(vi) For viscous flow between two parallel plates, the pressure drop per unit length is equal to

(a) $\frac{12\mu UL}{\rho g D^2}$ (b) $\frac{12\mu UL}{\rho g}$ (c) $\frac{32\mu UL}{D^2}$ (d) $\frac{12\mu U}{D^2}$.

(vii) For a laminar flow in pipe carrying a given discharge, the height of the surface roughness is doubled. In such case the Darcy-Weisbach friction factor will

(a) remain unchanged (b) be halved
(c) be doubled (d) increase four-hold.

(viii) In a steady flow of compressible liquid through a pipe, the density, area and velocity at a particular section are 1.5 kg/m^3, 0.5 m^2 and 3 m/s respectively. At another section the density and area are 0.75 kg/m^3 and 1.0 m^2 respectively. What is the velocity at this section?

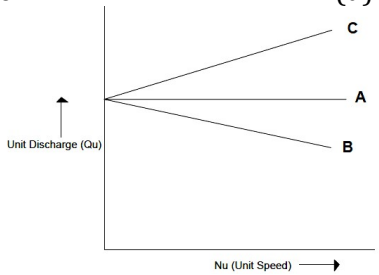
(a) 1.5 m/s (b) 3.0 m/s
(c) 4.5 m/s (d) 6.0 m/s.

(ix) The specific speed (N_s) of a turbine is given by

(a) $N_s \frac{N\sqrt{Q}}{{H_m}^{5/4}}$ (b) $N_s \frac{N\sqrt{Q}}{{H_m}^{2/4}}$ (c) $N_s \frac{N\sqrt{P}}{{H_m}^{2/4}}$ (d) $N_s \frac{N\sqrt{P}}{{H_m}^{5/4}}$

(x) The unit discharge (Q_u) and unit speed (N_u) curves for different turbines are shown below. Curve A denotes

(a) Francis Turbine (b) Kaplan Turbine
(c) Pelton Turbine (d) Propeller Turbine.



Group – B

2. (a) A trapezoidal channel has a side slope of 1 H to 2 V and the slope of the bed is 1 in 2000. The area of cross section is 30 m^2. Find the dimensions of the section, if it is most economical. Determine the discharge of the most economical section if Chezy's coefficient C = 60.

(b) "The hydraulic radius is equal to half the depth of flow for most efficient rectangular channel section". Derive the necessary expressions to support the above statement.

6 + 6 = 12

Group – E

8. (a) Vividly explain the following terms:-
(i) Mechanical Efficiency (η_m)
(ii) Volumetric Efficiency (η_v)
(iii) Guide flow in Radial flow reaction turbine.

(b) A Pelton Wheel is working under a gross head of 400 m. The water is supplied through the penstock of diameter 1m and length 4 km from reservoir to Pelton Wheel. The coefficient of friction for the penstock is 0.008. The jet of water of diameter 150 mm strikes the buckets of the wheel and gets deflected through an angle of 165^0. The relative velocity of water at the outlet is reduced by 15 % due to friction between inside surface of the bucket and water. If the velocity of buckets is (0.45) times the jet velocity at inlet and mechanical efficiency is 85 %, determine:-
(i) power given to the runner
(ii) Shaft power
(iii) Mechanical efficiency (η_m) and Hydraulic Efficiency (η_h)

(2 × 3) + 6 = 12

9. (a) Prove that the work done / sec/ unit weight of water in a reaction turbine is given by:-

$$= \frac{1}{g}(V_{w1}.u_1 + V_{w2}.u_2)$$

where, V_{w1} and V_{w2} are velocities of whirls at the inlets and outlets.
u_1 and u_2 are peripheral velocities at inlets and outlets.

(b) Describe the various types of casings present in centrifugal pumps. Also provide clear diagrams for the respective types.

6 + 6 = 12

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) A vertical wall is subjected to a pressure due to one kind of liquid on one of its sides of dimension 'h'. The total pressure on the wall acts at a distance _____ from the liquid surface
   (a) h/3 (b) h/2 (c) 2h/3 (d) 3h/4.

   (ii) For a submerged curved surface, the vertical component of the hydrostatic force is
   (a) mass of the liquid supported by the curved surface
   (b) weight of the liquid supported by the curved surface
   (c) the force on the projected area of the curved surface on vertical plane
   (d) equal to the pressure acting on the centroid.

   (iii) A floating body is in stable equilibrium when
   (a) the metacentric height is zero
   (b) its centre of gravity is below the centre of buoyancy
   (c) the metacentre is above its centre of gravity
   (d) the metacentre is below its centre of gravity.

   (iv) Dynamic similarity is said to exist between two flowing fluids when at corresponding points there are
   (a) geometric similarity and similarity of forces involved
   (b) kinematic similarity and dynamic similarity
   (c) one-to-one relation between inertia and viscous forces
   (d) the ratio of corresponding velocities and accelerations are same.

   (v) For a given discharge in a horizontal frictionless channel, two depths may have the same specific force. These two depths are known as
   (a) specific depths (b) sequent depths
   (c) alternate depths (d) normal depth and critical depth.

3. (a) A triangular gate which has a base of 1.5 m and an altitude of 2 m lies in a vertical plane. The vertex of the gate is 1 m below the surface of an open tank which contains oil of specific gravity 0.8. Find the force exerted by the oil on the gate and the position of the centre of pressure.

(b) Find the density of a metallic body which floats at the interface of mercury (sp. gravity 13.6) and water, such that 40% of its volume is submerged in mercury and 60% of its volume is submerged in water.

