12. (a) A flat plate 1.5 m × 1.5 m moves at 50 km/hour in stationary air of density 1.15 kg/m^3. If the coefficient of drag and lift are 0.15 and 0.75 respectively, determine :

(i) The lift force

(ii) The drag force

(iii) The resultant force

(iv) The force required to keep the plate in motion. 7

(b) A kite weighing 7.848 N has an effective area of 0.8 m^2. It is maintained in air at an angle of 10º to the horizontal. The string attached to the kite makes an angle of 45º to the horizontal and at this position the value of coefficient of drag and lift are 0.6 and 0.8 respectively. Find the speed of the wind and the tension in the string. Take density of air as 1.25 kg/m^3. 7

NTK/KW/15/7317/7343

Faculty of Engineering & Technology

Third Semester B.E. (Mechanical Engg.)/Power Engg.(C.B.S.) Examination

FLUID MECHANICS

Time : Three Hours] [Maximum Marks : 80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Solve **SIX** questions as follows :

Question No. **1** **OR** Question No. **2**

Question No. **3** **OR** Question No. **4**

Question No. **5** **OR** Question No. **6**

Question No. **7** **OR** Question No. **8**

Question No. **9** **OR** Question No. **10**

Question No. **11** **OR** Question No. **12**.

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

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

(5) Use of Steam tables/Thermodynamic tables for moist air/Psychrometric/Mollier's/Refrigeration charts is permitted.

(6) Assume suitable data wherever necessary.

1. (a) Define the following terms :

   (i) Specific weight

   (ii) Specific gravity

   (iii) Capillarity

   (iv) Compressibility. 6

   (b) A vertical gap 2.2 cm wide of infinite extent contains a fluid of viscosity 2.0 N s/m^2 and specific gravity 0.9. A metallic plate 1.2 m × 1.2 m × 2.0 cm is to be lifted up with a constant velocity of 0.15 m/s, through the gap if the plate is in the middle of the gap. Find the force required. The weight of the plate is 40 N. 7

OR

2. (a) Define the following terms :

   (i) Steady and Unsteady flow.

   (ii) Compressible flow and Incompressible flow.

   (iii) Laminar flow and Turbulent flow. 6

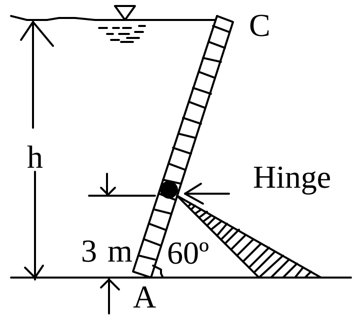
   (b) The velocity field in a fluid flow is given by V = x^2 t i + 2 xy t j + 2 yz t k. Determine the velocity vector at time (2, –1, 1) and time t = 1 s. Also determine acceleration of the flow for given location and time. 7

3. (a) State and prove the Pascal's law. 6

   (b) A 'U' tube differential manometer connects two pressure pipes A and B. Pipe A contains carbon tetrachloride having specific gravity 1.594 under a pressure of 11.772 N/cm^2 and pipe B contains oil of specific gravity 0.8 under a pressure of 11.772 N/cm^2. The pipe A lies 2.5 m above pipe B. Find the difference of pressure measured by mercury 'U' tube manometer. 7

OR

4. (a) A gate supporting water is shown in figure. Find the height h of the water so that the gate tips about the hinge. Take the width of the gate as unity. 6



   (b) A wooden block of 10 cm width, 8 cm depth and 20 cm long is in the form of a rectangular prism. It floats in water with its shortest axis vertical. The depth of immersion of block is 6 cm. Find the metacentric height and state the condition of its equilibrium. 7

5. (a) Derive Bernoulli's equation of motion along a streamline. 7

(b) A horizontal venturimeter with inlet diameter 20 cm and throat diameter 10 cm is used to measure the flow of water. The pressure at inlet is 17.658 N/cm^2 and the vacuum pressure at the throat is 30 cm of mercury. Find the discharge of water through venturimeter. 7

OR

6. (a) An orifice of diameter 40 mm fitted in the vertical side of tank discharges water. The water surface in the tank is at a constant level of 4 m above the centre of orifice. The head loss in the orifice is 0.4 m and the coefficient of contraction is 0.63. Find the coefficient of velocity and coefficient of discharge, and the discharge through the orifice. 7

(b) A circular tank of diameter 1.25 m contains water upto a height of 5 m. An orifice of 50 mm diameter is provided at its bottom. If Cd = 0.62, find the height of water above the orifice after 1.5 minutes. 7

7. (a) An oil of viscosity 0.1 N s/m^2 and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300 m. The rate of flow of fluid through the pipe is 3.5 litres/s. Find the pressure drop in a length of 300 m and also the shear stress at the pipe wall. 6

(b) A shaft having a diameter of 50 mm rotates centrally in a journal bearing having a diameter of 50.15 mm and length 100 mm. The angular space between the shaft and the bearing is filled with oil having viscosity of 0.9 poise. Determine the power absorbed in the bearing when the speed of rotation is 60 r.p.m. 7

OR

8. (a) The pressure difference Δp in a pipe of diameter D and length l due to viscous flow depends on the velocity V, viscosity μ and density ρ. Using Buckingham's π- theorem, obtain an expression for Δp. 6

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

$$V = \sqrt{2\,g\,H}\ \phi\left[\frac{D}{H}, \frac{\mu}{?VH}\right],$$

where H is the head causing flow, D is the diameter of the orifice, μ is the coefficient of viscosity, ρ is the mass density and g is the acceleration due to gravity. 7

9. (a) The rate of flow through a horizontal pipe is 0.3 m^3/s. The diameter of pipe is suddenly enlarged from 250 mm to 500 mm. The pressure intensity in the smaller pipe is 13.734 N/cm^2. Determine :

(i) loss of head due to sudden enlargement,

(ii) pressure intensity in the large pipe,

(iii) power lost due to enlargement. 6

(b) The difference in water surface levels in two tanks, which are connected by three pipes in series of lengths 300 m, 170 m and 210 m and of diameters 300 mm, 200 mm and 400 mm respectively, is 12 m. Determine the rate of flow if coefficient of friction are 0.005, 0.0052 and 0.0048 respectively considering minor losses only. 7

OR

10. (a) A Syphon of diameter 200 mm connects two reservoirs having a difference in elevation as 20 m. The total length of syphon is 800 m and the summit is 5 m above the water level in the upper reservoir. If the separation takes place at 2.8 m of water absolute find the maximum length of Syphon from upper reservoir to the summit. Take f = .004, and atmospheric pressure = 10.3 m of water. 7

(b) A horizontal pipe 4000 m long supplies water to a hydraulic machine through a 200 mm diameter pipe. Find the maximum power transmitted if the pressure at the inlet to the pipe is 8000 kPa. Take f = 0.007. 6

11. (a) Define the following terms :

(i) Pressure drag

(ii) Friction drag

(iii) Streamlined body

(iv) Bluff body. 6

(b) Define the following terms :

(i) Boundary layer thickness

(ii) Displacement thickness

(iii) Momentum thickness

(iv) Energy thickness. 8

OR