FLUID MECHANICS
(CIV2102)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) The pilot static tube measures
(a) stagnation pressure (b) static pressure
(c) dynamic pressure (d) difference in total and dynamic pressure

(ii) The major loss of energy in long pipes is due to
(a) sudden enlargement (b) sudden contraction
(c) gradual contraction or enlargement (d) friction

(iii) The discharge through a Cipolletti weir is given by
(a) $\frac{2}{3}C_d\sqrt{2g}LH^{3/2}$ (b) $\frac{8}{15}C_d\sqrt{2g}\tan\frac{\theta}{2}H^{3/2}$
(c) $\frac{8}{15}C_d\sqrt{2g}\tan\frac{\theta}{2}H^{5/2}$ (d) $\frac{2}{3}C_d\sqrt{2g}LH^{5/2}$

(iv) Cipolletti weir is a trapezoidal weir having side slope
(a) 4H:1V (b) 1H:4V
(c) 1.5H:3V (d) 1H:1V

(v) Head loss in pipe due to friction as per Chezy's formula is given by
(a) $V = C\sqrt{md}$ (b) $V = C\sqrt{mi}$
(c) $V = C\sqrt{mr}$ (d) $V = C\sqrt{mid}$

(vi) The maximum vacuum created at the summit of syphon is
(a) 5.4 m of water (b) 7.4 m of water
(c) 10.4 m of water (d) 3.4 m of water

(vii) The dimension of the Pressure is
(a) $ML^{-1}T^{-2}$ (b) MLT^{-2}
(c) $ML^{-1}T^{-3}$ (d) $ML^{-2}T^{-2}$

(viii) If the depth of flow in a trapezoidal channel is 2.0 m, velocity of water is 0.50 m/sec, the specific energy of water is
(a) 0.50 m (b) 2.00m
(c) 2.014m (d) 2.50m

(ix) If the angle of blade tip at outlet in an impulse turbine is ϕ, then maximum hydraulic efficiency is expressed as

(a) $1+\cos\frac{\theta}{2}$ (b) $1+\sin\frac{\theta}{2}$

(c) $1-\cos\frac{\theta}{2}$ (d) $1-\sin\frac{\theta}{2}$

(x) In a centrifugal pump casing, the flow of water leaving the impeller is

(a) Radial flow (b) Free vortex motion

(c) Forced vortex (d) Tangential flow.

Fill in the blanks with the correct word

(xi) _____ is the pressure where atmospheric pressure is taken as datum.

(xii) The line representing sum of pressure head and datum head w.r.t reference line is called _____.

(xiii) The discharge over a triangular notch, *Q* is proportional to the head of water, *H* as _____.

(xiv) The unit of kinematic viscosity is _____.

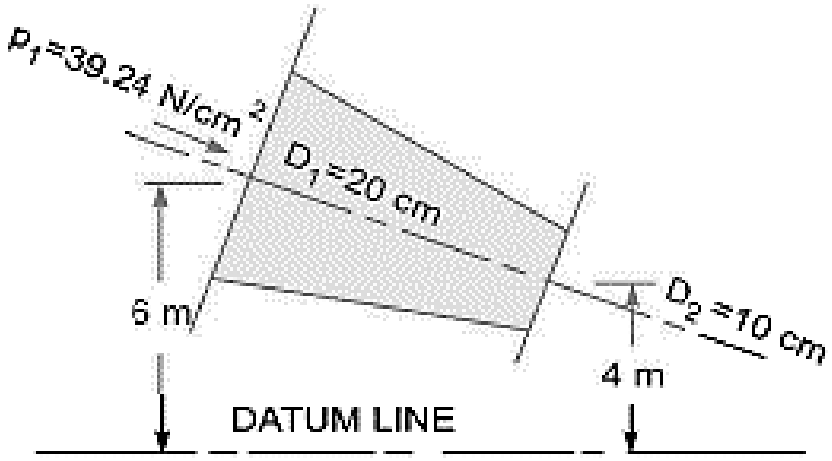
(xv) The point in the immersed body through which the resultant pressure of the liquid may be taken to act is known as _____.

Group - B

2. (a) State Bernoulli's theorem, derive Bernoulli's equation from Euler's equation. *[(CO3)(Analyse/HOCQ)]*

(b) A horizontal water pipe of diameter 15 cm converges to 7.5 cm diameter. If the pressures at the two sections are 400 kPa and 150 kPa respectively, calculate the flow rate of water. *[(CO2)(Apply/IOCQ)]*