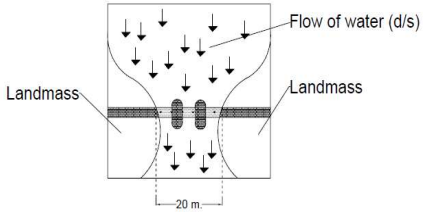
6 + 6 = 12

Group – C

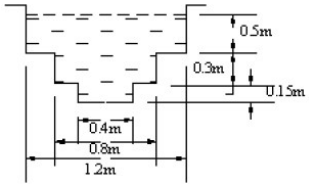
4. (a) Write short note on "Drowned weir". Provide the necessary conditions to differentiate between broad-crested weir and low-crested weir.

(b) A rectangular weir with end contractions has a weir of 2m. The head over the crest of weir is 300mm. The total width of the weir is 20m. The fig. below is given.
Find the rate of flow (Q) for the following case:- (Velocity of Approach (V_a) as well as end contractions both are considered):-

(i) Using normal derived formula (C_d = 0.62)
(ii) Francis Formula
(iii) Using Rehock formula. (z = 0.75 m)



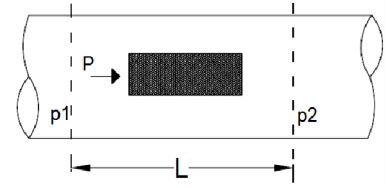
(c) Calculate the total discharge over the trapezoidal notch shown below. Assume C_d = 0.72.



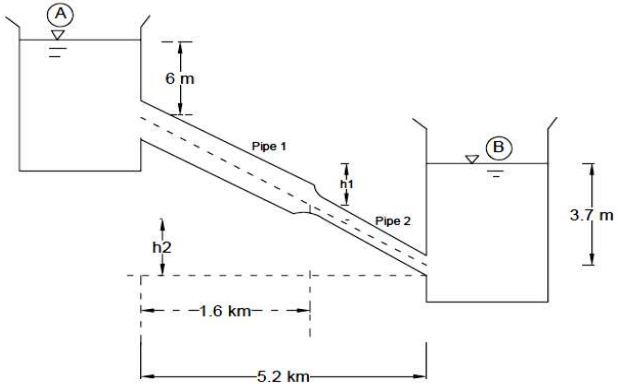
4 + 5 + 3 = 12

5. (a) For an element of water mass flowing through a pipe, derive the Hagen-Poiseuille formula given below: (No need to show the relationship between Pressure gradient and Shear stress gradient).

$$\frac{p1-p2}{\rho g} = hf = \frac{32\mu u' L}{\rho g D2}$$



(b) Two reservoirs 5.2 km apart are connected by a pipeline which consists of 225 mm. Φ pipe for the first 1.6 km, sloping at 5.7 m per km. For the remaining distance, the pipe Φ is 150 mm laid at a slope of 1.9 m/km. The levels of water above the pipe openings are 6 m. in the upper reservoir and 3.7 m in the lower reservoir. (Assume *f = 0.0024* for both the pipes and C_c = *0.6*). Calculate the rate of discharge through the pipeline.



7 + 5 = 12

Group – D

6. (a) The depth of flow of water at a certain section of a rectangular channel 6m wide is 0.8m. The discharge through the channel is 18 cumecs. Determine whether a hydraulic jump will occur and if so, find the height of the hydraulic jump and loss of energy.

(b) For the rectangular channel section derive the expression E = 1.5 y_c. Where, y_c is the critical depth of flow. Also consider that for the given specific energy E, the discharge per unit width 'q' is maximum.

6 + 6 = 12

7. (a) The pressure drop Δp in a pipe of diameter D and length l depends on mass density ρ and viscosity μ of the flowing fluid, mean velocity of flow V and average height k of roughness projections on the pipe surface. Obtain a dimensionless expression for Δp.

(b) A shallow river is 1500 m wide and the maximum depth of flow in it is 5 m. it carries a discharge of 3000 m^3/s, the velocity of flow being 1.5 m/s. The model of river is constructed to the horizontal scale of 1:800 and the vertical scale of 1:40. If Manning's coefficient n for the bed material in the river is 0.025, find the value of n for the bed material of the model. The hydraulic mean depth may be assumed to be equal to mean depth of flow.

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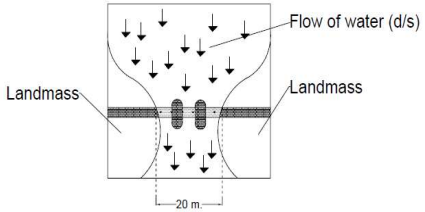

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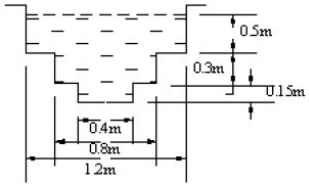

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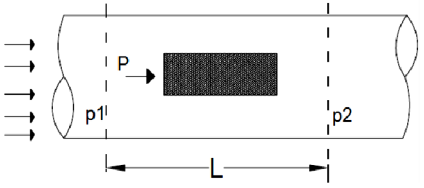

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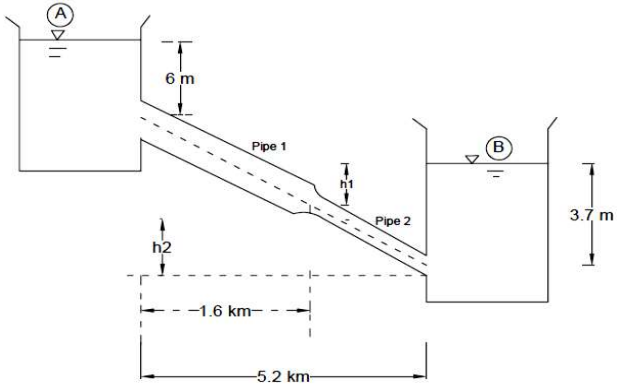

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