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ET-201(A)

B.Tech. Civil (Construction Management) / B.Tech. Civil (Water Resources Engineering) B.Tech. (Aero space Engineering)

Term-End Examination

December, 2011 02172

ET-201(A) : MECHANICS OF FLUIDS

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt **any seven** questions. Use of scientific calculator is permitted.*

1. (a) A hydraulic press has a ram of 100 mm and a plunger of 12.5 mm. Determine the force required on the plunger to raise a wight of 10000 N on the ram. **5+5**

(b) Two horizontal plates are kept 12.5 mm apart and the space between them is filled with oil of dynamic viscosity of 14 poise. If the top plate is moved at a constant velocity of 2.5 m/s, determine the shear stress on the lower plate.

2. (a) The velocity potential function ϕ is given by $\phi = x^2 - y^2$. Find the velocity components in x and y direction. Also show that ϕ represents a possible case of fluid flow. **5+5**

(b) Pipe A, 500 mm in diameter branches into two pipes B and C of diameters 320 mm and 210 mm respectively as shown in figure 1.

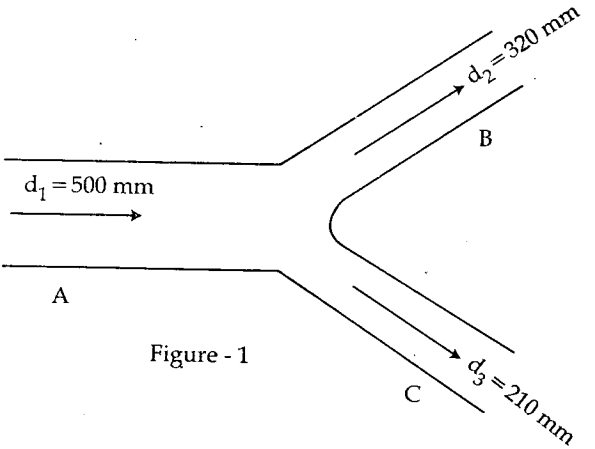

Figure - 1

If the average velocity in 500 mm diameter pipe is 3.2 m/sec, find :

(i) discharge through 500 mm diameter pipe, and

(ii) velocity in 210 mm diameter pipe, if the average velocity in 320 mm diameter pipe is 3.0 m/sec.

3. (a) In the laminar flow of a fluid in a circular pipe, the velocity profile is given by **5+5**

$$u = u_{max}\left[1-\left(\frac{\gamma}{\gamma_0}\right)^2\right],$$

Where γ_0 is the radius of the pipe. Find the ratio between the mean velocity to the maximum velocity.

(b) The velocity component in a two-dimensional flow for an incompressible fluid is as follows.

$u = x^3 - 6\,xy + 2\,y^2$,

Find out the v-component and analyse whether it is rotational or irrotational.

4. (a) If the velocity distribution over a flat plate is given by : **5+5**

$u = \frac{2}{3}\,y - y^2$, in which u is the velocity in m/s at a distance of y metres from the plate, determine the shear stress at $y = 0$ and $y = 0.15$m. Assume $\mu = 0.863$ Ns/m^2

(b) A balloon uses hot air to provide its lifting capacity. Prior to release, it is tethered to ground by a steel cable. If the gondola weight, passengers and material weight is 10 kN, determine the tension in the cable when the balloon is inflated as a sphere of ϕ = 20 m. Assume that the hot air has a specific weight of 6 N/m^3 and ambient air has a specific weight of 11 N/m^3.

5. (a) A jet of water, releasing from 5 mm diameter orifice working under a head of 2.0 m, was found to travel horizontal and vertical distances of 2.772 m and 1.0 m respectively. If C_C for the orifice is 0.61, determine the discharge. 5+5

(b) In a two-dimensional flow, the fluid-velocity components are

$$u = x - 4y \text{ and } u = -y - 4x.$$

Show that the flow satisfies the continuity equation and obtain the expression for the stream function.

6. (a) Briefly describe Reynolds experiment and mention its significance. 5+5

(b) Using the Buckingham's π theorem, show that the velocity U through a circular orifice is given by

$$U = \sqrt{2gH}\ \phi\left[\frac{D}{H}, \frac{\mu}{\rho UH}\right]$$

Where H is the head causing flow, D is the diameter of the orifice, μ is the co-efficient of viscosity, ρ is the mass density and g is the acceleration due to gravity.

7. (a) Define the term dynamical similarity as used in model studies of hydraulic structures. 5+5

(b) In a 1 in 20 model of a stilling basin, the height of the hydraulic jump in the model is observed to be 0.2 m. What is the height of hydraulic jump in the proto type ?

8. (a) A kite of dimensions 0.6 m × 0.6 m, weighing 5 N flies in equilibrium when it makes an angle of 10° with the horizontal in a wind of speed 40 km/hr and density 1.2 kg/m^3. If the string attached to it makes an angle of 45° with the horizontal and experiences a tension of 20 N, calculate the lift and drag coefficients. 5+5

(b) A lead sphere of 1.0 mm diameter acquired a terminal velocity of 7 mm/sec in an oil, while falling down. Assuming that the density of lead is 11000 kg/m^3, that of the oil is 1200 kg/m^3,

Determine

(i) the Reynolds number, and

(ii) the kinematic viscosity of the oil.

9. (a) Describe the phenomenon of boundary layer separation when the flow takes place over a curved surface. 5+5

(b) The leminar boundary layer profile in a case is approximated by a cubic parabola

$$\frac{u}{U} = \frac{3}{2}\left(\frac{y}{\delta}\right)^2 - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$$

Where u = velocity at a distance y from the surface and $y \to \delta$, $u \to U$.

Calculate the displacement thickness and momentum thickness in terms of δ.

10. Write short notes on ***any five*** of the following : **5x2=10**

(a) Diffuser

(b) Water hammer

(c) Head loss

(d) Gauge pressure

(e) Capillarity

(f) Isentropic flow

(g) Cavitation

(h) Surface Tension