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

PAPER ID : 0021 Roll No. | | | | | | | | | | |

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 m × 0.8 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'.

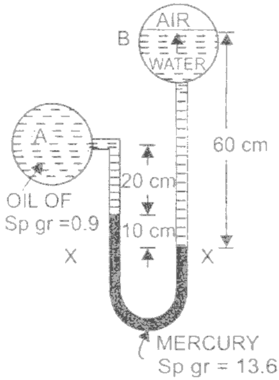

Fig. 1a

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

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

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

$$\varphi = -\frac{xy^3}{3} - x^2 + \frac{x^3 y}{3} + y^2$$; find the velocity components

u and v and show that φ 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 m^3/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/cm^2 and 23.544 N/cm^2.

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

(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 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 R_e. Explain Stoke's flow.