PAPER ID-411369

Roll No: | | | | | | | | | | | | | |

**MTECH**
**(SEM II) THEORY EXAMINATION 2023-24**
**ADVANCED MECHANICS OF SOLIDS**

**TIME: 3 HRS** **M.MARKS: 70**

**Note: 1.** Attempt all Sections. If require any missing data; then choose suitably.

## SECTION A

**1. Attempt *all* questions in brief. 2 x 7 = 14**

| | |
|---|---|
| a. | Define a Cartesian tensor and provide its classification based on order. |
| b. | Differentiate between a scalar and a vector quantity. Give an example of each in the context of mechanics. |
| c. | Briefly differentiate between point forces, surface forces, and body forces acting on a deformable body. |
| d. | What is the physical interpretation of the Cauchy stress tensor? |
| e. | Briefly differentiate between material and spatial coordinates in the context of deformation. |
| f. | Briefly explain the first law of thermodynamics in the context of constitutive modeling. |
| g. | Briefly explain the role of field equations and boundary conditions. |

## SECTION B

**2. Attempt any *three* of the following: 7 x 3 = 21**

| | |
|---|---|
| a. | Explain the concept of vector addition and scalar multiplication with relevant properties. Use mathematical notation and illustrate your explanation with diagrams. |
| b. | Prove Cauchy's relation, which connects the traction vector and the Cauchy stress tensor. |
| c. | Explain the role of thermodynamic principles in constitutive modeling, discussing the significance of both the first and second laws of thermodynamics. |
| d. | Explain the concept of hyperelastic material models, highlighting their key characteristics and advantages compared to linear elastic models. |
| e. | Define a functional in the context of solid mechanics. How does the concept of extremum (minimum or maximum) apply to functionals? |

## SECTION C

**3. Attempt any *one* part of the following: 7 x 1 = 7**

| | |
|---|---|
| a. | Derive the Kronecker delta function and explain its significance in index notation. Provide examples of its usage in representing tensor operations. |
| b. | Explain the concept of a contravariant vector and a covariant vector. How do their transformation rules differ under a coordinate transformation? |

**4. Attempt any *one* part of the following: 7 x 1 = 7**

| | |
|---|---|
| a. | Explain the principles of conservation of linear momentum and angular momentum in the context of a deforming body. |
| b. | Derive the stress equilibrium equations in a three-dimensional continuum. |

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**5. Attempt any *one* part of the following: 7 x 1 = 7**

| | |
|---|---|
| a. | Explain the concept of the Cauchy's small strain tensor and elaborate on its relationship to the rotation tensor. Include relevant equations in your explanation. |
| b. | Derive an expression for the Green-Lagrange strain tensor and explain the geometrical interpretation of its individual components. Discuss the sign convention used. |

**6. Attempt any *one* part of the following: 7 x 1 = 7**

| | |
|---|---|
| a. | Describe flow rules used in elasto-plastic constitutive relations, explaining how they govern the evolution of plastic strain during material deformation. |
| b. | Compare and contrast isotropic and anisotropic material models, providing examples of materials that fall into each category. |

**7. Attempt any *one* part of the following: 7 x 1 = 7**

| | |
|---|---|
| a. | Derive the Euler-Lagrange equation and explain its significance in finding the extremum of a functional. Provide a simple physical interpretation of the Euler-Lagrange equation. |
| b. | State the principle of virtual work and its relationship to the equilibrium equations in solid mechanics. Give an example of how the principle of virtual work can be used to analyze simple structures. |