

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0021

Roll No.

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B. Tech.

(SEM. III) THEORY EXAMINATION—2011-12

FLUID MECHANICS

Time : 3 Hours

Total Marks : 100

Note :— Attempt **all** the questions. All questions carry equal marks.

Assume any missing data suitably. Use sketches and diagrams to illustrate your answers.

1. Attempt any **four** parts :

(5×4=20)

- (a) If the velocity distribution over a plate is given by $(u = 2y - 1.5y^2)$ in which 'u' is the velocity in m/s at a distance 'y' m above the plate, determine the shear stress at $y = 0$, and at $y = 0.15$ m. Take dynamic viscosity of fluid as 8.63 poise.
- (b) Calculate the dynamic viscosity of oil, which is used for lubrication between a square plate of size $0.8 \text{ m} \times 0.8 \text{ m}$ and an inclined plane with angle of inclination 30° . The weight of the square plate is 300 N and it slides down the inclined plane with a uniform velocity of 0.3 m/s. Take thickness of oil film as 1.5mm.

- (c) A differential manometer is connected to two points 'A' and 'B' as shown in Fig. 1a. At 'B' air pressure is 9.81 N/cm^2 absolute, find the absolute pressure at 'A'.

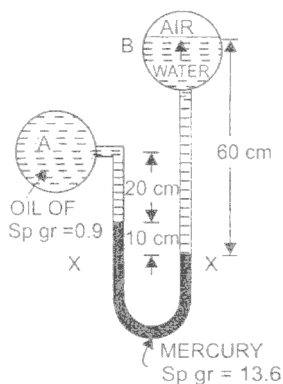


Fig. 1a

- (d) A circular plate 3 m diameter is under water with its plane making an angle 30° with the water surface. If the top edge of the plate is 1 m below the water surface, find the force on one side of the plate and its location.
- (e) A solid cone floats in water with its apex downwards. Determine the least apex angle of cone for stable equilibrium. Take specific gravity of the material of cone as 0.8.
- (f) With neat sketches, explain the conditions of equilibrium for floating and submerged bodies.

2. Attempt any **four** parts : (5×4=20)

(a) Differentiate the following :

- (i) Steady flow and unsteady flow
- (ii) Uniform flow and non-uniform flow

- (b) Explain the concept of fluid as continuum; and describe compressibility of fluids.
- (c) For steady - incompressible flows derive the continuity equation using 3 - D rectangular co-ordinate system.
- (d) The following cases represent the two velocity components, determine the third component of velocity such that they satisfy the continuity equation :

$$(i) \quad u = x^2 + y^2 + z^2; \quad v = xy^2 - yz^2 + xy$$

$$(ii) \quad v = 2y^2; \quad w = 2xyz$$

- (e) The velocity potential function ϕ is given by an expression

$$\phi = -\frac{xy^3}{3} - x^2 + \frac{x^3y}{3} + y^2; \text{ find the velocity components } u \text{ and } v \text{ and show that } \phi \text{ represents a possible case of flow.}$$

- (f) Explain the following with suitable sketches;

(i) *Source and sink*

(ii) *Doublet.*

3. Attempt any **two** parts :

(10×2=20)

- (a) A 30 cm × 15 cm venturimeter is inserted in a vertical pipe carrying water, flowing in the upward direction. A differential mercury manometer connected to the inlet and throat gives a leading of 20 cm. Find the discharge. Take $C_d = 0.98$.
- (b) A pipe of 300 mm diameter carrying 0.030 m³/s of water has a right angled bend in a horizontal plane. Find the resultant force exerted on the bend if the pressure at inlet and outlet of the bend are 24.525 N/cm² and 23.544 N/cm².
- (c) The pressure drop ' Δp ' in a pipe of diameter ' D ' and length ' L ' due to viscous flow depends on the velocity ' v ', dynamic viscosity ' μ ' and mass density ' ρ ' using Buckingham's Theorem, obtain an expression for ' Δp '.

4. Attempt any **two** parts :

(10×2=20)

(a) A fluid of viscosity 0.7 Ns/m^2 and specific gravity 1.3 is flowing through a circular pipe diameter 100 mm. The maximum shear stress at the pipe wall is given as 196.2 N/m^2 ; find the pressure gradient, average velocity and Reynolds number.

(b) Prove that the difference of local velocity and average velocity for turbulent flow through rough or smooth pipe is

$$\text{given by: } \frac{u - \bar{U}}{u} = 5.75 \log_{10} \left(\frac{y}{R} \right) + 3.75$$

(c) If water is flowing with a velocity of 1.5 m/s in a pipe of length 2500 m and of diameter 500mm. At the end of the pipe, a valve is fitted. Find the rise in pressure if the valve is closed in 25 seconds, take the value of velocity of pressure wave = 1460 m/s.

5. Attempt any **two** parts :

(10×2=20)

(a) Explain the displacement thickness, momentum thickness and energy thickness related to boundary layer flow. Find the displacement thickness for the velocity distribution in

$$\text{the boundary layer given by: } \frac{u}{U} = 2 \left(\frac{y}{\delta} \right) - \left(\frac{y}{\delta} \right)^2 .$$

(b) Explain the phenomenon of separation of boundary layer. Discuss the effect of the pressure gradient on boundary layer separation. How will you prevent the separation of boundary layer ?

(c) Explain the phenomenon of drag on a sphere; and draw a graph for C_D at various values of Re . Explain Stoke's flow.