Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, Dec. 2022

Course: Geomechanics **Semester: III**
Program: M.Sc. (PG) **Time: 03 hrs.**
Course Code: PEGS 8007 **Max. Marks: 100**

Instructions: All questions are compulsory

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	(A) Rock with higher Poisson's ratio will have (i.) Higher horizontal stress (ii.) Lower horizontal stress (iii.) Moderate horizontal stress (iv.) No horizontal stress (B) The data source for the vertical stress in GEM is (i.) Repeat Formation Tester (ii.) Drill Stem Test (iii.) Integrated Density (iv.) Leak-off Test (C) As per the Anderson scheme of classification, an area as being characterized by normal fault depending on the condition (i.) Sv>SHmax>SHmin (ii.) Sv=SHmax>SHmin (iii.) Sv<SHmax>SHmin (iv.) SHmax>Sv>SHmin (D) The data sourse for the pore pressure in GEM is (i.) Repeat Formation Tester (ii.) Drill Stem Test (iii.) Pressure while drilling (iv.) All	**4**	**CO1**
Q 2	(A) The elasticity of the material is defined as (i.) An ability to resist and recover from deformations produced by forces (ii.) The ability to flow of material (iii.) The ability to deform permanently (iv.) The ability to break easily (B) The data sources for the least principal stress in GEM is (i.) Leak-off Test (ii.) Extended leak-off Test	**4**	**CO1**

	(iii.) Minifrac (iv.) All (C) Formation bulk density at any given depth is the combination of which of the following (i.) Rock grain density (ii.) Pore fluid density (iii.) Porosity of rock formation (iv.) All (D) Which of the following is/are the direct approach to measure in-situ stresses, as suggested by Hudson and Harrison (i.) Hydraulic fracture test (ii.) The flatjack test (iii.) The overcoring gauge test (iv.) All		
Q 3	(A) Which of the following is/are the indirect approach to measure in-situ stresses (i.) Acoustic emission (ii.) Fault plane solutions (iii.) Both (iv.) None (B) which of the following is true for the Effective Stress (i.) The pressure below which a critical stress level is reached, due to high shear stress causing the rock formation to collapse into the borehole (ii.) The average normal stress transmitted directly from particle to particle of a porous material (iii.) The maximum engineering stress, in compression, expressing the capacity of a material to withstand axially directed pushing forces without fracture (iv.) The elements of the stress tensor that cause distortion in the volume (C) Which of the following will take place due to the decrease in mud level in the wellbore annulus (i.) The flow of formation fluid into the wellbore (ii.) Underground cross-flow/blowout (iii.) Wellbore instability (iv.) All (D) After the borehole is fractured the hole strength consists of the following (i.) Stress bridge (ii.) Least in-situ stress (iii.) Both (iv.) None	**4**	**CO1**
Q 4	A) The drill stem test (DST) is mainly used for measurement of (i.) Formation pore pressure (ii.) Pressure (iii.) Permeability	**4**	**CO2**

	(iv.) All (B) The critical breakout width/angle is very much dependent on (i.) Rock formation properties (ii.) Complexity in the location (iii.) Orientation, operation and condition of the wellbore (iv.) All (C) Which of the following is the most effective technique for obtaining the magnitude of the minimum horizontal in-situ stress in a wellbore (i.) Core discing (ii.) Differential strain analysis (iii.) Hydraulic fracture testing (iv.) All (D) Maximum shear stress in Mohr's circle is determined by (i.) Radius of the circle (ii.) Center of the circle (iii.) Sum of center and radius of the circle (iv.) Difference of center and radius of the circle		
Q 5	(A) "A short post, constructed from a tube of concrete, supports a compressive load of 24.5 metric tonnes. The inner and outer diameters of the tube are 91 cm and 127 cm, respectively, and its length is 100 cm. The shortening of the post is measured as 0.056 cm. The effect of post's weight is neglected. It is also assumed that the post does not buckle under the load. The axial compressive stress in the post is (i.) 2.36 MPa (ii.) 3.46 MPa (iii.) 5.36 MPa (iv.) 4.46 MPa (B) Assuming the data given in the question number 5A the strain developed in the post is (i.) 0.0056 (ii.) 0.056 (iii.) 0.00056 (iv.) 0.56	**4**	**CO2**
SECTION B (4Qx10M= 40 Marks)			
Q 6	Explain the following: (a) Lost circulation scenarios in detail (b) 2-D Mohr's Circle with associated formula and suitable diagram OR Write detailed notes on the following model calibration technique with suitable examples? (ii) Optimizing Model (iii) Expert Knowledge	**10**	**CO1**
Q 7	Discuss the following pore pressure prediction method (i) Miller's equation	**10**	**CO2**

<table>
<tr><td></td><td>(ii) Eaton's equation</td><td></td><td></td></tr>
<tr><td>Q 8</td><td>Derive the formula to determine principal stresses and its orientation in two dimensions.</td><td>10</td><td>CO3</td></tr>
<tr><td>Q 9</td><td>It has been determined that a point in a load-carrying member is subjected to the following stress condition:
σx = 400 MPa σy = -300 MPa τxy = 200 MPa (CW)
Perform the following:
(a) Find maximum and minimum principal stress and maximum shear stress
(b) Draw the complete Mohr's circle, labeling critical points</td><td>10</td><td>CO4</td></tr>
<tr><td colspan="4">SECTION-C
(2Qx20M=40 Marks)</td></tr>
<tr><td>Q 10</td><td>For an oil field, a vertical well is drilled to a maximum depth of 10,000 ft, the average specific gravity and pore pressure gradient are given as 2.3 and 0.38 psi/ft, respectively. Assume the Biot's constant and Poisson's ratio as 1 and 0.28, respectively. Calculate the following for the above data for the surrounding rock formation at the bottom of the vertical well.
(a) Overburden Stress
(b) Horizontal In-Situ Stress
(c) Normal Stress
(d) Shear Stress</td><td>20</td><td>CO3</td></tr>
<tr><td>Q 11</td><td>A core sample of 54 mm diameter and L/D ration 2.0 was obtained from the field for the determination of geomechanical properties as per the standard procedure. There was no confinement during the testing. The results of the testing are tabulated below. Draw stress-strain graph and determine the compressive strength, Elastic modulus and Poisson's ratio of the sample.
<table>
<tr><th>Load(kN)</th><th>Axial Displacement (mm)</th><th>Lateral displacement (mm)</th></tr>
<tr><td>227.1</td><td>0.26</td><td>0.014</td></tr>
<tr><td>293.5</td><td>0.3</td><td>0.053</td></tr>
<tr><td>376.7</td><td>0.34</td><td>0.014</td></tr>
<tr><td>391.4</td><td>0.35</td><td>0.029</td></tr>
<tr><td>415.5</td><td>0.38</td><td>0.048</td></tr>
<tr><td>414</td><td>0.42</td><td>0.054</td></tr>
</table>
OR
(a) The matrix below defines a given stress state. Determine the principal stresses.
$$[\sigma] = \begin{bmatrix} 16 & 3 & 3 \\ 3 & 12 & 6 \\ 3 & 6 & 12 \end{bmatrix}$$
(b) The following data is given for a vertical well drilled.</td><td>20</td><td>CO4</td></tr>
</table>

	$\sigma v = 10$ MPa $\sigma H = \sigma h = 9$ MPa P0 = 5 MPa $\mu = 0.3$ Compute the following (a) Fracture pressure for non-deviated well (b) Fracture pressure at the deviation $\Upsilon = 40^{o}$ and $\phi = 165^{o}$		