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 discharge through a V – notch varies as
(a) $H^{1/2}$ (b) $H^{3/2}$ (c) $H^{5/2}$ (d) $H^{5/4}$

(ii) In a V-notch weir, the included angle of notch commonly used is:
(a) 30° (b) 45° (c) 60° (d) 90°

(iii) The error in discharge due to the error in measurement of head over a triangular weir or notch is given by
(a) $\frac{dQ}{Q} = \frac{2}{5}\frac{dH}{H}$ (b) $\frac{dQ}{Q} = \frac{5}{2}\frac{dH}{H}$ (c) $\frac{dQ}{Q} = \frac{2}{3}\frac{dH}{H}$ (d) $\frac{dQ}{Q} = \frac{3}{2}\frac{dH}{H}$

(iv) For a right-angled V-notch having C_d = 0.6, the discharge is equal to
(a) 2.417 $H^{5/2}$ (b) 1.417 $H^{5/2}$ (c) 1.217 $H^{5/2}$ (d) 0.417 $H^{5/2}$

(v) 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

(vi) For viscous flow, the coefficient of friction is related to Reynold's number in Darcy's formula as
(a) $f = \frac{16}{R_e}$ (b) $f = \frac{64}{R_e}$ (c) $f = \frac{0.079}{R_e}$ (d) $f = \frac{16}{Re^{1/4}}$

(vii) Scale ratio for laws of Froude is expressed as for discharge
(a) $(L_r)^{5/2}$ (b) (Lr3.ρr) (c) $(L_r^2.\mu_r)$ (d) $(L_r^{1/2})$

(viii) If the depth of water in an open channel is greater than the critical depth, the flow is called
(a) Streaming flow (b) Critical flow
(c) Shooting flow (d) Sub-Critical flow

(ix) Characteristics range of specific speed (N_s) for a Kaplan Turbine is
(a) 40- 425 (b) 380 -900 (c) 100- 400 (d) 10- 40

(x) The efficiency of a centrifugal pump is maximum when the blades are
(a) Forward curved (b) Backward curved
(c) Radial (d) Mixed flow

Fill in the blanks with the correct word

(xi) Specific volume is the reciprocal of _____

(xii) The discharge over a rectangular notch, Q is proportional to the head of water, H as _____

(xiii) Pascal-second is the unit of _____

(xiv) Centre of buoyancy always _____ with centre of gravity.

(xv) The ratio of manometric head to theoretical head is known as_____

Group - B

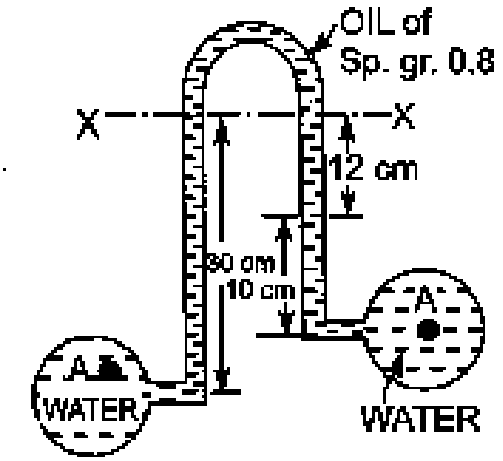
2. (a) What are the different types of real fluids, explain them with example. *[(CO1)(Remember/LOCQ)]*

(b) Define specific weight, specific volume, and specific gravity with unit. *[(CO1)(Remember/LOCQ)]*

(c) The velocity distribution over a plate is given by $v = \frac{2}{3}y - y^2$ in which u is the velocity in m/s and y is the distance above the plate. Determine shear stress at y = 0.01 and 0.2 and 3 m. Take μ = 6 poise. *[(CO2)(Apply/IOCQ)]*

3 + 3 + 6 = 12

3. (a) Water is flowing through two different pipes to which an inverted differential manometer having a liquid of specific gravity 0.8 is connected. The pressure head in pipe A is 2 m of water; find the pressure in pipe *B* for the manometer readings as shown in figure below.



[(CO3) (Apply/IOCQ)]

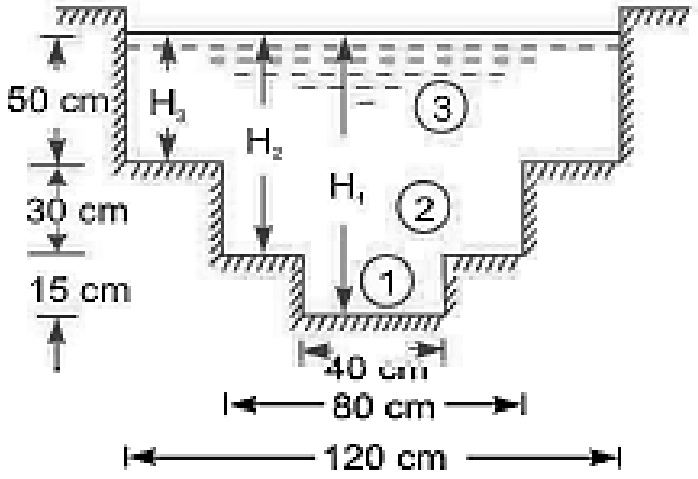
(b) An inverted differential manometer containing an oil of specific gravity 0.9 is connected to find the difference of pressures at two points of a pipe containing water. If the manometer reading is 40 cm, find the difference of pressures. *[(CO2)(Apply/IOCQ)]*

