Faculty of Engineering & Technology

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

FLUID MECHANICS—I

Paper—I

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Due credit will be given to neatness and adequate dimensions.

(3) Assume suitable data wherever necessary.

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

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

1. (a) Differentiate the following :—

(i) Newtonian and non-newtonian fluids

(ii) Ideal and real fluids

(iii) Cohesion and adhesion. 6

(b) A square plate 600 mm × 600 mm of mass 25 kg

slides down over an inclined plane of slope 1 vertical to 2.4 horizontal with a uniform velocity of 0.3 m/sec. If a thin layer of oil of thickness 1.0 mm fills the space between the plate and the plane, determine the dynamic viscosity of the oil in Pa. sec and in Poise. Also calculate the kinematic viscosity of the oil, if its sp. gr. is 0.8. 8

OR

2. (a) State and prove Pascal's law. 5

(b) Pipe A carries a liquid of sp.gr. 1.10 and is situated 10 cm above another pipe B which carries water. An inverted U-tube manometer containing a liquid of sp.gr. 0.70 on its upper portion is connected across these two pipes. If the liquid in pipe A and B rise 20 cm and 35 cm above the centre lines of their respective pipes. Find the pressure difference between the centre lines of the pipes. 6

(c) A tank contains water with a ht. of 1.5 m above the bottom. Calculate the pressure at a point 10 cm above the bottom of the tank. 3

3. (a) Show that for a plane submerged in a liquid, centre of pressure always lies below the centroid of the plane. 6

(b) A circular plate 2.0 m diameter is immersed in water in such a way that its greatest and least depth below the free surface are 3.0 m and 1.0 m respectively. Determine total pressure on one side of the plate and position of centre of pressure. 6

(c) A square plate of area 1.4 m^2 is immersed in water horizontally a depth of 0.5 m. How much hydrostatic force will act on the plate ? 2

OR

4. (a) Find the density of floating body if 80% of its volume is submerged in water and rest 20% is in air. 5

(b) A wooden prismatic block of length 'L' is immersed vertically in water. The base of the prism is a square of side 'a'. If 'S' is the sp.gr. of wood, prove that for stable equilibrium

$$\frac{a}{L} > \sqrt{6\,s\,(1-s)}\,.$$ 6

(c) Write the conditions for stable equilibrium for a partially submerged and fully submerged floating body. 3

5. (a) Differentiate the following :—

(i) Steady and unsteady flow

(ii) Rotational and irrotational flow

(iii) Uniform and non-uniform flow

(iv) Laminar and turbulent flow. 6

(b) Show that the flow is continuous, if velocity components are $u = 4xy$ and $v = x^2 - 2y^2$. 3

(c) Calculate the unknown velocity component for a three dimensional flow of incompressible fluid, if $u = 2x^2$, $v = 2xyz$. 4

OR

6. (a) Show that stream function and velocity potential function are orthogonal functions. 4

(b) In a flow the velocity vector is given by

$$V = 4xi + 4yj - 8\,zk.$$

Determine the equation of stream line passing through a point (1, 2, 3). 5

(c) For a flow, stream function given by $\Psi = 3xy$, calculate velocity at a point (1, 2). 4

7. (a) State Bernoulli's theorem for steady flow of an incompressible fluid. What are the assumptions made to derive it ? Also state its limitations. 6

(b) State the momentum equation. How will you apply momentum equation for determining the force exerted by a flowing liquid on a pipe bend ? 7

OR

8. (a) What do you mean by a pitot tube ? How is it used to measure velocity through a pipe and through a channel, explain with the help of sketches. 6

(b) A horizontal venturimeter with inlet diameter 200 mm and throat diameter 100 mm is used to measure the flow of water. The pressure at inlet is 0.18 N/mm^2 and the vacuum pressure at the throat is 280 mm of mercury. Find the rate of flow. Take value of $C_d = 0.98$. 7

9. (a) Differentiate orifice and mouth piece. 4

(b) Define C_v, C_c and C_d and establish a relationship between them. 4

(c) A large tank has a sharp edged orifice of 930 mm^2 area at a depth of 3 m below constant water level. The jet issues horizontally and in a horizontal distance of 2.4 m, it falls by 0.53 m. The discharge is measured as 4.3 lit/sec.

Determine coefficient of velocity, discharge and contraction for the orifice. 5

OR

10. (a) What is cippoletti weir ? Show that its sides slope of 1 horizontal to 4 vertical are provided for a specific purpose. 6

(b) A 10 m wide rectangular channel is provided with 1.5 m high sharp crested weir across its width, with two intermediate piers of 1.0 m width. Find the discharge through the channel, if the head over the weir is 80 cm. Neglect velocity of approach and end contraction effects. 7

11. (a) What do you mean by dimensional homogenity and differentiate dimensional homogeneous and dimensionally non-homogeneous equations. Check whether the equation,

$$Q = \frac{2}{3} Cd \sqrt{2g}\, LH^{3/2}$$

with usual notation is dimensionally homogeneous or not. 7

(b) By dimensional analysis show that Torque 'T' on a shaft of diameter 'd', revolving at a speed 'N' in a fluid of viscosity 'ν' and mass density 'ρ' is given by :

$$T = \rho d^2 N^2 \phi \left[\frac{\nu}{d^2 N} \right].$$ 6

OR

12. (a) Explain Reynold's number and give its significance. 5

(b) Write the dimension (M, L, T form) of Torque, Power, discharge, dynamic viscosity surface tension and work. 3

(c) What type of flow can be expected through a pipe of 200 mm, carrying an oil of kinematic viscosity 2.25 stoke at a mass flow rate of 10 kg/sec ? 5