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Total Pages : 3 Roll No. ....

MAMT-07

Viscous Fluid Dynamics

MA/M.Sc. Mathematics (MAMT/MSCMT)

2nd Year Examination, 2022 (June)

Time : 2 Hours] **Max. Marks : 80**

Note : This paper is of Eighty (80) marks divided into two (02) Sections A and B. Attempt the questions contained in these sections according to the detailed instructions given therein.

SECTION–A

(Long Answer Type Questions)

Note : Section 'A' contains Five (05) long answer type questions of Twenty (20) marks each. Learners are required to answer any Two (02) questions only.

(2×20=40)

1. Obtain Navier-Stokes equation of motion.

2. State and prove Buckingham π - theorem.

3. Discuss the Temperature distribution in pipe

   (a) When the wall of the pipe is kept at a constant temperature.

   (b) When the wall of the pipe is kept at a uniform temperature gradient.

4. Discuss the plane Poiseuille flow between two parallel plates.

5. Discuss stagnation point flow of an incompressible, viscous fluid (Hiemanz flow).

SECTION–B

(Short Answer Type Questions)

Note : Section 'B' contains Eight (08) short answer type questions of Ten (10) marks each. Learners are required to answer any Four (04) questions only. (4×10=40)

1. Velocity field at point is given by $1 + 2y - 3z$, $4 - 2x + 5z$, $6 + 3x - 5y$. Show that it represents a rigid body motion.

2. Define Stoke's law of friction.

3. Obtain equation of continuity in Cartesian coordinates system.

4. A 1:20 model of an air-duct is to be tested in water which is 45 times more viscous and 850 times denser than air. What should be the pressure drop in the prototype if the pressure drop is 3 kg/cm^2 in the model when tested under hydrodynamically similar conditions?

5. Discuss the plane Poiseuille flow between two parallel plates.

6. The stress tensor at a point P is

$$\sigma_{ij} = \begin{bmatrix} 7 & 0 & -2 \\ 0 & 5 & 0 \\ 2 & 0 & 4 \end{bmatrix}$$

Determines the stress vector on the plane at P whose unit normal is $\hat{n} = \frac{2}{3}\hat{i} - \frac{2}{3}\hat{j} + \frac{1}{3}\hat{k}$.

7. Prove that the vorticity $\vec{\Omega}$ satisfies the differential equation

$$\frac{D\vec{\Omega}}{Dt}\left(\vec{\Omega}.\nabla\right)\vec{q} + \upsilon\,\nabla^2\left(\vec{\Omega}\right).$$

8. Discuss the temperature distribution between two concentric rotating cylinders.
