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BIME-004

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

Term-End Examination 01621

December, 2012

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.*

1. (a) The velocity distribution over a plate is given by **2x5=10**

$$u = \frac{2}{3}y - y^2$$

in which u is the velocity in m/sec at a distance of y metre above the plate. Determine the shear stress at $y = 0$, 0.1 and 0.2 m.

Take $\mu = 6$ poise.

(b) Determine the bulk modulus of elasticity of a fluid which is compressed in a cylinder from a volume of 0.009 m^3 at 70 N/cm^2 pressure to a volume of 0.0085 m^3 at 270 N/cm^2 pressure.

2. (a) For the situation as shown in Figure 1, compute the force F. **2x5=10**

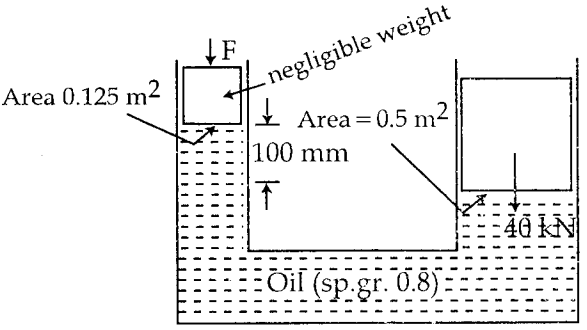

Figure - 1

(b) A 3 m diameter gate AB closes the size opening of a water tank as shown in figure 2. Determine the magnitude and location of force F to hold the gate without causing a reaction at the hinge at A.

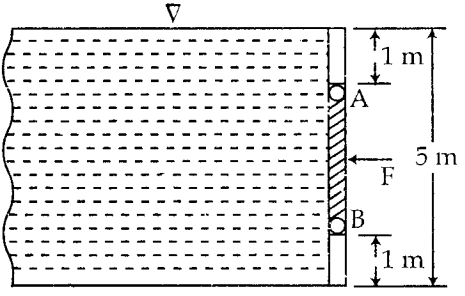

Figure - 2

3. (a) State if the flow represented by **2x5=10**
$u = 3x + 4y$, and
$v = 2x - 3y$
is rotational or irrotational. Find the potential function if the flow is irrotational and verticity if it is rotational.

(b) Water flows through a pipe AB 1.2 m diameter at 3 m/s and then passes through a pipe BC.

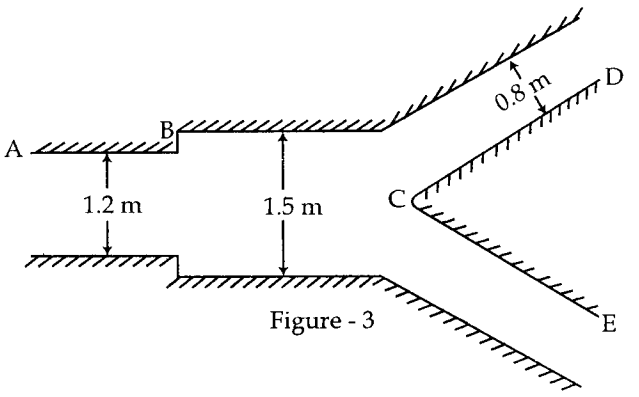

Figure - 3

1.5 m diameter. At C, the pipe branches. Branch CD is 0.8 m in diameter and carries one third of the flow in AB. The flow velocity in branch CE is 2.5 m/s. Find the volume rate of flow in AB, the velocity, in BC, the velocity in CD, and the diameter of CE.

4. (a) Differentiate between **2x5=10**

(i) Stream Function and velocity potential function

(ii) Stream line and streak line

(iii) Rotational and irrotational flows.

(b) If for a two - dimensional potential flow, the velocity potential is given by

$\Phi = x^2 - y^2$

determine the velocity at the point P(2, 3). Also compute the stream.

function Ψ.

5. (a) The velocity components in a two - dimensional flow field for an incompressible fluid are as follows : **2x5=10**

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

$$v = xy^2 - 2y - \frac{x^3}{3}.$$

Obtain an expression for the stream function Ψ.

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

$$u = 8x^2y - \frac{8}{3}y^3, \text{ and}$$

$$v = -8xy^3 + \frac{8}{3}x^3.$$

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

6. (a) Define the following and give one practical example for each : **2x5=10**

(i) Laminar flow

(ii) Turbulent flow,

(iii) Steady flow

(iv) Uniform flow

(v) Water hammer

(b) What do you mean by boundary layer separation ? What is the effect of pressure gradient on boundary layer separation.

7. (a) State Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli's equation from first principle and state the assumptions made for such a derivation. **2x5=10**

(b) An oil of sp.gr. 0.8 is flowing through a venturimeter having inlet diameter 20 cm and throat diameter 10 cm. The oil mercury differential manometer shows a reading of 25 cm. Calculate the discharge of oil through the horizontal venturimeter. Take $C_d = 0.98$.

8. (a) Prove that the velocity distribution for viscous flow between two parallel plates when both plates are fixed across a section is parabolic in nature. **2x5=10**

(b) Glycerine of density 1250 kg/m^3 and viscosity 0.72 kg/ms flows through a pipe of 80 mm diameter. If the shear stress at the wall is 300 N/m^2, calculate the :

(i) the pressure gradient along the flow,

(ii) the average velocity in the pipe,

(iii) the rate of discharge, and

(iv) the Reynolds number of the flow.

9. The variables controlling the motion of a flowing vessel through water are the drag force F, the speed V, the length L, the density P and dynamic viscosity μ of water and acceleration due to gravity g. Derive an expression for F by dimensional analysis. **10**

10. (a) What is a boundary layer ? Explain the significance of the terms : **2x5=10**

(i) Laminar boundary layer,

(ii) turbulent boundary layer, and

(iii) laminar sub - layer.

(b) If the velocity profile in a laminar boundary layer is approximated by parabolic profile :

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

Where u is the velocity at y and $u \rightarrow U$ as $y \rightarrow \delta$.

Calculate the displacement thickness and the momentum thickness.
