(vii) In a rectangular weir, there is an error of 4% in measurement of head. The error in computed discharge is
(a) 4% (b) 10% (c) 6% (d) 2.5%.

(viii) For hydrodynamically smooth pipes the friction factor f is a
(a) function of Reynolds number only
(b) function of relative roughness only
(c) function of Reynolds number and relative roughness
(d) constant.

(ix) In boundary layer flow a negative pressure gradient is called a
(a) adverse pressure gradient (b) unstable pressure gradient
(c) separation pressure gradient (d) favourable pressure gradient.

(x) Dynamic similarity exists when the model and prototype have the same
(a) length scale ratio and time scale ratio
(b) length scale ratio and velocity scale ratio
(c) length scale ratio, time scale ratio and velocity scale ratio
(d) length scale ratio, time scale ratio and force scale ratio.

Group – B

2. (a) Define centre of pressure.

(b) A parabolic gate AB is hinged at A and free at B as shown in Figure 1. The gate is 3m wide. Determine the components of net hydrostatic force on the gate exerted by water.

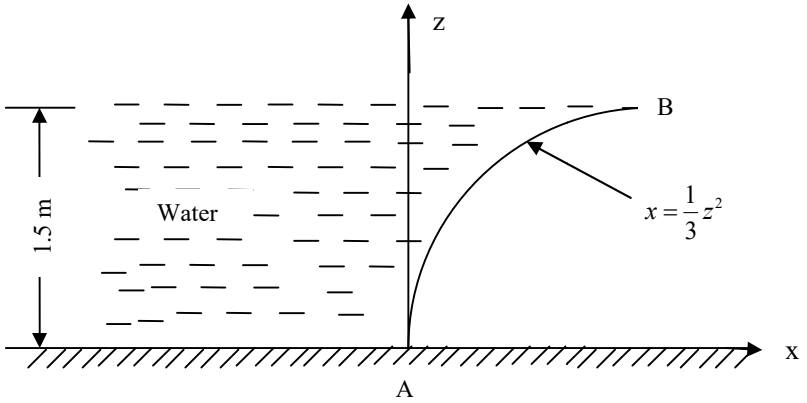

Figure 1

(c) A cube of side 'a' floats with one of its axis vertical in a liquid of specific gravity S_L. If the specific gravity of the cube material is S_C, find the values of (S_L/ S_C) for the metacentric height to be zero.

2 + 5 + 5 = 12

3. (a) The velocity field in a fluid medium is given by
$\vec{V} = 3xy^2\hat{i} + 2xy\hat{j} + (2zy + 3t)\hat{k}$
Find the magnitude and directions of (i) translational velocit rotational velocity and (iii) the vorticity of a fluid element at (1r 1m) and at time t = 3 sec .

(b) The velocity components of a two dimensional fluid flow in the x - y p given by $u = 2xy$ and v = ($a^2 + x^2 - y^2$) where a is constant. Show that th is possible and obtain an expression of the relevant stream functio check, whether the flow is rotational or irrotational.

(2 + 2 + 2) + (2 + 3 + 1

Group – C

4. (a) The water is flowing through a pipe from section 1 to section 2 l diameters 20 cm and 10 cm respectively. The rate of flow through p 35 lit/s. The section 1 is 6 m above datum and section 2 is 4 m datum. If the pressure at section 1 is 39.24 N/cm^2, find the press section 2, considering water as ideal fluid without any losses during

(b) A 20 cm diameter inclined water pipe has in it a venturimeter of t diameter 12.5 cm, which is connected to a differential me manometer showing a deflection of mercury 86.5 cm. Find the ve of water in throat, and the discharge.

6 + (4 + 2

5. (a) A pipe of 300 mm diameter conveying 0.3 m^3/s of water has a angled bend in a horizontal plane as shown in Figure 2. Fin resultant force exerted on the bend if the pressure at inlet and ou the bend are 24.525 N/cm^2 and 23.544 N/cm^2.

