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ASP-641

M.A./M.Sc. (Final) Examination, 2021 MATHEMATICS

Paper - VII

(Continuum Mechanics)

Time: $1\frac{1}{2}$ Hours] [Maximum Marks: 100 Section—A (Marks: $2 \times 10 = 20$)

Note: Answer all ten questions. (Answer limit 50 words). Each question carries2 marks.

Section–B (Marks : $4 \times 5 = 20$)

Note: Answer all *five* questions. Each question has internal choice (Answer limit **200** words). Each question carries **4** marks.

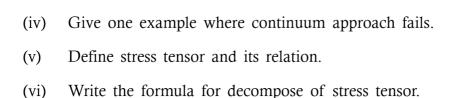
Section–C (Marks: $20 \times 3 = 60$)

Note: Answer any *three* questions out of five (Answer limit **500** words). Each question carries **20** marks.

Section–A 2 each

- 1. (i) Define Kronecker delta.
 - (ii) Write the orthogonal component of A_i in the n_i direction.
 - (iii) Define $\operatorname{curl} \overrightarrow{A}$ in index notation.

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- (vii) Define Hookean elastic solid.
- (viii) Define Youngs modulus of elasticity.
- (ix) Write the heat term of first law of thermodynamics.
- (x) Write the dissipation function for second law of Thermodynamics.

Section–B 4 each

2. Prove:

$$\overrightarrow{\nabla} \times \overrightarrow{\mathbf{A}} = \in_{ijk} \mathbf{A}_{k,j}$$

Or

Prove:

$$\in_{ijk}\in_{kmn}=\delta_{im}\,\delta_{jn}-\delta_{in}\delta_{jn}$$

3. The vector F_i is given by the relationship:

$$F_i = -\phi$$
, i

where

$$\phi = y_1^2 - y_2^2 + y_3^2$$

then show that $f_{i,i} = 0$.

Or

If Q be a point on the stress quadric and if PQ = R, then normal stress at P acting across the surface normal to PQ, is inversely proportional to r^2 . Prove it.

4. Explain the equation of motion in Eulerian description.

Or

Explain the isotropic material and homogeneous material in reference to elasticity.

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5.	Prove	for	incompressible	fluid	$\mu = \frac{E}{A}$
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Or

Explain the momentum integral theorem for forces.

6. Explain the energy equation for the Thermodynamics.

Or

Explain the principal of superposition for elastic problems.

Section-C

20 each

- 7. (a) State and prove first extension of Stokes' theorem.
 - (b) Show that the determinant:

$$\left|a_{ij}\right| = \in_{ijk} a_{1i} a_{2j} a_{3k}$$

where \in_{ijk} is the permutation symbol.

8. (a) Prove that:

$$\sigma_i = \sigma_{ji} n_j$$

(b) Find the principal stress for :

$$\sigma_{ij} = \begin{bmatrix} 0 & 0 & -cy_2 \\ 0 & 0 & cy_1 \\ -cy_2 & cy_1 & 0 \end{bmatrix}$$

where c is a constant.

- 9. (a) State and prove Reynold transport theorem.
 - (b) Derive the first law of Thermodynamics.

- 10. (a) Prove that the absence of body moments, stress tensors are symmetric.
 - (b) If $A_i(y_1, y_2, y_3)$ is everywhere normal to a closed surface S bounding a region R, then show that :

$$\int\limits_{\mathsf{R}} \in_{ijk} \mathsf{A}_{k,j} \, d\nu = 0$$

- 11. (a) Prove that elastic constants are tensor of fourth order.
 - (b) Find the generalized Hook's law in terms of E and v for isotropic homogeneous linear elastic solid.