S-2015

PMM/KS/15/7038

Faculty of Engineering & Technology

Fifth Semester B.E. (Civil Engg.) (C.B.S.)

Examination

FLUID MECHANICS—I

Time : Three Hours] [Maximum Marks : 80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Assume suitable data wherever necessary.

(3) Illustrate your answers wherever necessary with the help of neat sketches.

(4) Use of non-programmable electronic calculator is permitted.

1. (a) Define with its SI units : Specific weight, specific gravity and surface tension. 3

(b) Distinguish between :

(i) Newtonian and Non-newtonian fluid

(ii) Surface tension and capillarity. 4

(c) State Newton's law of viscosity. Explain the effect of temperature on viscosity of water and that of air. 6

OR

2. (a) Convert a pressure head of 100 m of water to a Carbon Tetrachloride of specific gravity 1.6. 3

(b) Define Atmospheric pressure, Gauge pressure and Absolute pressure. Mention the relationship between them with the help of neat sketch. 4

(c) A cylindrical block of diameter 0.2 m is placed over an inclined plane such that its length is perpendicular to the plane. The weight of the block is 500 N and inclination of the plane is 35° with the horizontal. The sliding velocity is 0.4 m/sec downwards. There is a lubricant between the block and the plane, whose viscosity is 11.6 poise. Determine the thickness of lubricant in millimeter. 6

3. (a) If the top edge of a vertical circular sluice gate of 1.2 m diameter is located at a depth of 6.0 m below the water surface, find the total pressure and position of the centre of pressure. 7

(b) A rectangular tank 3 m long, 2 m wide and 2 m deep contains water to a depth of 1.25 m. If it is accelerated horizontally at 3 m/sec^2 in the direction of its length, find :

(i) The inclination of water surface with the horizontal,

(ii) Depths of water at the two ends,

(iii) Total pressure on the two ends of the tank. 6

OR

4. (a) Explain the term metacentric height and metacentre. 3

(b) Explain the stability of a floating body with reference to its metacentric height. 4

(c) A cylinder 1.5 m diameter and 2 m long floats in sea water with its axis vertical. The base of the cylinder is 1.5 m below the surface of water. Find the total weight of the cylinder and its position of the centre of gravity if it is 0.3 m below the metacentre. Sea water weighs 10055 N/m^3. 6

5. (a) Define path line, streak line and the stream line. Also show that stream lines and equipotential lines intersect each other orthogonally. 6

(b) Does the velocity distribution :

$u = -x$, $v = 2y$ and $w = 2 - z$ represent a possible case of flow of an incompressible fluid ? 4

(c) A two dimensional flow is described by the velocity components :

$$u = 5x^3 \text{ and } v = -15x^2y.$$

Determine :

(i) Velocity and acceleration at point p(1, 2). 4

OR

6. (a) For a flow field, the stream function is given by,

$$\psi = 3x^3y + 8xy - 3xy^3$$

Show that, the flow is irrotational. Also determine expression for potential function ϕ. 8

(b) Derive continuity equation in 3D Cartesian co-ordinates. 6

7. (a) Derive an expression for Bernoulli's theorem from first principle and state the assumptions made for such a derivation. 6

(b) A pipe 300 m long has a slope of 1 in 100 and taken from 1.2 m diameter at higher end to 0.6 m diameter at lower end. If the pressure at higher end is 7 N/cm^2, find the pressure at lower end considering the rate of flow as 5.40 m^3/min. Neglect losses. 8

OR

8. (a) Explain briefly (any ***two***) :

(i) Kinetic energy correction factor

(ii) Momentum equation

(iii) Impact of jet on vertical plate. 6

(b) A horizontal venturimeter 300 mm × 150 mm is used to measure the flow of oil of specific gravity 0.8. The discharge of oil through venturimeter is 0.5 m^3/s. Find the reading of oil-mercury differential manometer. Take venturimeter constant as 0.98. 8

9. (a) A vertical sharp-edged orifice 120 mm in diameter is discharging water at the rate of 98.2 litres/sec under a constant head of 10 m. A point on the jet, measured from the vena-contracta of the jet has co-ordinates 4.5 m horizontal and 0.54 vertical. Find coefficients of velocity, coefficients of discharge and coefficients of contraction. 7

(b) Find the discharge from a 80 mm diameter external mouthpiece, fitted to a side of a large vessel, if the head over the mouthpiece is 6 m. 6

OR

10. (a) During an experiment in a laboratory, 0.05 m^3 of water flowing over a right-angled notch was collected in one minute. If the head above the apex is 50 mm calculate the co-efficient of discharge of the notch. 7

(b) Explain briefly (any ***three***) :

(i) Cipolletti weir

(ii) Velocity of approach

(iii) End contraction

(iv) Broad-crested weir. 6

11. (a) What is meant by geometric, kinematic and dynamic similarities ? Are these similarities truly attainable ? If not, why ? 6

(b) Prove that shear stress (τ) in a fluid flowing through a pipe can be expressed by the equation :

$$\tau = \rho V^2 \phi \left[\frac{\mu}{\rho VD}, \frac{k}{D} \right]$$

D $\rightarrow$ Diameter of pipe, $\rho \rightarrow$ mass density, V $\rightarrow$ velocity, $\mu \rightarrow$ viscosity and k is height of roughness projection. 7

OR

12. (a) Explain how the laminar flow can be demonstrated with the help of Reynold's apparatus. 6

(b) Crude oil of kinematic viscosity 2.25 cm^2/sec flows through a 20 cm diameter pipe and the rate of flow is 15 litres/sec. Find the type of flow. 4

(c) What are dimensionless numbers and their significance ? 3