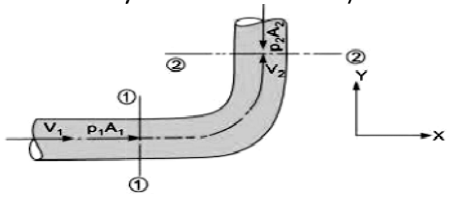

Figure 2

(b) A rectangular channel 2.0 m wide has a discharge of 250 litre second, which is measured by a right angled V notch weir. Fir position of the apex of the notch from the bed of the chan maximum depth of water is not to exceed 1.3 m. (Take C_d = 0.62.)

6 + (

Group – D

6. (a) For fully developed for laminar, steady flow through pipe show that $U_{\max} = 2U_{avg}$ where $U_{\max}$ = maximum velocity and U_{avg} = average velocity.

   (b) A viscous liquid is flowing in a laminar regime in a 12 cm diameter, circular horizontal pipe. A Pitot tube at a radial distance of 2 cm from the axis indicates a velocity of 0.6 m/s. Calculate the maximum velocity and the discharge in the pipe. If dynamic viscosity of the liquid is 0.1 N-s/m^2, find the shear stress at the pipe wall.

5 + (2 + 3 + 2) = 12

7. (a) Discuss different types of minor losses that occur in pipe flow, with relevant expressions.

   (b) Three pipes of 400 mm, 200 mm and 300 mm diameters and having lengths of 400 m, 200 m and 300 m respectively are connected in series to make a compound pipe. The ends of this compound pipe are connected with two tanks whose difference in water levels is 16 m. If the Darcy's friction factor *f*, for all the pipes is the same and equal to 0.02, determine the discharge through the compound pipe. (Take coefficient of contraction = 0.6).

5 + 7 = 12

Group – E

8. (a) Define Pressure Drag and Friction Drag. Distinguish between Stream lined Body and Bluff Body.

   (b) Given that the velocity distribution in a laminar boundary layer due to flow over a flat plate is $\frac{u}{U} = \left[\frac{3}{2}\eta - \frac{1}{2}\eta^3\right]$ where $\eta = \frac{y}{\delta}$, calculate the displacement and momentum thicknesses in terms of the nominal boundary layer thickness δ.

(2 + 2 + 1) + 7 = 12

9. (a) The efficiency η of a fan depends on density ρ, viscosity μ, angular velocity ω, diameter D of the rotor and the discharge Q. Using Buckingham's π theorem, obtain an expression for η in terms of ρ, μ, ω, D, Q.

   (b) For the two velocity profiles given below, state with reason whether the boundary layer has separated or on the verge of separation or will remain attached with the surface:

   (i) $\frac{u}{U} = 2\left[\frac{y}{\delta}\right] - \left[\frac{y}{\delta}\right]^2$ (ii) $\frac{u}{U} = \frac{3}{2}\left[\frac{y}{\delta}\right]^2 + \frac{1}{2}\left[\frac{y}{\delta}\right]^3$

8 + 4 = 12

FLUID MECHANICS
(MECH 2103)

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) Dynamic Viscosity (μ) has the dimension as
   (a) MLT^{-2} (b) $ML^{-1}T^{-1}$ (c) $ML^{-1}T^{-2}$ (d) $M^{-1}L^{-1}T^{-1}$.

   (ii) In an isothermal static atmosphere, the pressure
   (a) decreases linearly with elevation
   (b) decreases exponentially with elevation
   (c) increases logarithmically with elevation
   (d) increases linearly with elevation.

   (iii) The centroid of the volume of liquid displaced by a submerged body is called
   (a) centre of gravity (b) centre of volume
   (c) metacentre (d) centre of buoyancy.

   (iv) If a stream function Ψ exists, it implies that
   (a) the function Ψ represents a possible flow field
   (b) the flow is irrotational
   (c) the flow is steady, incompressible
   (d) the potential function also exists.

   (v) A two-dimensional flow in x-y plane is irrotational if
   (a) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ (b) $\frac{\partial u}{\partial x} = \frac{\partial u}{\partial y}$
   (c) $\frac{\partial v}{\partial x} = \frac{\partial u}{\partial y}$ (d) $\frac{\partial v}{\partial x} = \frac{\partial v}{\partial y}$

   (vi) Non-zero value of convective acceleration indicates
   (a) non-uniform flow (b) turbulent flow
   (c) irrotational flow (d) unsteady flow.