M.Sc. DEGREE EXAMINATION, April 2021
BRANCH I – MATHEMATICS
FOURTH SEMESTER

COURSE : CORE
PAPER   : CONTINUUM AND FLUID MECHANICS
TIME   : 90 minutes   MAXIMUM MARKS : 50

Section – A
Answer ALL questions $(2 \times 2 = 4)$

1. Evaluate $\epsilon_{ijk}\epsilon_{kij}$.

2. The velocity components in a three-dimensional flow field for an incompressible fluid are $(2x, -y, -z)$.

   Determine the equations of the stream line passing through the point $(1,1,1)$.

Section – B
Answer ANY TWO questions $(2 \times 6 = 12)$

3. Given that $a_{ij} = \alpha\delta_{ij}b_{kk} + \beta b_{ij}$ where $\beta \neq 0, 3\alpha + \beta \neq 0$, find b_{ij} in terms of a_{ij}.

4. Prove that the pressure at any point of a moving inviscid fluid is the same in all directions.

5. Discuss the steady viscous flow in a tube having uniform elliptic cross-section.

Section – C
Answer ANY TWO questions $(2 \times 17 = 34)$

6. (a) Let $\bar{a}$ and $\bar{b}$ be vectors with components a_i and b_i and $\bar{A}$ be a tensor with components a_{ij}. Show that

   $a_i b_i$ and a_{ii} are scalar invariants.

   (b) The state of stress throughout a continuum is given with respect to the Cartesian axes $0x_1x_2x_3$ by

   the array $\Sigma = \begin{pmatrix} 3x_1x_3 & 5x_2^2 & 0 \\ 5x_2^2 & 0 & 2x_3 \\ 0 & 2x_3 & 0 \end{pmatrix}$. Determine the stress vector acting at the point $P(2,1,\sqrt{3})$ of

   the plane that is tangent to the cylindrical surface $x_2^2 + x_3^2 = 4$ at P.

   (8+9)

7. (a) Derive the equation of continuity of the fluid flow.

   (b) Explain the working of Pitot tubes in measuring the velocity of fluid velocity.

   (9+8)

8. (a) Discuss the uniform flow past a fixed infinite circular cylinder.

   (b) Derive the Navier-Stokes equations of motion of a viscous fluid.

   (7+10)

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