

(4)

4. With the help of suitable sketches, explain the geological conditions of development of contractional-, extensional- and strike-slip duplex structure separately. 4
5. Write six (6) major field evidences, which help us to identify ductile shear zone in a deformed terrain. 4
6. (a) With the help of neat sketches represent graphically the normal and shear stress component on an inclined plane with respect to the principal stress axes in two dimensions.
(b) Write Coulomb- and Griffith- failure criteria and draw the failure envelopes of each criterion. 2+2
7. (a) Write tensile failure criteria.
(b) Which conditions are needed to form tensile fracture in nature?
(c) What is plastic yielding? 1+2+1

★ ★ ★

EX/SC/GEOL/PG/CORE/TH/03/2025

MASTER OF SCIENCE EXAMINATION, 2025

(1st Year, 1st Semester)

APPLIED GEOLOGY

PAPER : CORE/TH/03

(Structural Geology)

Time : 2 Hours

Full Marks : 40

(Use separate Answer Scripts for each Part)

PART—I (20 Marks)

Answer any **four** questions :

5×4=20

1. (a) Using examples show the principal differences between a scalar and a tensor quantity.
(b) Explain diagrammatically the meaning of tensor dimensions.
(c) A mathematical equation is expressed in a tensor form as

$$\frac{\partial^2 \epsilon_{ij}}{\partial x_m \partial x_n} + \frac{\partial^2 \epsilon_{mn}}{\partial x_i \partial x_j} - \frac{\partial^2 \epsilon_{im}}{\partial x_j \partial x_n} - \frac{\partial^2 \epsilon_{jm}}{\partial x_i \partial x_n} = 0$$

Is the tensor expression in the above equation correct?

Justify your answer.

2+2+1=5 (CO1)

(2)

2. (a) Find the differences in the effects of body forces and surface forces acting in a body.
- (b) The total stress (σ_{ij}) at a point is split as $\sigma_{ij} = \sigma'_{ij} + \sigma_o \delta_{ij}$. What do the two terms on the right hand side of the equation mean and what are their implications in the deformation mechanics? 2+3=5
3. Using the divergence theorem show that the stress tensor (σ_{ij}) in a body under the equilibrium condition holds the following equation :
- $$\frac{\partial \sigma_{ji}}{\partial x_j} + \rho X_i = 0$$
- where ρ is the material density and X_i represents body force per unit mass. 5 (CO1)

4. An isotropic elastic body obeys Hooke's law, expressed by :

$$\sigma_{ij} = \lambda \varepsilon_{kk} \delta_{ij} + 2\mu \varepsilon_{ij}$$

where σ_{ij} and ε_{ij} are the stress and strain tensors, respectively. λ and μ are the Lame's parameters.

- (a) Explain the physical implications of the two terms on the right-hand side of the equation, giving the significance of the parameters λ and μ in elastic deformations.
- (b) Prove that $K = \lambda + \frac{2}{3}\mu$, where K denotes the bulk modulus of the elastic material. 3+2=5 (CO2)
5. (a) Consider the displacement field in a medium, $u_i(x, t)$ and derive the expression of the strain-rate tensor in terms of the velocity vector (v_i) as

$$\dot{\varepsilon}_{ij} = \frac{1}{2} \left(\frac{\partial v_i}{\partial x_j} + \frac{\partial v_j}{\partial x_i} \right)$$

(3)

- (b) Using a diagrammatic presentation, explain the principle of the Fry method for estimating finite strain in deformed rocks.
- (c) Draw a graphical plot to represent the rheology of a Bingham fluid. 2+2+1=5 (CO2)
6. (a) Develop a mechanical model to represent the firmo-viscous rheology of materials.
- (b) Layered rocks in a multiply deformed terrain show a set of small fold waves running over a large antiformal structure. How would you interpret this observation? 3+2=5 (CO4)

PART—II (20 Marks)

Answer *any five* questions :

4×5=20

1. (a) What is Pseudotachylite?
- (b) How do you differentiate them from the fault rock in field? 1+3
2. How do you separate Proto-, Ortho- and Ultra- mylonite in the field? Briefly describe with specific features for three cases. 4
3. (a) Briefly describe three possible states of wedge deformation and their important features in contractional regime based on critical taper angle of thrust wedge.
- (b) In which geological situations the large-scale pull-apart basins are developed in nature? 3+1