(c) Differentiate between peizometer and pressure gauges? *[(CO1)(Remember/LOCQ)]*

5 + 4 + 3 = 12

Group - C

4. (a) Find the discharge through the stepped notch taking C_d = 0.62 for all sections.



[(CO3)(Analyse/HOCQ)]

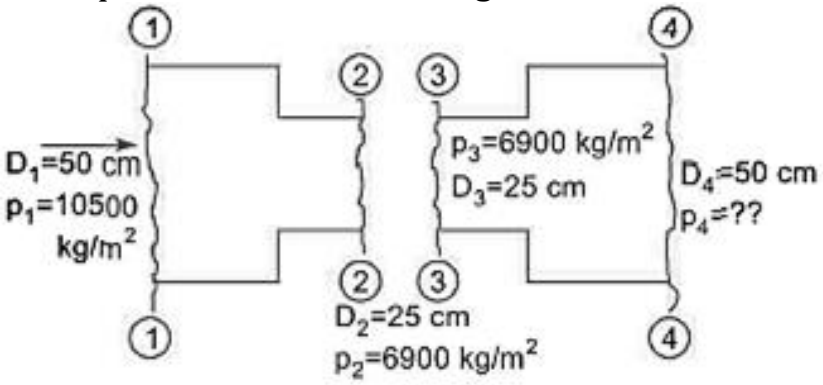
(b) Derive the expression for time required to empty a reservoir with a triangular notch/weir. *[(CO4)(Remember/LOCQ)]*

(c) Derive the expression for discharge through a rectangular weir in terms of head of water over the crest. *[(CO4)(Remember/LOCQ)]*

5 + 4 + 3 = 12

5. (a) Water is flowing through a pipe of diameter 300 mm and length 100 m. The rate of flow through the pipe is 50 lt/s. The kinematic viscosity of water is 10-4 m2/s. Calculate the head lost due to friction using Darcy's formula. Take Chezy's constant, C = 50. *[(CO3)(Analyse/HOCQ)]*

(d) In the fig. , when a sudden contraction is introduced in a horizontal pipe from 50 cm to 25 cm, the pressure changes from 10500 kg/m^2 to 6900 kg/m^2. Calculate the rate of flow. Assume C_c of jet is 0.65. Following this if there is a sudden enlargement from 25 cm to 50 cm and if pressure at 25 cm section is 6900 kg/m^2, what is the pressure at 50 cm enlarged section?



[(CO3)(Apply/IOCQ)]

3 + 9 = 12

Group - D

6. (a) Enumerate the limitations of Raleigh method of dimensional analysis? *[(CO5)(Remember/LOCQ)]*

(b) The resistance force F, of a ship is a function of its length L,V velocity, acceleration due to gravity g, and fluid properties like μ,ρ. Using Buckingham π theory, deduce the relationship in following dimensional form $\frac{F}{\rho V^2 L^2} = \varphi[Fr, Re]$, where Fr is Froude's number and Re is Reynolds number. *[(CO5) (Apply/IOCQ)]*

3 + 9 = 12

7. (a) Water flows a steady and uniform depth of 2 m in an open channel of rectangular cross section having base with 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 of 1200 mm diameter delivers 2000 lit of water /sec for a head of 6 m at a speed of 200 rpm. The vanes are curved back at an angle of 26° to the tangent at the outlet and the velocity is constant at 2.4 m/sec. Find the manometric efficiency and the power required to operate the pump. *[(CO5)(Apply/IOCQ)]*

(b) Derive an equation for estimating the power required to drive a centrifugal pump for a lifting height h m. *[(CO6)(Remember/LOCQ)]*

7 + 5 = 12

9. (a) A pelton wheel has a mean bucket speed of 20m/sec with a jet of water flowing at 500 lt/sec with a head of 20 m. The bucket deflects the jet through an angle of 110°. Calculate the power given by the water to the runner and the hydraulic efficiency of the turbine. Assume C_v =0.98. *[(CO6) (Analyse/HOCQ)]*

(b) A centrifugal pump 2 m diameter runs at 250 rpm for discharge of 200 lt/sec. The angle which the vanes make at exit with the tangent to the impeller is 45°, assuming radial entry and the velocity of flow throughout as 1.5m/sec. Determine the power required to drive the pump. If the manometric efficiency of the pump is 85% determine also the average lift of the pump? *[(CO6) (Analyse/HOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	30.2	41.66	28.12