Group – D

6. (a) Obtain an expression for the efficiency, $\eta = \phi[\mu/(\rho D^2\omega), Q/(D^2\omega)]$ of a fan in terms of dimensionless parameters when it depends on the discharge Q, runner diameter D, angular velocity ω, mass density ρ and dynamic viscosity μ.

   (b) In a geometrically similar model of spillway, discharge per metre length is 0.25 m^3/sec. If the scale of the model is 1/36, then find the discharge per metre run of the prototype.

8 + 4 = 12

7. (a) A trapezoidal channel has side slopes of 1 horizontal to 2 vertical and the slope of the bed is 1 in 1500. The area of the section is 40 m^2. Determine the dimensions of the section if it is most economical. Also find the discharge of the most economical section when the Chezy's constant is 54.

   (b) Find the discharge through a rectangular channel if its width is 2 m, bed slope is 1 in 1500, depth of flow is 1.5 m and the Manning's constant is 0.012.

8 + 4 = 12

Group – E

8. (a) (i) Define cavitation. What are the effects of cavitation? Give the necessary precautions against cavitation.
   (ii) Write a short note on Centrifugal pump.

   (b) A Francis turbine has been manufactured to develop 15000 HP at the head of 81 m and speed 375 rpm. The mean atmospheric pressure at the site is 1.03 kgf/cm^2 and vapour pressure 0.03 kgf/cm^2. Calculate the maximum permissible height of the runner above the tail water level to ensure cavitation free operation. The critical cavitation factor for Francis turbine is $314 \times 10 - 8\ N_S^2$.

(4 + 3) + 5 = 12

9. (a) A single acting reciprocating pump, running at 50 rpm, delivers 0.01 m^3/s of water. The diameter of the piston is 200 mm and stroke length 400 mm. Determine: the theoretical discharge of pump; coefficient of discharge; slip and percentage slip of pump.

   (c) Draw a schematic diagram of a reciprocating pump showing its parts and also explain the working principle.

6 + 6 = 12

FLUID MECHANICS
(CIVL 2113)

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

   (ii) A stone weighs 400 N in air and 200 N in water. Determine the volume of the body.
   (a) 0.0204 m^3 (b) 0.0105 m^3
   (c) 0.0306 m^3 (d) any of the above.

   (iii) An orificemeter to carry water is calibrated with air in a geometrically similar model at 1/5 prototype scale. If the ratio of kinematic viscosity of air to water is 12.5, then dynamic similar flow will be obtained when the discharge ratio (air to water) is
   (a) 0.4 (b) 2.5 (c) 62.5 (d) 5.

   (iv) The acceleration ratio for a model based on Froude model law is equal to
   (a) $\sqrt{L_r}$ (b) $1/\sqrt{L_r}$ (c) L_r^2 (d) 1.

   (v) Differential manometer is used to measure
   (a) Pressure at a point in a fluid
   (b) Velocity difference between two points in a fluid
   (c) Velocity at a point in a fluid
   (d) Pressure difference between two points in a fluid.

(vi) Find the discharge over a Cipoletti weir of length 2 m when the head over the weir is 1 m. Take $C_d = 0.62$

(a) 3.661 m^3/s (b) 2.5 m^3/s
(c) 3.0 m^3/s (d) 14.0 m^3/s.

(vii) Find the value of Chezy's constant, when the rate of flow of water through a pipe having hydraulic radius of 0.075 m is 3 m/s and hydraulic gradient is 1 in 30.

(a) C = 60 (b) C = 40
(b) C = 80 (d) C = 20.

(viii) If theoretical discharge is 30 m^3/s and actual discharge is 100 m^3/s, then the slip of the pump is

(a) 50 m^3/s (b) 70 m^3/s
(c) 40 m^3/s (d) 300 m^3/s.

(ix) Calculate Reynold's number for a flow of 3 m/s, flowing through a pipe of 200 mm diameter and Kinematic viscosity of water = 0.01×10^{-4} m^2/s.

(a) $R_e = 6000$ (b) $R_e = 400$
(c) $R_e = 6 \times 10^5$ (d) $R_e = 4 \times 10^8$

(x) The mean diameter of Pelton wheel is given by (symbols have their usual meaning)

(a) D = 60u/3.14N (b) D = 15uN
(c) D = 30u/3.14N (d) D = uN.

Group – B

2. (a) A spar buoy is a buoyant rod weighted to float and protrude vertically, as in Fig.1. Suppose that the buoy is maple wood (SG = 0.6), 5 cm by 3.6 m, floating in seawater (SG = 1.025). How many kilograms of steel (SG = 7.85) should be added to the bottom end so that h = 50 cm?

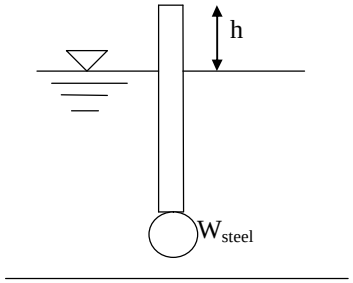

Fig.1

(b) The right limb of a simple U-tube manometer containing mercury is open to the atmosphere while the left limb is connected to a pipe in which a fluid of SG = 0.8 is flowing. The centre of the pipe is 15 cm below the level of

mercury in the right limb. Find the pressure of fluid in the pipe if the difference of mercury level in the two limbs is 25 cm.

7 + 5 = 12

3. (a) Using Buckingham pi theorem, show that the frictional torque T of a disc is given by $T = D^5N^2\rho\phi[\mu/(\rho ND^2)]$, where, D is the diameter of disc, N is the speed, ρ is the density and μ is the viscosity of the fluid.

(b) A hydraulic jump takes place in a 0.6 m wide rectangular channel at a point where the depth of water flow is 0.16 m and the Froude number is 2.4. Find (i) the specific energy, (ii) critical and sequent depth, (iii) loss of head and (iv) power dissipated in jump.

8 + 4 = 12

Group – C

4. (a) Derive an expression for the discharge over a stepped notch.

(b) A right-angled V-notch is used for measuring a discharge of 30 lt/s. An error of 1.5 mm was made while measuring the head over the notch. Calculate the percentage error in the discharge. Take coefficient of discharge = 0.62.

6 + 6 = 12

5. (a) Define Moody's diagram and boundary layer.

(b) Water is flowing through a pipe at a rate of 5 lt/sec as shown in Fig.2. If the gauge pressure of 12 kPa, 11.5 kPa and 10.3 kPa are measured for P_1, P_2, P_3 respectively, what are the head losses between 1 and 2; 1 and 3.

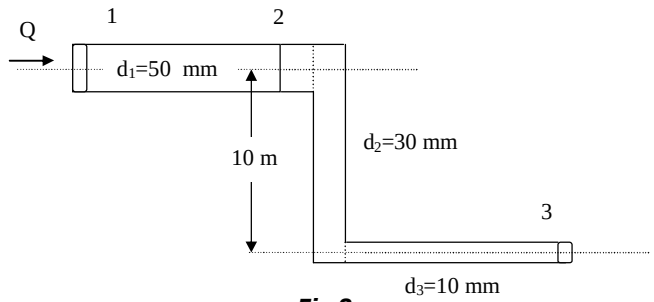

Fig.2

(c) At a sudden enlargement of a water pipe from 240 mm to 480 mm diameter, the hydraulic gradient rises by 20 mm. Estimate the rate of flow.

3 + 6 + 3 = 12