m wide has a discharge of 250 lit per second, which is measured by a right angled V-notch weir. Determine the position of the apex of the notch from the bed of the channel if maximum depth of water is not to exceed 1.3 m. C_d = 0.62.

4 + 8 = 12

5. (a) A horizontal pipe line 40 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 m of its length from the tank, the pipe is 150 mm diameter and its diameter is suddenly enlarged to 300 mm. The height of water level in the tank is 8 m above the centre of the pipe. Considering all the losses of head which occur determine the rate of flow. Take f = 0.01 for both sections of the pipe.
   (b) Explain drag and lift.

10 +2 = 12

Group - D

6. (a) Distinguish between Specific Energy (E_c) and Critical depth flow (CDF).
   (b) It is known that, for critical flow in rectangular channel,Hydraulic depth:

$$D_c = \frac{A_c}{T_c} = y_c \text{ and} \frac{V_c}{\sqrt{g y_c}} = 1$$

where, A_c= area of the channel, T_c= top width of critical channel flow, y_c= critical depth Compose and prove that, for maximum discharge:

$$\boxed{\frac{Q^2}{g} = \frac{A_c^3}{T}}$$

   (c) Classify Froude's no. based on critical, subcritical and supercritical flow.

3 + 6 + 3 = 12

7. (a) List the dimensions for the following:
      (i) Angular velocity
      (ii) Angular Acceleration
      (iii) Kinematic viscosity.
   (b) Define Buckingham's Π Theorem. List the repeating variables used in Buckingham's Π Theorem.
   (c) Estimate the no. of Π terms for F=ø (D.V, ω, μ, P). Also find out Π_1 and Π_2 terms.

3 + (3 + 3) + 3 = 12

Group - E

8. (a) What are the different types of turbines?

(b) Explain the difference between impulse turbine and Reaction turbine. Show various components of a Pelton wheel turbine with a neat sketch.

6 + 6 =12

9. A penstock supplies water from the reservoir to the Pelton wheel with a gross head of 500 m. One third of the gross head is lost in friction in penstock. The rate of flow of water through the nozzle fitted at the end of penstock is 2 .0 m^3/s. The angle of deflection of jet is 165^0. Determine the power given by the water to the runner and also hydraulic efficiency of the Pelton wheel. (Given, ø= 0.45, C_v= 1.0).

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