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

Seat No.	

[4757]-110

S.E. (Civil) (Second Semester) EXAMINATION, 2015

FLUID MECHANICS-I

(2008 Pattern)

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

N.B. :— (*i*) Answers to the two sections should be written in separate answer-books.

(*ii*) Answer any *three* questions from each section.

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

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

(*v*) Use of calculator is allowed.

(*vi*) Assume suitable data, if necessary.

Section I

1. (*a*) Using Buckingham's π-theorem, show that the velocity through a circular orifice is given by : [8]

$V = \sqrt{2}\ gH\ f[D/H,\ \mu/(\rho VH)]$

P.T.O.

Where

H = head causing flow

D = diameter of the orifice

μ = coefficient of dynamic viscosity

ρ = mass density &

g = acceleration due to gravity

(*b*) Define and explain the terms : [4]

(*i*) Kinematic and dynamic viscosity

(*ii*) Compressibility and elasticity.

(*c*) A model 1/20th of prototype of a spillway is to be tested. Find the following : [6]

(*i*) Prototype velocity when model velocity is 2 m/s

(*ii*) Prototype discharge per unit width when model discharge is 0.25 m^3/s

(*iii*) Pressure head in prototype when model pressure head is 5 cm of mercury.

Or

2. (*a*) Write short notes on the following : [6]

(*i*) Capillarity

(*ii*) Surface tension.

(*b*) Explain Froude's Model law and importance of model studies. [4]

(*c*) A body weighing 441.45 N with a flat surface area of 0.093 m^2 slides down lubricated inclined plane making an angle of 30° with the horizontal. For viscosity of 0.1 Ns/m^2 and body speed of 3 m/s, determine the lubricant film thickness. [8]

3. (*a*) Derive an expression for total pressure and the depth of centre of pressure from free surface of liquid, at inclined plane surface submerged in the liquid. [8]

(*b*) How thick is the layer of mud of S.G. 1.6, at the bottom of tank if the water 7.5 m deep above it, if there is a pressure of 490.5 kN/m^2 against the bottom of the tank ? [8]

Or

4. (*a*) An isosceles triangular plate of base 4 m and altitude 4 m immersed vertically in an oil of specific gravity 0.9. The base of plate coincides with the free surface of oil. Determine : [8]

(*i*) Total pressure on the plate

(*ii*) Centre of pressure.

(*b*) Define the terms : Stable, unstable and neutral equilibrium for submerged and floating bodies. [8]

5. (*a*) Show that the streamlines and equipotential lines intersect each other orthogonally. What are the uses and limitations of flow net ? [8]

(*b*) The velocity potential function for a two-dimensional flow is $f = x\ (3y - 1)$, at a point P(3, 5) determine : [8]

(*i*) the velocity and

(*ii*) the value of stream function.

Or

6. (*a*) Derive the continuity equation for one-dimensional flow, stating the assumption made in deriving the equation. [8]

(*b*) Given that :

$$U = -4ax\left(x^2 - 3y^2\right)$$

$$V = 4ay\ (3x^2 - y^2)$$

Examine whether these velocity components represent a physically possible two-dimensional flow. If so whether the flow is rotational or irrotational ? [8]

Section II

7. (*a*) In an experiment on determination of hydraulic coefficients of sharp edged orifice, 2.0 cm of diameter, it was found that the jet issuing horizontally under a head of 1 m travelled a horizontal distance of 1.2 m from vena contracta in a course of vertical drop of 0.5 m from the same point. Further if a flat plat held normal to the jet at vena contracta, the force of 5 N would be exerted on the plate. Determine C_c, C_v and C_d for the orifice. [10]

(*b*) Derive Euler's equation of motion for one-dimensional flow. Also derive Bernoulli's equation from it. [8]

Or

8. (*a*) A pipe line carrying gasoline (SG = 0.8) changes in its dia. from 20 cm to 50 cm in a height 5 m. The pressures at the 20 cm and 50 cm dia. are 100 kPa & 60 kPa respectively. The discharge through the pipe is 0.2 m^3/s. Find the loss of head during the flow and direction of flow. [10]

(*b*) State the Bernoulli's equation. List out the assumptions of Bernoulli's equation. [4]

(*c*) Explain the terms briefly : [4]

(1) Potential head

(2) Velocity head.

9. (*a*) For the velocity profile in laminar boundary layer as

$$\frac{u}{U} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$$

find the thickness of the boundary layer and the shear stress 1.2 m from the leading edge of a plate. The plate is 2 m long and 1.2 m wide and is placed in water which is moving with a velocity of 220 mm per second. Find the total drag force on the plate if μ of water is 0.011 poise. [8]

(*b*) An oil with density 850 kg/m^3 and dynamic viscosity 0.18 N-s/m^2 flows through a 12 cm diameter horizontal pipe. The pressure drop over a 2 m length of pipe is 20 kPa. Determine the average velocity, the flow rate and the wall shear stress. [8]

Or

10. (*a*) What is boundary layer ? Explain with neat sketch the development of boundary layer over a smooth flat plate. [8]

(*b*) A flow in a tube is laminar. Find the distance from the wall surface where the local velocity is equal to the average velocity of the fluid through the tube. [8]

11. (*a*) Derive Karman-Prandtl equation for velocity distribution in turbulent flow near hydrodynamically smooth boundary. [8]

(*b*) Write short notes on : [8]

(*i*) Prandtl's mixing length theory

(*ii*) Hydrodynamically smooth and rough pipes.

Or

12. (*a*) What are the equivalent pipes ? Explain in detail the major and minor losses in pipes. [8]

(*b*) A horizontal pipe 150 mm in diameter is joined by sudden enlargement to a 225 mm diameter pipe. Water is flowing through it at the rate of 0.05 m^3/s. Find : [8]

(*i*) Loss of head due to abrupt expansion

(*ii*) Pressure difference in the two pipes

(*iii*) Change in pressure if the change of section is gradual without any loss