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BT-4 / M–15

FLUID MECHANICS

(2006 onwards)

(Common with Auto & Aeronautics)

Paper–ME–208–E

Time allowed : Three hours]          [Maximum marks : 100

Note :  Attempt any five questions, selecting at least one question from each part, Assume missing data, if any.

## Part–A

1.  (a)  State and prove Pascal's law.          10

    (b)  A trapezoidal channel 2.4 m wide at the bottom and 1.2 m deep has side slopes 1:1. Find total pressure and center of pressure on the vertical gate closing the channel when it is full of water.          10

2.  (a)  Derive the equation of continuity for 3 D flow in polar coordinates.          10

    (b)  A 3 D flow is given by : $V=(y^2+z^2)i+(x^2+z^2)j+(x^2+y^2)k$. Find the components of acceleration at a point $(2,3,4)$.          10

## Part–B

3.  (a)  A 30 cm diameter pipe carries water under a head of 20 m with a velocity of 3.5 m/s. If the axis of the pipe turns through 45°, find the magnitude and direction of the resultant force on the bend.          10

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    (b)  Find the kinetic energy correction factor for the laminar flow through a pipe given by :

$$u=\frac{1}{4\mu}\frac{\partial p}{\partial x}\left(R^2-r^2\right),$$ where R is the radius of the pipe and u is the velocity at radius r.          10

4.  (a)  For a doublet of strength 20 m²/s, calculate the velocity at point P (1, 2) and the value of stream function passing through it.          10

    (b)  Explain the flow past a cylinder without circulation.          10

## Part–C

5.  (a)  Show that for a steady laminar flow through two fixed parallel plates

         (i)   velocity distribution is parabolic

         (ii)  average velocity is two-third of maximum velocity.  10

    (b)  What is a viscometer ? Describe with sketch the rotating cylinder viscometer.          10

6.  A pipeline ABC is 300 m long and is laid on an upward slope 1 in 50. The portion AB is 150 m long and 120 mm in diameter. At B the diameter suddenly enlarges to 240 mm and remains so far for rest of the length BC of the pipe. At the lower end, 300 litres of water per second is pumped into the pipe under a pressure of 300 kN/m², which is discharged at the upper end into a closed tank. Assuming a coefficient of friction of 0.008, determine the pressure at point C. Also draw the energy gradient and hydraulic gradient lines.          20

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## Part–D

7. (a) What is boundary layer separation ? Discuss the various methods to prevent the separation of a boundary layer.     10

 (b) Derive Von Karman momentum equation. How it is useful in calculating drag on a flat plate ?     10

8. (a) Discuss the variation of drag on a cylinder over a wide range of Reynolds number.     10

 (b) Deduce expressions for velocity distribution in a smooth as well as a rough pipe in terms of average velocity.     10

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