Total No. of Questions—12] [Total No. of Printed Pages—4+2

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S.E. (MECH) EXAMINATION, 2010

FLUID MECHANICS

(2003 COURSE)

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

N.B. :— (*i*) Answer any *three* questions from each Section.

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

(*iii*) Neat diagrams must be drawn wherever necessary.

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

(*v*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(*vi*) Assume suitable data if necessary.

SECTION I

1. (*a*) Plot the stress strain relation of the various fluids in one diagram and discuss the behaviour of each fluid under an external shear force. [6]

(*b*) A soap bubble, 62.5 mm diameter, has an internal pressure in excess of the outside pressure of 20 N/m^2. What is tension in soap film ? [4]

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

P.T.O.

Or

2. (*a*) The space between two square flat parallel plates is filled with oil. Each side of the plate is 720 mm. The thickness of the oil film is 15 mm. The upper plate, which moves at 3 m/s requires a force of 120 N to maintain the speed. Determine :

(*i*) The dynamic viscosity of the oil;

(*ii*) The kinematic viscosity of oil if the specific gravity of oil is 0.95. [6]

(*b*) If $\phi = 3xy$, find x and y components of velocity at (1, 3) and (3, 3). Determine the discharge passing between streamlines passing through these points. [6]

(*c*) Explain the concept of 'Stream tube' with sketch. [4]

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

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

(*c*) Define the following terms :

(*i*) Buoyancy

(*ii*) Centre of buoyancy

(*iii*) Principle of floatation

(*iv*) Archimedes's Principle. [4]

Or

4. (*a*) Explain with neat sketch the working of single column manometer. [4]

(*b*) A solid cylinder 2 m in diameter and 2 m high is floating in water with its axis vertical. If the specific gravity of the material of cylinder is 0.65, find its metacentric height. State also whether the equilibrium is stable or unstable. [6]

(*c*) Prove that with usual notations, $BM = \frac{I}{\forall}$. [6]

5. (*a*) State different types of heads of liquid in motion. [4]

(*b*) Derive Bernoulli's equation, using first principle. [6]

(*c*) A 300 mm × 150 mm venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0.9, flow being upward. The difference in elevation of the throat section and entrance section of the venturimeter is 300 mm. The differential U-tube mercury manometer shows a gauge deflection of 250 mm. Calculate :

(*i*) The discharge of oil, and

(*ii*) The pressure difference between the entrance section and the throat section.

Take C_d = 0.98 and specific gravity of mercury as 13.6. [8]

Or

6. (*a*) Compare Venturimeter and Orifice-meter. [8]

(*b*) What is Pitot tube ? Derive an expression for velocity. Draw with all labels Pitot Static tube. [8]

(*c*) State the assumptions of Bernoulli's equation. [4]

SECTION II

7. (*a*) Starting from the first principle, derive the expression for velocity at distance '*y*' from one fixed plate for laminar flow between two parallel fixed plates. Also find the discharge. [10]

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

Or

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

(*b*) Torque T of a propeller depends on density of liquid ρ, viscosity of liquid μ, speed of shaft N rpm, linear velocity V, diameter of the propeller shaft D.

Using Buckingham π-theorem, show that :

$$T = \rho N2\ D^5\ \Phi\ (ND/V,\ \rho ND^2/\mu).$$ [8]

9. (*a*) Derive an expression for the power transmission through the pipes. Find also the condition for maximum transmission of power. [6]

(*b*) Two reservoirs, having a difference in elevation of 15 m, are connected by a 200 mm diameter siphon. The length of the siphon is 400 mm and the summit is 3 m above the water level in the upper reservoir. The length of the pipe from upper reservoir to the summit is 120 m. If the coefficient of friction is 0.005, determine :

(*i*) Discharge through the siphon, and

(*ii*) Pressure at the summit.

Neglect minor losses. [8]

(*c*) Explain briefly the following :

(*i*) Hydraulic Grade Line (HGL)

(*ii*) Energy Grade Line (EGL). [2]

OR

10. (*a*) In a 80 mm diameter pipeline an oil of specific gravity 0.8 is flowing at the rate of 6.0125 m^3/s. A sudden expansion takes place into a second pipeline of such diameter that maximum pressure rise is obtained. Find :

(*i*) Loss of energy in sudden expansion;

(*ii*) Differential gauge length indicated by an oil-mercury manometer connected between the two pipes. [8]

(*b*) Derive Dupit's equation. [4]

(*c*) Explain major and minor losses occurred in pipe. [4]

11. (*a*) Distinguish clearly between hydrodynamically smooth and rough boundaries. [6]

(*b*) State the practical importance of the following boundary layer thickness :

(*i*) Displacement thickness

(*ii*) Momentum thickness.

(*iii*) Energy thickness. [6]

(*c*) Air blows over a cylinder of diameter 60 mm and finite length with a velocity of 0.12 m/s. Find the total drag, shear drag and pressure drag on 1 m length of the cylinder if the total drag and shear drag coefficients are 1.25 and 0.18 respectively. Take density of air = 1.25 kg/m^3. [6]

12. (*a*) Explain the significance of the boundary layer concept in fluid mechanics. [6]

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

(*c*) Define 'angle of attack' for an aerofoil. Explain its significance clearly. [6]