BACHELOR OF SCIENCE EXAMINATION, 2019

(1st Year, 2nd Semester)

GEOLOGICAL SCIENCES

Structural Geology

Paper : CORE : 4

Time : Two hours Full Marks : 50

Use separate Answer Script for each part.

PART - I (25 marks)

Answer any ***five*** questions.

1. (a) State the fundamental concept in continuum mechanics.

   (b) Using examples express the displacement and temperature gradients at a point in a continuum.

   (c) Is the eleasticity of an anisotropic crystal a scalar quantity ? Justify the answer. 2+2+1

2. (a) With illustrations explain the difference between a pathline and a streamline in fluid flow.

   (b) Describe the principal types of rigid body motion with appropriate geological examples. 2+3

3. (a) Would you consider deformation of a body as a scalar quantity ? Explain the answer.

(b) Show that a straight line will remain a straight line after homogeneous deformation in a continuum space.

(c) In a Cartesian space a deformable body is subjected to a displacement field. What is the condition required for rotational deformation in the body ? 2+2+1

4. (a) A soft object is dropped in vacuum under the Earth's gravity field. Can the object undergo distortion ? Explain with a dynamic analysis.

(b) Express the stress on a plane.

(c) Prove that the stress at a point is not a vector quantity. 2+1+2

5. (a) Two rectangular objects in 2D space are subjected to normal and stresses. Show the differences in their deformed shapes.

(b) A stress matrix is written as : $\begin{bmatrix} \sigma_{xx} & \sigma_{xy} \\ \sigma_{xy} & \sigma_{yy} \end{bmatrix}$. Derive equations to show the normal and the shear stresses on a plane at an angle of θ to x-axis.

(c) Find the orientations of the principal axes of stress, and the plane of maximum shear stress. 1+2+2

(b) What is the mean stress ?

(c) Comment on this state of stress. Is it reasonable ? Explain your answer. 2+1+2

12. Write short note on (any ***two***) : (a) Fault gauge; (b) Splay fracture; (c) Transcurrent fault; (d) Transform fault. 2.5+2.5

13. What is meant by the term Griffith cracks, and how do they affect the rock strength ? 5

14. Define the following terms with proper figures (any ***two***) : (a) Net-slip (b) Net-Separation (c) Nappe complex (d) Domino fault. 2.5+2.5

15. What is the difference between displacement vector and displacement field (describe with suitable figures) ? 5

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6. (a) A two-dimensional body is subjected to the following linear transformations : $x = ax + by$ and $y = cx + dy$. Derive the equation to prove that the body will not experience any rigid rotation when $b = c$.

   (b) Using the same transformation equations, determine the orientation of the principal axes of strain ellipse. 3+2

7. (a) With the help of a sketch explain the principal curvatures of a fold surface.

   (b) How would you define a cylindrical curvatures ?

   (c) Does a crest point always coincide with the hinge point ? Justify the answer.

   (d) Describe the principal geometrical parameters used in Ramsay's classification of folds. 1+1+3

8. (a) A rock layer is buckled to produce folds. Describe the characteristic features of these folds.

   (b) A layer is folded by pure flexural deformation. Show the strain distributions in the folded layer.

   (c) Using sketches explain the following phenomena : cleavage fanning and cleavage refraction. 2+1+2

PART - II (25 marks)

Answer any ***five*** questions.

9. The following questions apply to the "ramp & flat" model in thrust belts :

   (a) Draw a cross section of a hanging wall (or fault-bend fold) anticline and its associated fault. Also label the ramps and flats. Show the amount of dip separation.

   (b) Assuming that Anderson's Law holds and that the coefficient of internal friction is 0.73, what angle would you expect the fault ramps to form at and why ? 3+2

10. What are the different modes of fractures (describe with Mohr circle) ? 2+2+1

11. The stress tensor at the Earth's surface, referred to a North-East-Down coordinate system, is given by the following matrix :

$$\sigma_{ij} = \begin{matrix} 100 & 30 & 25 \\ 50 & 70 & 20 \\ 30 & 20 & 40 \end{matrix}$$

   (a) What are the normal and shear stresses on a plane that is parallel to the surface of the Earth ?