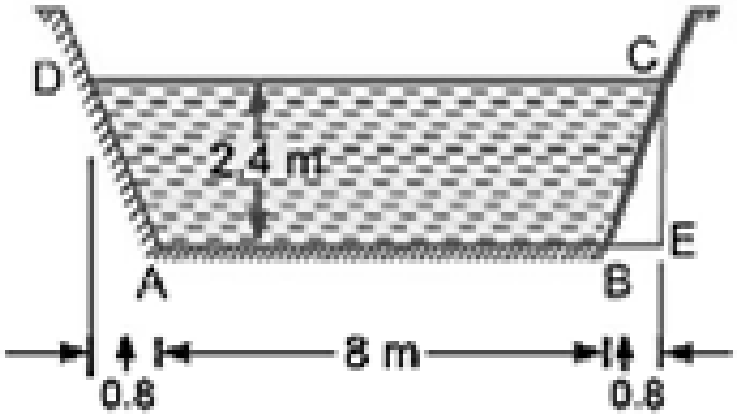
(c) The water is flowing through a pipe having diameter 20 cm 10 cm at sections 1 and 2 respectively. The rate of flow through the pipe is 35 lt/s. Section 1 is 6 m above the datum and section 2 is 4 m above the datum. If the pressure at section 1 is 39.24 N/cm^2, find the intensity of pressure at section 2. *[(CO2)(Apply/IOCQ)]*



5 + 2 + 5= 12

3. (a) Find the diameter of a circular sewer pipe which is laid at a slope of 1 in 8000 and carries a discharge of 800 lt/s when flowing half full. Take value of Maning's N as 0.02. *[(CO3)(Analyse/HOCQ)]*

(b) Find the discharge through a trapezoidal channel of width 8 m, side slope of 1H to 3V. The depth of water is 2.4 m and value of Chezy's constant, C = 50. The slope of the bed of channel is 1 in 4000. *[(CO3)(Apply/IOCQ)]*



6 + 6 = 12

Group - C

4. (a) A right-angled V-notch is inserted in the side of a tank of length 4 m and width 2.5 m. Initial height of water above the apex of the notch is 30 cm. Find the height of water above the apex if the time required to lower the water level in tank from 30 cm to final height is 3 mins. Take C_d = 0.6. *[(CO3)(Analyse/HOCQ)]*

(b) The head of water over a triangular notch of angle 60° is 50 cm and C_d = 0.62. The flow measured by it is to be within an accuracy of 1.5% up or down. Find the limiting values of the head. *[(CO2)(Apply/IOCQ)]*

6 + 6 = 12

5. (a) Find the head lost due to friction in a pipe of diameter 300mm and length 50 m, through which water is flowing with a velocity of 3 m/s using Darcy's formula and Chezy's formula. Take Chezy's constant, C = 50 and the kinematic viscosity of water is 10^{-4} m^2/s. *[(CO3)(Analyse/HOCQ)]*

(b) What are the various types of loss of energy in a pipe flow? *[(CO4)(Remember/LOCQ)]*

(c) Find the head lost when a pipe of diameter 200 mm is suddenly enlarged to a diameter of 400 mm. The rate of flow through the pipe is 250 lt/s. *[(CO3)(Analyse/HOCQ)]*

7 + 2 + 3 = 12

Group - D

6. (a) Show that the resistance (R) to the motion of a sphere of diameter (D) moving with a uniform velocity (V) through a real fluid having mass density (ρ) and viscosity (μ)is given by $R = \rho V^2 D^2 f \frac{\mu}{\rho VD}$. Assume R= f (D, V, ρ, μ). *[(CO5)(Analyse/HOCQ)]*

(b) What is dimensional homogeneity? Examine the dimensional homogeneity of equation, $v^2 = 2gh.$, where v is velocity, h is head of water. *[(CO5)(Remember/LOCQ)]*

7 + 5 = 12

7. (a) Water flows a steady and uniform depth of 2 m in an open channel of rectangular cross section having base width equal to 5 m and laid at a slope of 1 in 1200. It is

desired to obtain critical flow in the channel by providing a hump in the bed. Calculate the height of the hump and draw a neat sketch of flow profile. Assume $N = 0.02$. *[(CO4)(Analyse/HOCQ)]*

(b) Draw and explain specific energy curve of water and mention different types of flow. *[(CO4)(Remember/LOCQ)]*

7 + 5 = 12

Group - E

8. (a) A centrifugal pump 1.5 m diameter runs at 210 rpm for discharge of 180 *lt*/sec. The angle which the vanes make at exit with the tangent to the impeller is 25°, assuming radial entry and the velocity of flow throughout as 2.5m/sec. Determine the power required to drive the pump. If the manometric efficiency of the pump is 65% determine also the average lift of the pump. *[(CO6)(Analyse/HOCQ)]*

(b) What do you understand by efficiency of a centrifugal pump? What is cavitation in pumps? *[(CO6)(Remember/LOCQ)]*

8 + 4 = 12

9. (a) A Kaplan turbine working under a head of 20 m develops 11780 KW shaft power. The outer diameter of the runner is 3.5 m and the hub diameter is 1.75 m. The guide blade angle at the extreme edge of the runner is 35°. The hydraulic and overall efficiencies of the turbine are 88% and 84% respectively. If the velocity of whirl is zero at outlet determine runner vane angle at inlet and outlet at the extreme edge of the runner and Speed of the turbine. *[(CO6)(Analyse/HOCQ)]*

(b) With the help of a neat sketch and force diagram explain the working principle of Kaplan turbine. *[(CO6)(Remember/LOCQ)]*

7 + 5 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	16.7	25	58.3