Total No. of Questions—**12**] [Total No. of Printed Pages—**7**

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S.E. (Mech.) (Sem. I) (Common to Sandwich)

EXAMINATION, 2011

FLUID MECHANICS

(2008 PATTERN)

Time : Three Hours **Maximum Marks : 100**

N.B. **:—** (*i*) Answer *three* questions from Section I and *three* questions from Section II.

(*ii*) Figures to the right indicate full marks.

(*iii*) Draw suitable sketches wherever necessary.

(*iv*) Assume suitable data wherever necessary.

(*v*) Answers to the two Sections should be written in separate answer-books.

(*vi*) Use of electronic pocket calculator is allowed.

SECTION I

UNIT I

1. (*a*) What is kinematic viscosity ? Why is it so called ? Give its unit. [4]

(*b*) Explain : [6]

(*i*) Streak Line

(*ii*) Vapor Pressure

(*iii*) Ideal Fluid

(*iv*) Compressibility.

P.T.O.

(*c*) A piston 100 mm in diameter, 125 mm in length moves in a vertical cylinder of 100.4 mm diameter. The annular space between the piston of the cylinder is filled with lubricating oil of dynamic viscosity equal to 0.08 PaS. If the weight of the piston is 30 N, at what velocity the piston would slide. [8]

Or

2. (*a*) What is flow net ? Enlist different methods to draw the flow nets. [4]

(*b*) Distinguish between the following with *one* example : [6]

(*i*) Uniform and non-uniform flow

(*ii*) Rotational and irrotational flow

(*iii*) One, two and three-dimensional flow.

(*c*) A stream function is given by $\psi = 3xy$.

Determine : [8]

(*i*) Whether flow is possible ?

(*ii*) Whether flow is rotational or irrotational ?

(*iii*) The potential function ϕ.

(*iv*) Acceleration components at (1, 1).

UNIT II

3. (*a*) Prove that the centre of the pressure of a plane surface is always below the centre of gravity when immersed in liquid. [6]

(*b*) Explain the term Metacentre and stability of floating body. [4]

(*c*) A rectangular barge 21 m long, 5 m wide has the water line 1.6 m and the centre of gravity 2 m above the bottom. Determine the metacentric height. [6]

Or

4. (*a*) State and prove hydrostatic law. [4]

(*b*) State and explain Pascal's law. [4]

(*c*) 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. Find the hydrostatic force on the plate and the depth of centre of pressure from free surface of water. [8]

UNIT III

5. (*a*) Derive an expression for Bernoulli's equation along a streamline. State the assumptions made. What are limitations of the Bernoulli's equation ? [10]

(*b*) Explain HGL and TEL with figure. [6]

Or

6. (*a*) For a given flow, show that the reading of differential manometer remains unchanged irrespective of the inclination of venturimeter. [8]

(*b*) A pump is pumping water at the rate of 7536 lt/min. The pump inlet is 40 cm in diameter and the vacuum pressure over there is 15 cm of Mercury. The pump outlet is 20 cm in diameter and it is 1.2 m above the inlet. The pressure at the outlet is 107.4 kN/m^2. Estimate the power added by the pump. [8]

SECTION II

UNIT IV

7. (*a*) Laminar flow takes place in a circular tube. At what distance from the boundary does the local velocity equal to the average velocity ? Derive. [8]

(*b*) A 1/10 model of an airplane is tested in a variable density wind tunnel. The prototype plane is to fly at 400 km/hr speed under atmospheric conditions. The pressure used in the wind tunnel is 10 times the atmospheric pressure. Calculate the velocity of air in the model. To what prototype value would a measured drag of 500 N in the model correspond ? [10]

Or

8. (*a*) The discharge Q over a small weir is known to depend upon the head 'H' over a weir, the weir height 'P', gravity 'g', width of the weir 'L' and fluid properties density 'ρ' dynamic viscosity 'μ' and surface tension 's'. Express the relationship between the variables in the dimensionless form. [8]

(*b*) There is a horizontal crack 40 mm wide and 2.5 mm deep in a wall of thickness 100 mm. Water leaks through the crack. Find the rate of leakage of water through the crack if the difference of pressure between the two ends of crack is 0.02943 N/cm^2. Take the viscosity of water equal to 0.01 poise. [10]

UNIT V

9. (*a*) A straight 25 cm pipeline 5 km long is laid between two reservoirs having a difference in level of 40 m. To increase the capacity of the system an additional 2.5 km long 25 cm pipe is laid parallel from the first reservoir to the midpoint of the original pipe. Assuming friction factor as 0.025 for both the pipes; find the increase in discharge due to installation of the new pipe. [10]

(*b*) What is siphon ? On what principle does it work ? Explain. [6]

Or

10. (*a*) A pipeline, 300 mm in diameter and 3200 m long is used to pump up 50 kg per second of an oil whose density is 950 kg/m^3 and whose kinematic viscosity is 2.1 stokes. The center of the pipeline at the upper end is 40 m above than that at the lower end. The discharge at the upper end is atmospheric. Find the pressure at the lower end and draw H.G.L and T.E.L. [10]

(*b*) Describe Prandtl mixing length theory for finding the shear stress in Turbulent flow. [6]

UNIT VI

11. (*a*) Explain the basic of Computational Fluid Dynamics. [6]

(*b*) For the following velocity profiles in the boundary layer on a flat plate, calculate the displacement thickness in terms of the nominal boundary layer thickness δ : [10]

(*i*) $u/U = \eta$

(*ii*) $u/U = 2\eta - \eta^2$

where $\eta = y/\delta$

Or

12. (*a*) Explain boundary layer separation and its control. [6]

(*b*) A kite has a planform area of 0.025 m^2 and is flying in a wind of velocity 25 km/hr. The kite has a net weight of 1.2 N. When the string is inclined at an angle of 15° to the vertical, the tension in the string was found to be 3 N. Evaluate the coefficients of lift and drag. Take density of air equal to 1.15 kg/m^3. [10]