S.E. (Mechanical) (Semester – I) Examination, 2010
FLUID MECHANICS
(2003 Course)

Time : 3 Hours Max. Marks : 100

Instructions : *1) Answer **any three** questions from **each** Section.*
*2) Answers to the **two** Sections should be written in **separate** books.*
*3) **Neat** diagrams must be drawn **wherever** necessary.*
*4) Black figures to the **right** indicate **full** marks.*
*5) **Use** of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is **allowed**.*
*6) Assume **suitable** data, if **necessary**.*

SECTION – I

Unit – I

1. a) A U tube is made up of two capillaries of bores 1.5 mm and 2 mm respectively. The tube is dipped in the liquid whose $\sigma = 0.075$ N/m. Find out the mass density of the liquid if the difference in two menisci is 2 mm. Assume angle of contact is zero. **6**

   b) State and explain Newton's Law of viscosity. **4**

   c) Describe various types of flow with examples. **6**

OR

2. a) Through a narrow gap of height δ, a thin plate of large surface is pulled with a velocity U on one side of the plate, oil is of viscosity μ_1 and on the other side of μ_2.

   Determine i) The position of the plate so that shear force on the sides is equal and ii) Pull required to drag the plate is minimum. **8**

   b) Derive three dimensional continuity equation in Cartesian coordinate. **8**

Unit – II

3. a) A well-type manometer has the measurement leg inclined at 30° from the horizontal. The diameter of the well is 50 mm while that of measurement leg is 5 mm. An oil of specific gravity of 0.85 is used as the fluid. A differential pressure produces a reading of 15 cm from zero level. What is the differential pressure in Pa ? Assume that inclined tube is open to atmosphere. **8**

b) Derive an expression for total pressure and center of pressure for inclined plane submersed in liquid and hence derive the expression for center of pressure for vertical plane. **8**

OR

4. a) Define following terms :

i) Buoyancy ii) Centre of buoyancy iii) Principle of floatation iv) Archimedes' Principle. **4**

b) A square plate of diagonal 1.5 m is immersed in water with its diagonal vertical and upper corner 0.5 m below the free surface of water. Calculate the depth of the centre of pressure on the plate from the free surface of water and the hydrostatic force resulting on the plate in kN. **8**

c) Explain with neat sketch the method of determining metacentric height of floating body. **4**

Unit – III

5. a) Determine the discharge through an orifice 1 m wide and 0.6 m deep in the vertical wall of a large tank having water level 1.5 m above the upper edge of the orifice. Water on downstream side is 0.25 m above the bottom edge of the orifice. Take $C_d = 0.6$. **10**

b) Sketch with equations various measurement arrangements of Pitot tube. **8**

OR

6. a) Obtain an expression for pressure drop from inlet to throat in a horizontally mounted venturimeter in terms of rate of volume flow (Q) and inlet diameter (D) for inlet/throat diameter ratio is equal to 2. **8**

   b) A sub-marine fitted with a pitot tube moves horizontally in sea with its axis is 12 m below the surface of water. The Pitot tube fixed infront of the sub-marine and along its axis connected to the two limbs of a U-tube containing mercury, the reading of which is found to be 200 mm. Find the speed of the sub-marine.

   Take the specific gravity of seawater = 1.025 times fresh water. **6**

   c) List the various forces acting on fluid mass. Explain the significance of each term. **4**

SECTION – II

Unit – IV

7. a) Derive expression for Hagen Poiseulli's equation. **10**

   b) What are repeating variables ? What points are important while selecting repeating variables ? **6**

OR

8. a) An oil is flowing between two parallel plates kept at 10 cm apart with maximum velocity of 1.5 m/s. Find out the discharge per meter (perpendicular to paper), shear at the plates; the pressure difference between two points 20 m apart along the flow direction. Also find out the velocity gradient at the plates and velocity at 2 cm from the plate surface. Take μ for oil = 25 Poise. **8**

   b) Using Buckingham-π theorem, show that the velocity through a circular orifice in a pipe is given by $V = \sqrt{2gH}\, f\left(\frac{d}{H}, \frac{\mu}{\rho VH}\right)$. **8**

Unit – V

9. a) Derive expression for Darcy Weisbatch equation for head loss due to friction. **6**

   b) Two tanks 2.5 km long are connected by a pipe of 30 cm diameter. The water level difference between two tanks is 10 m. Find the diameter of another pipe which would provide twice the discharge of the first. Consider f is same in both cases and consider only frictional losses in both cases. **10**

OR

10. a) What is siphon ? Where it is used ? Explain its action. Derive formula for the length of its leg. 8

b) Determine the diameter of the pipe required to supply water to a turbine developing 180 KW under the following condition.

Head = 100 m, Pipe length = 1000 m, η = 80% Take f = 0.005. What would be the diameter of the pipe if it is to be designed for maximum power condition ? 8

Unit – VI

11. a) Explain the characteristics of laminar and turbulent boundary layers. 6

b) Discuss the phenomenon of separation for flow over curved surface. What are the methods used to prevent the separation ? 6

c) Air with a velocity of 0.5 m/s is flowing over a cylinder of 10 cm diameter. Find the total drag, shear drag and pressure drag if the length is 1 m. 6

OR

12. a) Define drag and lift and differentiate between friction drag and pressure drag. Under what circumstances friction drag becomes zero and pressure drag becomes zero. 6

b) Explain development of fully developed turbulent flow in circular pipes with sketches. 6

c) Which factors affect the thickness of boundary layer ? 6