No. of Printed Pages : **6** **BIME-004**

B.Tech. Mechanical Engineering / B.Tech Civil Engineering (BTMEVI/BTCLEVI)

Term-End Examination

June, 2012

01799

BIME-004 : FLUID MECHANICS

Time : 3 hours *Maximum Marks : 70*

Note: *Answer **any seven** questions. All questions carry **equal** marks. Use of calculator is permitted.*

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1. (a) If the velocity distribution over a solid surface is given by **2x5=10**
$u = 30y - 200y^2$,
What would be the shear stress at the flat surface and at an elevation of 50 mm from it. Take $\mu = 0.048 Pas$.

(b) Calculate the magnitude and direction of the resultant force on the semi-cylindrical gate AB. The width of the gate is 3 m.

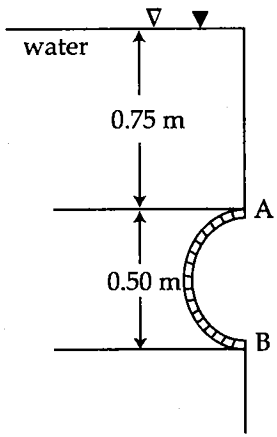

Figure - 1

2. (a) A cylindrical vessel open at top measures 0.2 m in diameter and 0.5m in height. It is filled with water to a height of 0.3 m, determine the speed of rotation in rad/s which will raise the water just to the rim.

(b) What percentage of an iceberg floats visibly above the sea level if the density of the iceberg is 900 kg/m^2 and density of sea water is 1020 Kg/m^3. **2x5=10**

3. (a) If for a two-dimensional potential flow, the velocity potential is given by the expression $\phi = x(2y-1)$, **2x5=10**

(i) determine the velocity at the point P(4,5).

(ii) What is the value of the stream function ψ at the point P ?

(b) The diameters of a small piston and a large piston of a hydraulic jack are 2 cm, and 10cm respectively. A force of 60 N is applied on the small piston. Find the load lifted by the large piston; when :

(i) The pistons are at the same level, and

(ii) Small piston is 20 cm above the large piston. The density of the liquid in the jack is given as 1000 Kg/m^3.

4. (a) A 30 cm diameter pipe conveying water, branches into two pipes of diameters 20 cm and 15 cm respectively. If the average velocity in the 30cm diameter pipe is 2.5 m/s, Find the discharge in this pipe. Also determine the velocity in 15 cm pipe if the average velocity in 20 cm diameter pipe is 2 m/s. **2x5=10**

(b) The velocity potential function ϕ is given by an expression :

$$\phi = -\frac{xy^3}{3} - x^2 + \frac{x^3 y}{3} + y^2$$

(i) Find the velocity components in x and y direction.

(ii) Show that ϕ represents a possible case of flow.

5. (a) The stream function for a two-dimensional flow is given by : $\psi = 2xy$,
Calculate the velocity at the point P(2,3).
Find the velocity potential function ϕ. **2x5=10**

(b) The velocity components in a two-dimensional flow are :

$$u = \frac{y^3}{3} + 2x - x^2 y, \text{ and } v = xy^2 - 2y - \frac{x^3}{3}$$

Show that these components represent a possible case of an irrotational flow.

6. (a) Distinguish between : **2x5=10**

(i) Steady flow and un-steady flow

(ii) Uniform and non-uniform flow

(iii) Compressible and incompressible flow

(iv) Rotational and irrotational flow

(v) Laminar and turbulent flow

(b) A pipe, through which water is flowing, is having diameters, 20 cm, and 10 cm at the cross-sections 1 and 2 respectively. The velocity of water at section 1 is given by 4.0 m/s. Find the velocity head at sections 1 and 2 and also compute the rate of discharge.

7. (a) Define the equation of continuity. Obtain an expression for continuity equation for a three-dimensional flow. **2x5=10**

(b) The head of water over the centre of an orifice of diameter 20 mm is 1 m. The actual discharge through the orifice is 0.85 litres/s. Find the co-efficient of discharge.

8. (a) Prove that the maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of the flow. **2x5=10**

(b) An oil having a viscosity of 0.0098 kg second per square metre and a specific gravity of 1.59 flows through a horizontal pipe of 5 centimetres diameter with a pressure drop of 0.06 kg per square centimetre per metre length of pipe.

Determine :

(i) The rate of flow in Kilogram per minute.

(ii) The shear stress at the pipe wall.

(iii) The total drag for 100 metre length of pipe.

9. (a) An oil having a viscosity of 0.048 kg/m-s flows through a 50 mm diameter pipe at an average velocity of 0.12 m/s. Calculate the pressure drop in 65 m of pipe and the velocity at 10 mm from the pipe wall. **2x5=10**

(b) The resistance R, to the motion of a completely sub-merged body depends upon the length of the body L, velocity of flow V, mass density of fluid P and kinematic viscosity of fluid v. By dimensional analysis prove that :

$$R = \rho V^2 L^2 \phi\left(\frac{VL}{v}\right)$$

10. (a) With the help of neat sketches, explain the development of a boundary layer along a thin flat smooth plate held parallel to a uniform flow and explain the salient features. **2x5=10**

(b) The laminar boundary layer profile in a case is approximated by a cubic parabola :

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

Where u = velocity at a distance y from the surface and $y \rightarrow s$, $u \rightarrow U$. Calculate the displacement thickness and momentum thickness in terms of δ and work out the shear stress at the surface.
