Name: **Enrolment No:**	

UPES

End Semester Examination, Dec. 2023

Program: M.Sc. (PG) **Semester: III**
Course: Reservoir Geomechanics **Time: 03 hrs.**
Course Code: PEGS 8021 **Max. Marks: 100**
Nos. of page(s): 03
Instructions: All questions are compulsory
****Note: Graph Sheet is required for few Question**

SECTION A

S. No.		Marks	CO
Q 1	Enumerate the general steps for analysis of stresses around a wellbore.	**4**	**CO1**
Q 2	Describe faulting theory with suitable stress relations and neat sketch.	**4**	**CO1**
Q 3	Define the following: (a) Geomechanical Earth Model (GEM) (b) In-Situ Stress (c) 3-D Mohr's Circle (d) Model validation	**4**	**CO1**
Q 4	(a) If the Poisson's ratio is given as 0.3 and the Young's modulus is given to 7 X 10^{10}. What will be the value for shear modulus? (b) The state of stress at a point under plane stress condition is σx = 40 MPa, σy = 100 MPa and τxy = 40 MPa. Determine the radius of the Mohr's circle representing the given state of stress in MPa	**2+2**	**CO3**
Q 5	Describe the correlation between linear stress and strain components in cartesian and in-situ coordinate system with suitable formulation.	**4**	**CO1**

SECTION B

Q 6	Compute the (axial) strain expected for a rock subjected to 3,000 psi of (axial) stress under unconfined axial loading for: • A soft mudrock with E = 1 GPa • A soft sandstone with E = 10 GPa • A hard limestone with E = 50 GPa OR Write detailed notes on the following with suitable examples (a) 3-D Geomechanical Earth Model (b) 4-D Geomechanical Earth Model	**10**	**CO3**
Q 7	Discuss pore pressure prediction method with associated formulations	**10**	**CO2**

Q 8	A rectangular block of material is subjected to a tensile stress of 110 N/mm^2 on one plane and a tensile stress of 47 N/mm^2 on the plane at right angles to the former. Each of the above stresses is accompanied by a shear stress of 63 N/mm^2 and that associated with the former tensile stress tends to rotate the block anticlockwise. Find: (i) The direction and magnitude of each of the principal stress and (ii) Magnitude of the greatest shear stress	**10**	**CO2**
Q 9	Describe the conditions for tensile failure during hydraulic fracturing.	**10**	**CO2**
	SECTION-C		
Q 10	Given that for a general orthotropic elastic material there are 12 unique coefficients such that: $$[D] = \begin{bmatrix} \frac{1}{E_{11}} & -\frac{\nu_{12}}{E_{11}} & -\frac{\nu_{13}}{E_{11}} & 0 & 0 & 0 \\ -\frac{\nu_{21}}{E_{22}} & \frac{1}{E_{22}} & -\frac{\nu_{23}}{E_{22}} & 0 & 0 & 0 \\ -\frac{\nu_{31}}{E_{33}} & -\frac{\nu_{32}}{E_{33}} & \frac{1}{E_{33}} & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{\mu_{23}} & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{\mu_{31}} & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{\mu_{12}} \end{bmatrix}$$ The constitutive equation for this form would then be: $$\{\varepsilon\} = [D]\{\sigma\}$$ where the stress has the following values $$\{\sigma\} = \begin{Bmatrix} \sigma_{xx} = 5 \text{ ksi} \\ \sigma_{yy} = 10 \text{ ksi} \\ \sigma_{zz} = 20 \text{ ksi} \\ \sigma_{yz} = 0 \text{ ksi} \\ \sigma_{zx} = 0 \text{ ksi} \\ \sigma_{xy} = 7.5 \text{ ksi} \end{Bmatrix}; \quad \{\varepsilon\} = \begin{Bmatrix} \varepsilon_{xx} \\ \varepsilon_{yy} \\ \varepsilon_{zz} \\ \varepsilon_{yz} \\ \varepsilon_{zx} \\ \varepsilon_{xy} \end{Bmatrix}$$ Suppose that the 12 material coefficients have the following values: $E_{11} = 10^6$ psi $\quad \mu_{23} = 10^4$ psi $E_{22} = 3 \times 10^7$ psi $\quad \mu_{31} = 2 \times 10^4$ psi $E_{33} = 0.2 \times 10^6$ psi $\quad \mu_{12} = 3 \times 10^4$ psi	**20**	**CO4**

	$\nu_{12} = 0.2$ $\nu_{13} = 0.25$ $\nu_{21} = 0.33$ $\nu_{23} = 0.43$ $\nu_{31} = 0.05$ $\nu_{32} = 0.06$ Calculate the infinitesimal strain tensor.		
	(a) Derive the formula using Mohr's Coulomb criteria to determine the following: (i) Relation between compressive and tensile stress (ii) Correlation between major and minor principal stress OR The following data is given for a vertical well drilled. $\sigma v = 10$ MPa $\sigma H = \sigma h = 9$ MPa $P0 = 5$ MPa $\mu = 0.3$ Determine the following (a) Fracture pressure for non-deviated well (b) Fracture pressure at the deviation $\Upsilon = 40^o$ and $\phi = 165^o$	**20**	**CO3**