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BMS College of Engineering, Bangalore-560019

(Autonomous Institute, Affiliated to VTU, Belgaum)

July / August 2017 Supplementary Semester Examinations

Course: Mechanics Of Fluids **Duration: 3 hrs**
Course Code: 10CV3DCMOF **Max Marks: 100**
Date: 31.07.2017

Instructions:
1. Question No. 1 is compulsory.
2. Answer any FOUR full questions from question No. 2 to question No. 6.
3. Assume missing data suitably.

1. a. An open tank contains water up to a depth of 2 m and above it an oil of specific gravity 0.90 for a depth of 1.0 m. Estimate the pressure intensity i) at the interface of two liquids and ii) at the bottom of the tank. **4**

   b. Determine the total pressure and the centre of pressure on a circular plate of 1.5m diameter, which is placed vertically in water in such a way that the centre of the plate is 3 m below the free water surface. **4**

   c. For a 3-D flow field described by $\mathbf{V} = (y^2 + z^2)\,\mathbf{i} + (x^2 + z^2)\,\mathbf{j} + (x^2 + y^2)\,\mathbf{k}$. At a point P (1, 2, 3) determine the components of rotation. **4**

   d. A jet of water issues from a sharp edged orifice under a constant head of 0.51m. At a certain point of issuing jet, the horizontal and vertical coordinates measured from the vena-contracta are 0.406 m and 0.085 m respectively. **4**
      i) Determine the coefficient of velocity of the orifice.
      ii) If the coefficient of discharge of the orifice is 0.62, determine the coefficient of contraction.

   e. Explain any four minor head losses in pipe lines with equations. **4**

2. a. A differential U-tube manometer is connected between two points A and B as shown in the fig.2a. Compute the pressure difference between A and B. Specific gravity of oil in the manometer is 0.8 and specific gravity of the liquid in the pipe is 1.5. **6**

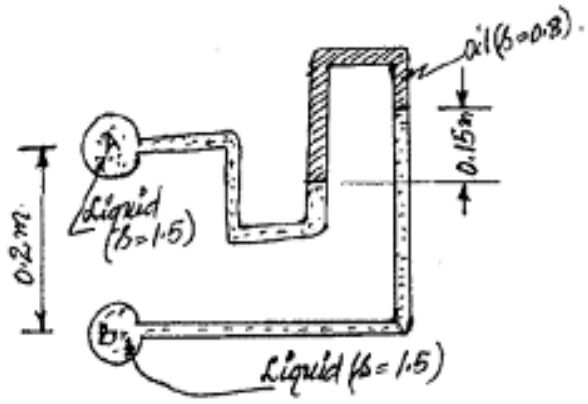

Fig. 2a

b. Explain the phenomenon of capillarity and derive an expression for capillary rise of a liquid in a tube of small diameter *d* inserted in a liquid. **6**

c. A 90 N rectangular solid block slides down a 30^o inclined plane. The plane is lubricated by a 3 mm thick film of oil of relative density 0.90, and viscosity 8.0 poise. If the contact area between the block and oil is 0.3 m^2, estimate the terminal velocity of the block. **8**

3. a. Derive an expression for total pressure and centre of pressure on an inclined plane submerged in a static mass of liquid. **6**

b. A rectangular plane surface 2 m wide and 3 m deep, lies in water in such a way that the plane makes an angle of 30^0 with the free water surface. Determine the total pressure and position of centre of pressure when the upper edge is 1.5 m below the free water surface. **6**

c. The lower corner of a water tank has the shape of a quadrant circle MN of radius 1.2 m as shown in fig.3c. The water surface is 2.4 m above the centre of curvature. The water tank is 3.0 m long. Estimate the magnitude, direction and location of the total pressure exerted by water on this curved surface. **8**

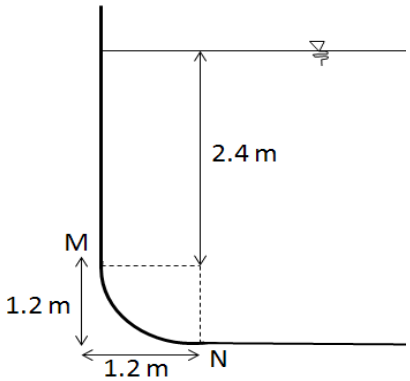

Fig.3c

4. a. Explain stream line, path line and streak line. **6**

b. Two velocity components are given in the following cases, derive the third component such that they satisfy the continuity equation. **6**

i) $u = x^3 + y^2 + 2z^2$; $v = - x^2y – yz – xy$

ii) $u = - 4x^2 + 3xy$; $w = z^3 – 4xy – 2yz$

c. The stream function for a two dimensional flow is given by $\Psi = 2xy$. Calculate the velocity at the point P (2, 3). Also, derive the corresponding velocity potential function Φ. **8**

5. a. State Bernoulli's theorem and derive the Bernoulli's equation, mentioning clearly the assumptions underlying it. **6**

b. Compute the depth and top width of a V-notch discharging 0.7 m^3/s. The head over the notch is 10 cm when the discharge is 0.009 m^3/s. Take coefficient of discharge $C_d = 0.6$. **6**

c. A venturi meter having a diameter of 7.5 cm at the throat and 15 cm diameter at the enlarged end is installed in a horizontal pipeline 15 cm in diameter carrying an oil of specific gravity 0.9. The difference of pressure head between the enlarged end and the throat recorded by a differential U-tube manometer is 17.5 cm of mercury. Determine the discharge through the pipe. Assume the coefficient of discharge of the venturi meter as 0.9. **8**

6. a. A valve is suddenly closed at the downstream end of a 0.90 m diameter pipeline carrying water in such a manner that the velocity is decreased from 4 m/s to 1.0 m/s instantaneously. Estimate the maximum pressure rise in the pipe due to the sudden closure of the valve. Assume the pipe to be rigid and Bulk modulus for water as 2.20×10^3 MPa. **6**

b. A compound pipe system consists of 1800 m length of 0.5 m diameter, 1200 m length of 0.40 m diameter and 600 m length of 0.30 m diameter cast iron pipes connected in series. The entire pipe network is to be replaced with new ones so that the head loss remains the same. **6**

i) Estimate the equivalent length of a 0.40 m diameter pipe.

ii) Estimate the equivalent diameter of a pipe of 3600 m long.

c. Using Buckingham π– theorem, formulate the expression for the velocity (V) through a circular orifice as, **8**

$$V = \sqrt{2gH}\ \phi\left[\left(\frac{D}{H}\right), \left(\frac{\mu}{\rho VH}\right)\right]$$

Where, H = Head causing the flow

D = Diameter of the orifice

μ = Coefficient dynamic viscosity

ρ = Mass density

g = Acceleration due to gravity

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