11-05-2023

Paper / Subject Code: 41222 / Fluid Mechanics

S.E. Sem IV (C Scheme, R-2019) Mechanical May2023

Duration: 3hrs **[Max Marks: 80]**

N.B. : (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.

1 **Attempt any FOUR** **[20]**

a A 120 mm disc rotates on a table separated by an oil film of 1.8 mm thickness. Find the viscosity of oil if the torque required to rotate the disc at 60 r.p.m is 3.6×10^{-4} Nm. Assume the velocity gradient in the oil film to be linear. **[5]**

b Explain Lagrangian and Eulerian method of representing fluid flow. **[5]**

c A 3 m long wooden stick of cross section area 0.01 m^2 is made to float vertically in water with 0.6 m length above the water surface by attaching a lead piece at the lower end of the stick. Find out the weight of the lead piece to be attached if the specific weight of wood is 6 kN/m^3 and that of lead is 120 kN/m^3 **[5]**

d Explain Hydraulic gradient line and Energy gradient line in detail. **[5]**

e Define drag and lift and explain types of drag. **[5]**

2 a Does the velocity potential exist for two dimensional, incompressible flow prescribed by $u = x - 4y$ and $v = -(y + 4x)$? If so, determine its form as well as that of stream function. **[10]**

b A cylindrical gate of 4 m diameter 2 m long has water on its both sides. Determine the magnitude and direction of the resultant force exerted by the water on the gate. **[10]**

3 a The pressure difference Δp in a pipe of diameter D and length l due to viscous flow depends on the velocity V, viscosity μ and density ρ. Using Buckingham's π-theorem, obtain the expression for Δp. **[10]**

b The diameter of a pipe bend 30 cm at inlet and 15 cm at outlet and flow is turned through 120° (angle measured in clockwise direction between direction of fluid flow at inlet and outlet) in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.5 m below the centre of inlet section. Total volume of water in the bend is 0.9 m^3. Neglecting friction, calculate the magnitude and direction of force exerted on the bend by water flowing through it at 250 lit/s and when inlet pressure is 0.15 N/mm^2. **[10]**

4 a An oil of viscosity 1 poise and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300 m. The rate of fluid through the pipe is 3.5 litres/s. Find [10]
(i) Is the flow laminar?
(ii) the pressure drop in a length of 300 m
(iii) shear stress at the pipe wall

b Derive Reynold's transport theorem [10]

5 a Derive the expression for velocity distribution, discharge per unit width and shear stress distribution when flow of viscous fluid between two parallel plates in which one plate moving and other at rest. [10]

b A venturimeter is to be fitted in a pipe 0.25 m diameter where the pressure head is 7.6 m of flowing liquid and the maximum flow is 8.1 m^3 per minute. Find the least diameter of the throat to ensure that the pressure head does not become negative. Take $C_d = 0.96$ [10]

6 a Three pipes with details as following are connected in parallel between two points.
Pipe 1 : length = 1000 m diameter = 20 cm coefficient of friction $f = 0.02$
Pipe 2 : length = 1200 m diameter = 30 cm coefficient of friction $f = 0.015$
Pipe 3 : length = 800 m diameter = 15 cm coefficient of friction $f = 0.02$
When the total discharge of 0.30 m^3/sec flows through the system, calculate distribution of discharge and head loss between the junctions. [10]

b The velocity distribution in the boundary layer is given by

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

Calculate the following
(i) Displacement thickness (ii) Momentum thickness (iii) Energy thickness
(iv) Check whether the boundary layer separation occurs or not

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